Incidence of Kidney Replacement Therapy and Subsequent Outcomes Among Patients With Systemic Lupus Erythematosus: Findings From the ERA Registry

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Rationale & Objective: There is a dearth of data characterizing patients receiving kidney replacement therapy (KRT) for kidney failure due to systemic lupus erythematosus (SLE) and their clinical outcomes. The aim of this study was to describe trends in incidence and prevalence of KRT among these patients as well as to compare their outcomes versus those of patients treated with KRT for diseases other than SLE.

Study Design: Retrospective cohort study based on kidney registry data.

Setting & Participants: Patients recorded in 14 registries of patients receiving KRT that provided data to the European Renal Association Registry between 1992 and 2016.

Predictor: SLE as cause of kidney failure.

Outcomes: Incidence and prevalence of KRT, patient survival while receiving KRT, patient and graft survival after kidney transplant, and specific causes of death.

Analytical Approach: Kaplan-Meier methods and Cox regression models were fit to compare patient survival between the SLE and non-SLE groups, overall KRT, dialysis, and patient and graft survival after kidney transplant.

Results: In total, 1,826 patients commenced KRT for kidney failure due to SLE, representing an incidence of 0.80 per million population (pmp) per year. The incidence remained stable during the study period (annual percent change, 0.1% [95% CI, −0.6% to 0.8%]). Patient survival among patients with SLE receiving KRT was similar to survival in the comparator group (hazard ratio [HR], 1.11 [95% CI, 0.99-1.23]). After kidney transplant, the risk of death was greater among patients with SLE than among patients in the comparator group (HR, 1.25 [95% CI, 1.02-1.53]), whereas the risk of all-cause graft failure was similar (HR, 1.09 [95% CI, 0.95-1.27]). Ten-year patient overall survival during KRT and patient and graft survival after kidney transplant improved over the study period (HRs of 0.71 [95% CI, 0.56-0.91], 0.43 [95% CI, 0.27-0.69], and 0.60 [95% CI, 0.43-0.84], respectively). Patients with SLE receiving KRT were significantly more likely to die of infections (24.8%) than patients in the comparator group (16.9%; $P < 0.001$).

Limitations: No data were available on extrarenal manifestations of SLE, drug treatments, comorbidities, kidney transplant characteristics, or relapses of SLE.

Conclusions: The prognosis of patients with SLE receiving KRT has improved over time. Survival of patients with SLE who required KRT was similar compared with patients who required KRT for other causes of kidney failure. Survival following kidney transplants was worse among patients with SLE.

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Systemic lupus erythematosus (SLE) is an autoimmune disease involving different organ systems. It is typically a disease of young women in reproductive age, with a women-to-men ratio averaging approximately 9:1.[1] Lupus nephritis (LN) is one of the most frequent and important types of organ involvement in SLE and has a negative impact on patient outcome, partly because of the morbidity and mortality associated with chronic kidney disease.[2] The risk of developing LN varies significantly between regions and ethnicities, ranging from 10% to 70% of the SLE population.[3-7] Kidney failure has been reported in 10%-30% of patients with LN.[7,8] Approximately 1% of patients undergoing kidney replacement therapy (KRT) in the United States[9] do so because of LN.

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In recent decades, registry-based data on the outcomes of patients with SLE receiving KRT have been presented by the US Renal Data System (USRDS),[9-16] the Taiwanese National Registry (NHIRD),[17,18] the French Registry of Renal Epidemiology and Information Network (REIN),[19] and the Australia and New Zealand Dialysis and Transplant Registry (ANZDATA).[20] These studies have shown mixed results for patient survival during dialysis and patient and allograft survival after kidney transplant. To our knowledge, even though patients with SLE differ substantially from patients undergoing KRT for kidney failure due to other causes, only a few of these studies used advanced analytical methods to compare patients with versus without SLE receiving KRT. Furthermore, to our knowledge, no registry-based study has examined time trends in the incidence and mortality of patients with SLE receiving KRT outside the United States.

PLAIN-LANGUAGE SUMMARY

There is a dearth of information about the incidence and prognosis among patients with systemic lupus erythematosus (SLE) requiring kidney replacement therapy (KRT). We performed a study using data from the European Renal Association Registry focusing on the period between 1992 and 2016 in which we compared patients with SLE in whom a need for KRT developed versus patients who required KRT as a result of another cause of kidney disease. The overall survival of patients with SLE receiving KRT was not identified to differ from the survival in the comparator group despite higher infection-related mortality rates, lower kidney transplant rates, and higher patient mortality rates after kidney transplant in the setting of SLE. Graft survival was also not different between groups. The incidence of patients with SLE receiving KRT in the European population studied remained stable over time.

Using data from the European Renal Association (ERA) Registry, we aimed to compare patient characteristics, overall survival during KRT, survival after kidney transplant, and causes of death for patients with SLE starting KRT versus an age-, sex-, and time period–matched comparator group of patients without SLE. In addition, we aimed to explore the trends in incidence and prevalence of KRT for kidney failure due to SLE and in survival of patients with SLE during a recent 25-year period.

Methods

Data Collection

The ERA Registry collects data annually from national and regional kidney registries in Europe on patients who initiate KRT. The details of data collection and data processing methods are described elsewhere.[21] For this study, data from kidney registries providing individual patient data to the ERA Registry for patients receiving KRT between 1992 and 2016 were used, including data from Andalusia (Spain), Austria, Basque country (Spain), Belgium (French-speaking), Catalonia (Spain), Denmark, Finland, Greece, Iceland, The Netherlands, Norway, Scotland (United Kingdom), Sweden, and the Valencian region (Spain). Together, the Spanish regions covered 49.2% of the general population of Spain. Data on children were not available for French-speaking Belgium. All participating national and regional renal registries provided full coverage of the population within their corresponding region, accounting for 85 million Europeans in 1992 and 96 million in 2016. The national and regional registries complied with national legislation with regard to ethics committee approval and with European and national data protection regulations. Informed consent was not obtained separately for the present study because data collection was part of the routine work of the participating registries for which, according to each country's rules and regulations, informed consent was or was not required. Cause of death was defined and categorized according to the ERA–European Dialysis and Transplant Association (EDTA) coding system.[21]

Patients With SLE and Matched Comparison Group

The analyses included data on patients receiving KRT (dialysis and kidney transplant) for kidney failure due to SLE (ERA-EDTA primary renal disease code 84[21]; Fig S1). These patients will hereafter be referred to as SLE patients, and all other patients will be designated non-SLE patients. The median age at the onset of KRT differed substantially between SLE patients (42.9 years) and non-SLE patients (66.4 years). Therefore, we matched the entire cohort of SLE patients who started KRT between 1992 and 2016 to non-SLE patients starting KRT within the same period by age at KRT initiation (per 5 years) and by sex and year of KRT initiation (per 5 years) at a ratio of 1 to 5. In addition, we separately matched SLE patients who received a kidney transplant between 1992 and 2016 to non-SLE transplant recipients by age at the time of kidney transplant (per 5 years) and by sex and year of transplantation (per 5 years) at a ratio of 1 to 5. The same strategy was applied separately for recipients of living- and deceased-donor kidneys. SLE patients who started KRT between 1992 and 2016 and received a kidney transplant in the same period were included in the KRT cohort and the kidney transplant cohort, but the comparator group was assembled separately because of differences in matching variables for the KRT cohort (eg, age at KRT onset) and the kidney transplant cohort (eg, age at kidney transplant).

Statistical Analysis

The incidence of KRT per million population (pmp) was studied per country/region over the entire study period. For the time trend analysis, the incidence rate was studied by year of KRT onset, and prevalence was assessed on December 31 of each year for all participating European countries/regions combined. To enable comparisons over time and between countries, the adjusted incidence and prevalence were calculated using the age and sex distribution of the European Union population in 2005. Time trends were examined using Joinpoint regression, with the observed rate as the outcome and the year as the explanatory variable. The average annual percent change was computed using Poisson regression as provided by the Joinpoint regression program (National Cancer Institute; version 4.6.0).[22] To compare the characteristics of the SLE patients versus the comparator group, the Mann-Whitney

test was used for continuous variables and the χ^2 test for categorical variables. A two-tailed P value of less than 0.05 was considered statistically significant.

The survival analyses were performed using the Kaplan-Meier method and Cox regression analysis and were performed unadjusted and adjusted for age, sex, time period, and country. To allow all patients to complete the follow-up period of 10 years for all survival analyses, a subset of the initial 1992-2016 cohort was used that included patients only until 2006 (Fig S1). For patient survival during KRT, individuals who initiated treatment between 1992 and 2006 were included. The first day of KRT was defined as the starting point, and patient death was the event studied. Follow-up time included treatment changes from dialysis to kidney transplant and vice versa and was censored at recovery of kidney function (defined as interruption of dialysis, excluding kidney transplant, for more than 30 days), loss to follow-up, the end of the follow-up period on December 31, 2016, or 10 years of follow-up, whichever occurred first. Patient survival during KRT was compared between SLE patients and the comparator group, between men and women with SLE, and among the periods of 1992-1996, 1997-2001, and 2002-2006. Furthermore, we examined the impact of time spent undergoing dialysis versus with a functioning kidney transplant during follow-up on the risk of death in a sensitivity analysis in which treatment modality for kidney failure was incorporated as a time-dependent covariate in a Cox regression model that compared patients with SLE versus the comparator group.

For patient survival during dialysis (hemodialysis or peritoneal dialysis), individuals who initiated dialysis between 1992 and 2006 were included. The starting point was defined as the first day undergoing dialysis, and the event studied was patient death. Follow-up time was censored at recovery of kidney function, loss to follow-up, the day of kidney transplant (unless a patient restarted dialysis within 7 days after transplant), the end of the follow-up period on December 31, 2016, or at 10 years of follow-up, whichever occurred first. Patient survival during dialysis was compared between SLE patients and the comparator group, between patients undergoing hemodialysis and peritoneal dialysis at day 90, and among the periods of 1992-1996, 1997-2001, and 2002-2006.

Patient and graft survival after kidney transplant was investigated for patients who received their first kidney transplant between 1992 and 2006. The date of the first kidney transplant was defined as the first day of follow-up. For patient survival after kidney transplant, the event studied was death, and, for graft survival, the event was all-cause graft failure (defined as return to dialysis, repeat transplant, or death). Patient and graft survival after kidney transplant were compared between SLE patients and the comparator group, between recipients of living- and deceased-donor kidneys, and among the periods of 1992-1996, 1997-2001, and 2002-2006. Hazard ratios (HRs) for patient and graft survival after kidney transplant were additionally adjusted for dialysis vintage.

Competing risk analyses were carried out to calculate the cumulative incidence of kidney transplant from the onset of KRT in SLE patients and the comparator group, taking into account the competing risk due to death. To examine the trend in the probability of transplant over time, this analysis was done separately for patients starting KRT in the periods of 1992-1996, 1997-2001, and 2002-2006. All analyses were performed using SAS software, version 9.4.

Results

Incidence and Prevalence

Among 280,892 patients who started KRT between 1992 and 2016, 1,826 commenced this treatment as a result of SLE-related kidney failure (0.65%, ranging from 0.46% to 1.00% in kidney registries across Europe; Table 1). The age- and sex-standardized incidence of KRT for kidney failure due to SLE ranged from 0.46 pmp in Finland to 1.24 pmp in the Valencian region of Spain. Figure 1 shows that the age-standardized incidence of KRT due to SLE was stable between 1992 and 2016 overall (annual percent change, 0.1% [95% CI, −0.6% to 0.8%]) and in men and women. The prevalence of KRT for kidney failure due to SLE increased from 5.5 pmp in 1992 to 12.1 pmp in 2016 (annual percent change, 3.0% [95% CI, 2.7%-3.3%]).

Characteristics of SLE Patients and Non-SLE Comparator Group

The 1,826 SLE patients starting KRT between 1992 and 2016 were matched to 9,130 patients without SLE by age (median, 42.9 years), sex (79% were female), and year of KRT initiation (Table 2). SLE patients more frequently started KRT with hemodialysis (73.8%) than matched non-SLE patients (70.4%; $P = 0.003$), but, after 90 days, this difference became nonsignificant. By contrast, SLE patients underwent preemptive kidney transplant less often (5.0%) than matched non-SLE patients (7.8%; $P < 0.001$), and, during the first 10 years of follow-up after KRT initiation, fewer SLE patients (46.9%) received a first kidney transplant compared with matched non-SLE patients (51.9%; $P < 0.001$).

In addition, 999 patients with SLE who received a first kidney transplant (SLE transplant recipients) between 1992 and 2016 were matched with 4,995 patients without SLE who received a first transplant (non-SLE transplant recipients; Table 2). In the SLE transplant recipients, the median age at the time of kidney transplant was 39.1 (interquartile range, 31.3-48.9) years, and 82.2% were women. SLE transplant recipients spent more time undergoing dialysis before transplant (median, 2.0 [interquartile range, 0.9-3.9] years) than matched non-SLE transplant recipients (1.5 [interquartile range, 0.5-3.0] years; $P < 0.001$).

Table 1. Incidence of KRT for Kidney Failure Due to SLE by Country/Region in 1992-2016

Country/Region	Total KRT Patients	KRT Patients With SLE				
		Total Group			Male Patients[a]	Female Patients
		N	Crude Incidence pmp	Adj Incidence pmp[a]	Adj Incidence pmp[a]	Adj Incidence pmp[a]
Andalusia (Spain)	21,662	216 (1.00%)	1.12	1.14	0.40	1.84
Austria	27,644	166 (0.60%)	0.81	0.81	0.32	1.27
Basque country (Spain)	5,779	50 (0.87%)	0.95	0.93	0.46	1.38
Catalonia (Spain)	24,135	127 (0.53%)	0.74	0.74	0.36	1.10
Denmark	16,265	109 (0.67%)	0.80	0.83	0.28	1.36
Finland	11,342	59 (0.52%)	0.45	0.46	0.19	0.72
French-speaking Belgium	17,990	86 (0.48%)	0.77	0.79	0.49	1.08
Greece	45,724	209 (0.46%)	0.77	0.76	0.34	1.16
Iceland	514	4 (0.78%)	0.54	0.53	0	1.04
Norway	11,214	106 (0.95%)	0.91	0.95	0.52	1.37
Scotland (UK)	12,839	77 (0.60%)	0.60	0.61	0.20	0.99
Sweden	27,613	198 (0.72%)	0.87	0.91	0.34	1.45
The Netherlands	41,787	278 (0.67%)	0.69	0.70	0.35	1.03
Valencian region (Spain)	16,384	141 (0.86%)	1.25	1.24	0.35	2.09
All countries	280,892	1,826 (0.65%)	0.80	0.82	0.35	1.26

Abbreviations: Adj, adjusted; KRT, kidney replacement therapy; pmp, per million population; SLE, systemic lupus erythematosus.
[a]Adjusted for age and sex distribution using the European Standard Population of 2005 as reference population.

Patient Survival After KRT Initiation

Within 90 days after commencing KRT, a larger proportion of SLE patients than matched non-SLE patients died (3.1% vs 2.2%; P = 0.03; Table 2). The unadjusted patient survival during KRT in SLE patients and in the comparator group is shown in Fig 2A and Table 3. SLE patients showed lower survival probabilities during the first 10 years after KRT initiation than did the comparator group without SLE, and this was also the case for patient and graft survival after a first kidney transplant. There was a nominally greater overall adjusted risk of death during KRT in SLE patients versus matched non-SLE patients, but this was not statistically significant (adjusted HR, 1.11 [95% CI, 0.99-1.23]; P = 0.06). In sensitivity analyses additionally adjusting for treatment modality as a time-dependent covariate, the HR was 1.04 (95% CI, 0.93-1.16). Within the group of SLE patients, survival during KRT tended to be worse in men, with an adjusted HR for women of 0.81 (95% CI, 0.64-1.02; P = 0.07; Table S1). As shown in Table S2, patient survival was better for SLE patients and comparator-group patients who started KRT in 2002-2006 than for those who initiated treatment in 1992-1996.

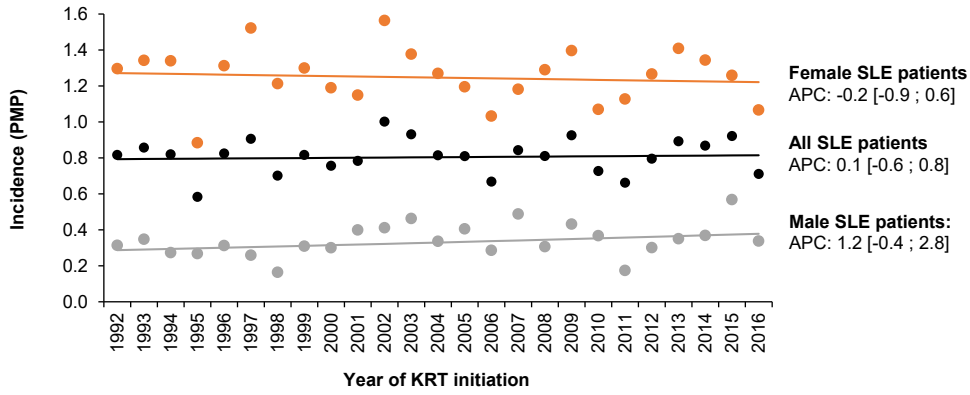

Figure 1. Trends in the incidence of kidney replacement therapy (KRT) for kidney failure caused by systemic lupus erythematosus (SLE) per million population (pmp). The incidence rates (presented as dots) were adjusted for age and sex using the European Standard Population of 2005 as a reference. The solid line shows the estimated rates as modeled by Joinpoint. Abbreviation: APC, annual percent change.

Table 2. Characteristics of Patients with and Without SLE, Including Matched Comparator Group, Initiating KRT by Dialysis or Transplant or Receiving a First Kidney Transplant in 1992-2016

Characteristic	SLE	No SLE		P[b]
		Total	Matched Comparators[a]	
Kidney replacement therapy cohort				
No. of patients	1,826	279,066	9,130	
Age at KRT onset, y	42.9 [32.0-55.9]	66.4 [53.9-75.1]	42.9 [31.9-55.9]	NA
Age category at KRT onset				NA
0-19 y	72 (3.9%)	4,235 (1.5%)	360 (3.9%)	
20-64 y	1,533 (84.0%)	125,326 (44.9%)	7,665 (84.0%)	
≥65 y	221 (12.1%)	149,505 (53.6%)	1,105 (12.1%)	
Female sex	1,442 (79.0%)	103,633 (37.1%)	7,210 (79.0%)	NA
Primary kidney disease				NA
Glomerulonephritis/sclerosis	0	35,831 (12.8%)	1,779 (19.5%)	
Pyelonephritis	0	18,391 (6.6%)	928 (10.2%)	
Polycystic kidney disease, adult type	0	16,779 (6.0%)	772 (8.5%)	
Diabetes mellitus	0	63,191 (22.6%)	1,830 (20.0%)	
Hypertension/RVD	0	45,697 (16.4%)	794 (8.7%)	
Lupus nephritis	1,826 (100%)	0	0	
Miscellaneous	0	45,831 (16.4%)	1,639 (18.0%)	
Unknown/missing	0	53,346 (19.1%)	1,388 (15.2%)	
Treatment modality at day 1				
Hemodialysis	1,348 (73.8%)	224,377 (80.4%)	6,425 (70.4%)	0.003
Peritoneal dialysis	386 (21.1%)	45,526 (16.3%)	1,994 (21.8%)	0.5
Kidney transplant	92 (5.0%)	9,109 (3.3%)	710 (7.8%)	<0.001
Unknown	0	54 (0.0%)	1 (0.0%)	NA
Recovered kidney function ≤90 d after initiating KRT	46 (2.5%)	4,167 (1.5%)	88 (1.0%)	<0.001
Death ≤90 d after initiating KRT	57 (3.1%)	15,982 (5.7%)	205 (2.2%)	0.03
Loss to follow-up ≤90 d after initiating KRT	7 (0.4%)	663 (0.2%)	27 (0.3%)	0.5
KRT discontinued ≤90 d after initiation	0	66 (0.0%)	4 (0.0%)	NA
Treatment modality at day 91 after initiating KRT				
Hemodialysis	1,175 (64.3%)	199,546 (71.5%)	5,780 (63.3%)	0.4
Peritoneal dialysis	422 (23.1%)	47,340 (17.0%)	2,138 (23.4%)	0.8
Kidney transplant	119 (6.5%)	11,148 (4.0%)	884 (9.7%)	<0.001
Unknown	0	154 (0.1%)	4 (0.0%)	NA
Kidney transplant				
Received first transplant ≤10 y after initiating KRT	857 (46.9%)	66,644 (23.9%)	4,742 (51.9%)	<0.001
Received second transplant ≤10 y after initiating KRT	49 (2.7%)	3,469 (1.2%)	333 (3.6%)	0.04
Kidney transplant cohort				
No. of patients	999	74,359	4,995	
Age at kidney transplant, y	39.1 [31.3-48.9]	50.9 [38.7-60.8]	39.2 [31.5-49.2]	NA
Age category at kidney transplant				NA
0-19 y	31 (3.1%)	3,641 (4.9%)	155 (3.1%)	
20-64 y	937 (93.8%)	59,466 (80.0%)	4,685 (93.8%)	
≥65 y	31 (3.1%)	11,252 (15.1%)	155 (3.1%)	
Women	821 (82.2%)	26,978 (36.3%)	4,105 (82.2%)	NA
Primary kidney disease				NA
Glomerulonephritis/sclerosis	0	18,257 (24.6%)	1,289 (25.8%)	
Pyelonephritis	0	6,428 (8.6%)	583 (11.7%)	
Polycystic kidney disease adult type	0	9,566 (12.9%)	555 (11.1%)	
Diabetes mellitus	0	9,761 (13.1%)	687 (13.8%)	
Hypertension/RVD	0	7,427 (10.0%)	315 (6.3%)	
Lupus nephritis	999 (100%)	0	0	
Miscellaneous	0	11,686 (15.7%)	834 (16.7%)	
Unknown/missing	0	11,234 (15.1%)	732 (14.7%)	

(Continued)

Table 2 (Cont'd). Characteristics of Patients with and Without SLE, Including Matched Comparator Group, Initiating KRT by Dialysis or Transplant or Receiving a First Kidney Transplant in 1992-2016

Characteristic	SLE	No SLE		*P*[b]
		Total	Matched Comparators[a]	
Preemptive kidney transplant	92 (9.2%)	9,151 (12.3%)	693 (13.9%)	<0.001
Dialysis vintage at kidney transplant, y	2.0 [0.9-3.9]	1.7 [0.7-3.2]	1.5 [0.5-3.0]	<0.001
Donor type				
Living donor	300 (30.0%)	17,738 (23.9%)	1,441 (28.8%)	0.5
Deceased donor	668 (66.9%)	55212 (74.3%)	3,463 (69.3%)	0.1
Unknown	31 (3.1%)	1,409 (1.9%)	91 (1.8%)	0.009

Unless otherwise indicated, values for categorical variables given as count or count (percentage) and those for continuous variables given as median [25th-75th percentile]. Abbreviations: KRT, kidney replacement therapy; NA, not applicable; RVD, renovascular disease.
[a]For patients with SLE starting KRT, the comparator group comprised a subgroup of patients without SLE starting KRT (matched by age group and sex). For patients with SLE receiving a first transplant, the comparator group comprised a subgroup of patients without SLE receiving a first transplant (matched by age group and sex).
[b]*P* values are based on comparison between patients with SLE and the matched non-SLE comparator group.

Patient and Graft Survival After Kidney Transplant and Access to Kidney Transplant

Patient and graft survival after a first kidney transplant in SLE patients and in the comparator group is shown in Fig 2B and C and in Table 3. SLE patients had lower patient and graft survival probabilities during the first 10 years after a first kidney transplant than the matched comparator group without SLE, but only the risk of death was statistically significantly higher for SLE patients (HR, 1.25 [95% CI, 1.02-1.53]; P = 0.03). This greater risk of death for SLE kidney transplant recipients was also observed after deceased-donor kidney transplants (Table S3), but there was no statistically significant difference after living-donor kidney transplants. The risk of all-cause graft failure was similar for SLE patients and matched non-SLE patients (HR, 1.09 [95% CI, 0.95-1.27]; P = 0.2; Table 3), and this was also the case for living- and deceased-donor kidney transplants (Table S3). Within the group of SLE patients, patient mortality after a first kidney transplant was similar for recipients of living- and deceased-donor grafts (HR for mortality, living- vs deceased-donor grafts, 0.64 [95% CI, 0.38-1.08]; P = 0.09), whereas the risk of all-cause graft failure was lower for recipients of living-donor grafts (HR for graft failure, living- vs deceased-donor grafts, 0.60 [95% CI, 0.41-0.88]; P = 0.009; Table S1). Patient and graft survival in patients who received their first kidney transplant improved over time in SLE patients and the non-SLE comparator group (Table S2). This finding was accompanied by an increase in the median age of SLE patients commencing KRT and undergoing transplants (from 37.6 and 30.7 years, respectively, in 1992-1996 to 43.6 and 35.1 years in the most recent period).

Figure S2 shows a longer median time to a first kidney transplant for SLE patients than in the non-SLE comparator group. However, because the median time to first kidney transplant in the non-SLE comparator group increased over time, the difference in access to kidney transplants between SLE patients and the comparator group became similar in the most recent period.

Causes of Death

As shown in Table 4, the percentage of deaths due to cardiovascular (CV) diseases among patients receiving KRT

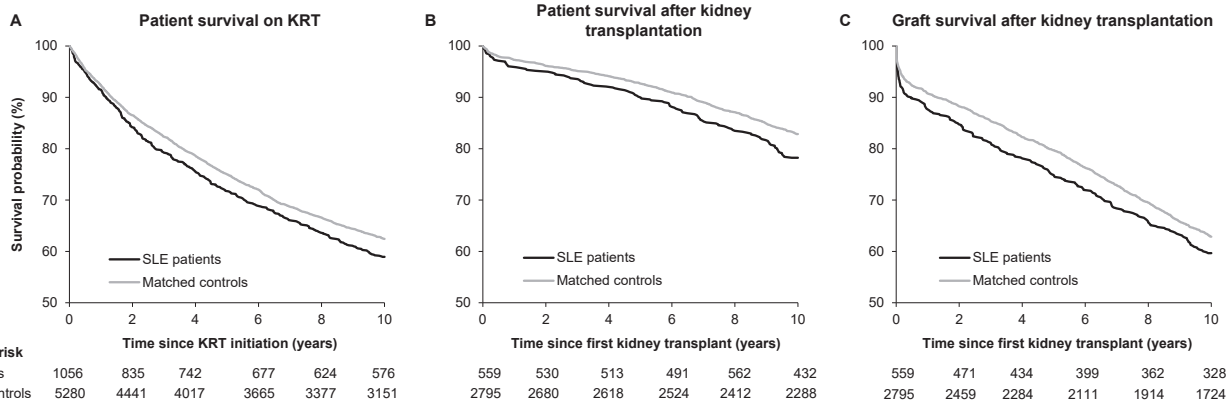

Figure 2. Kaplan-Meier survival analysis comparing (A) patient survival from day 1 after starting kidney replacement therapy (KRT) in 1992-2006 and (B) patient and (C) graft survival after first kidney transplant in 1992-2006 in patients with systemic lupus erythematosus (SLE) and the matched comparator group.

Table 3. Survival During KRT in 1992-2006 in Patients With SLE Versus Matched Comparator Group

	No. at Risk	No. of Events	Mean Follow-up, y	Event Rate	Crude Survival Probability (95% CI)				Hazard Ratio (95% CI)	
					1 y	2 y	5 y	10 y	Crude	Adjusted[a]
Patient survival on KRT										
SLE	1,056	408	6.9	0.39	91.5 (89.6-93.1)	84.2 (81.8-86.3)	71.8 (68.9-74.5)	58.9 (55.8-61.9)	1.13 (1.01-1.25)	1.11 (0.99-1.23)
Comparator group	5,280	1,925	7.4	0.36	92.3 (91.6-93.0)	86.5 (85.6-87.4)	75.0 (73.8-76.2)	62.4 (61.1-63.8)	1.00 (reference)	1.00 (reference)
Patient survival on dialysis										
SLE	944	318	3.5	0.34	91.6 (89.5-93.3)	83.4 (80.5-85.8)	63.4 (59.2-67.3)	33.8 (28.7-39.0)	0.97 (0.86-1.09)	1.00 (0.89-1.13)
Comparator group	4,683	1,461	3.2	0.31	91.5 (90.6-92.3)	84.1 (82.8-85.2)	62.4 (60.4-64.3)	33.1 (30.7-35.6)	1.00 (reference)	1.00 (reference)
Patient survival after kidney transplant										
SLE	559	122	8.9	0.22	96.1 (94.1-97.4)	95.2 (93.0-96.7)	90.1 (87.3-92.3)	78.2 (74.6-81.4)	1.32 (1.08-1.61)	1.25 (1.02-1.53)
Comparator group	2,795	476	9.1	0.17	97.3 (96.6-97.9)	96.1 (95.3-96.8)	92.7 (91.6-93.6)	82.9 (81.4-84.2)	1.00 (reference)	1.00 (reference)
Graft survival after kidney transplant										
SLE	559	225	7.5	0.40	87.8 (84.8-90.3)	84.8 (81.5-87.5)	74.9 (71.0-78.3)	59.7 (55.4-63.6)	1.14 (0.99-1.32)	1.09 (0.95-1.27)
Comparator group	2,795	1,030	7.8	0.37	90.8 (89.6-91.8)	88.2 (87.0-89.4)	79.7 (78.2-81.2)	62.9 (61.0-64.6)	1.00 (reference)	1.00 (reference)

Comparator group is matched for age, sex, and time period. Abbreviations: KRT, kidney replacement therapy; SLE, systemic lupus erythematosus.
[a]Adjusted for age, sex, time period, dialysis vintage (for patient and graft survival after kidney transplant only), and country.

was similar between the SLE and comparator groups (31.1% vs 34.3%; P = 0.2). However, the percentage of deaths due to infection was significantly higher in SLE patients (24.8% vs 16.9%; P < 0.001). On the contrary, a higher percentage of patients in the non-SLE comparator group died of malignancy (8.7% vs 5.4%; P = 0.03). There was no statistically significant difference in causes of death between the SLE group and the comparator group after kidney transplant.

Discussion

In this study of a European cohort with SLE, we found a stable incidence of KRT for kidney failure. The results suggest similar survival of SLE patients receiving KRT when compared with an age- and sex-matched group of patients receiving KRT for other causes of kidney failure. Patient survival after a first kidney transplant appeared to be worse in SLE patients, although graft survival was similar. CV disease was the most common cause of death in both groups. A greater probability of death due to infection was observed in the SLE patients. Finally, we found significant improvement in patient survival during KRT over the studied period.

Our results show that, even though the incidence of KRT for kidney failure due to SLE varied between countries (from 0.46 to 1.24 pmp), it has remained stable over the studied period of 25 years. This finding corresponds with the most recently reported data from the USRDS by Ward[23] and Sexton et al[12] showing a stable or decreasing incidence of KRT among patients with SLE. However, it remains unclear whether the risk of kidney failure in patients with SLE and LN has changed over time. Lack of national data on the annual incidence and prevalence of LN precludes the opportunity to define the number of SLE patients at risk of kidney failure. Data from the first decade of the 21st century in a cohort from the United Kingdom[24] suggested a gradual decrease in SLE incidence, which might result in a decreased incidence of LN and eventually also of SLE-related kidney failure, but this still needs to be determined. Nevertheless, a potential benefit of new therapies for LN introduced at the turn of century, such as mycophenolate mofetil and rituximab, could not be demonstrated because the coverage of this era by the study period was too short. However, over time, we observed a 6-year increase in the median age of SLE patients at the time of KRT initiation, implying that some improvement in the outcome of the disease has been achieved even though it is not yet reflected in the incidence of patients with LN-related kidney failure.

Our data show that the survival of SLE patients undergoing KRT is similar compared with patients with kidney failure due to other causes. Comparable mortality of SLE and non-SLE patients receiving KRT has also been reported by Sexton et al[12] even though their US-based cohort differed demographically. The median follow-up of patients in the present study was 4.4 years, which may not

Table 4. Causes of Death Distribution Among Patients with SLE and Matched Comparator Group Who Died Within 10 Years After Starting KRT or Receiving a First Kidney Transplant in 1992-2006

Outcome	SLE	Matched Comparator[a]	*P*
KRT cohort			
No. of patients	1,056	5,280	–
No. of deaths at ≤10 y	408	1,925	–
Cause of death			
Cardiovascular disease	127 (31.1%)	661 (34.3%)	0.2
Myocardial ischemia/infarction	35 (8.6%)	200 (10.4%)	0.3
Heart failure	23 (5.6%)	124 (6.4%)	0.5
Cardiac arrest; other cause/unknown	42 (10.3%)	205 (10.6%)	0.8
Cerebrovascular accident	27 (6.6%)	132 (6.9%)	0.9
Infection	101 (24.8%)	325 (16.9%)	<0.001
Suicide/refusal of treatment	10 (2.5%)	50 (2.6%)	0.9
Withdrawal of treatment	18 (4.4%)	70 (3.6%)	0.5
Cachexia	7 (1.7%)	48 (2.5%)	0.3
Malignancies	22 (5.4%)	167 (8.7%)	0.03
Miscellaneous	65 (15.9%)	294 (15.3%)	0.7
Unknown/unavailable/missing	58 (14.2%)	310 (16.1%)	0.3
Kidney transplant cohort			
No. of patients	559	2,795	–
No. of deaths at ≤10 y	121	476	–
Cause of death			
Cardiovascular disease	36 (29.8%)	150 (31.6%)	0.7
Myocardial ischemia/infarction	12 (9.9%)	36 (7.6%)	0.4
Heart failure	8 (6.6%)	31 (6.5%)	0.9
Cardiac arrest; other cause/unknown	10 (8.3%)	45 (9.5%)	0.7
Cerebrovascular accident	6 (5.0%)	38 (8.0%)	0.3
Infection	32 (26.4%)	94 (19.7%)	0.1
Suicide/refusal of treatment	2 (1.7%)	9 (1.9%)	0.9
Withdrawal of treatment	0	8 (1.7%)	0.2
Cachexia	0	4 (0.8%)	0.3
Malignancies	14 (11.6%)	49 (10.3%)	0.7
Miscellaneous	23 (19.0%)	83 (17.4%)	0.7
Unknown/unavailable/missing	14 (11.6%)	79 (16.6%)	0.2

Percentages may not add up to 100% because of rounding. Abbreviations: KRT, kidney replacement therapy; SLE, systemic lupus erythematosus.
[a]For patients with SLE starting KRT, the comparator comprised patients without SLE starting KRT matched by age group and sex. For patients with SLE receiving a first kidney transplant, the comparator group comprised patients without SLE receiving a first kidney transplant matched by age group and sex.

allow for the development of specific complications that are unique to patients with SLE. A variety of factors may contribute to adverse outcomes in SLE patients, such as history of aggressive immunosuppressive treatment and presence of antiphospholipid antibodies potentiating the risk of vascular access failure and thrombotic complications, including allograft thrombosis.[25,26] Delayed waitlisting for kidney transplant and prolonged time to transplant (as shown in our study), likely due to persistent disease activity or complications arising from the disease itself,[27] result in a lower overall rate of transplant, including preemptive kidney transplant.

Even though the survival of SLE patients after kidney transplant was inferior to the matched non-SLE comparator group in our study, there was no difference in graft survival, suggesting that SLE patients are more prone to fatal outcomes of complications, especially infections. A similar patient survival disadvantage after kidney transplant and a tendency of comparable graft survival was noted in 2 other registry studies.[16,20] Recurrence of LN does not appear to have significant clinical relevance.[28] To date, only a few registry studies have analyzed the prognosis of patients with SLE after kidney transplant. Marked improvement in patient outcomes has recently been demonstrated by Jorge et al.[10] The investigators compared outcomes of SLE patients on dialysis who were waitlisted for kidney transplant and those who eventually received a transplant. Patients who received a kidney transplant had a 70% reduction in all-cause mortality compared with patients who continued to receive hemodialysis (adjusted HR, 0.30 [95% CI, 0.27–0.33]).

Although SLE has been shown to be among important nontraditional risk factors of CV disease, we found no difference in CV mortality in patients with SLE receiving KRT compared with matched non-SLE patients. Comparable CV morbidity measured by hospitalization rate in

SLE patients receiving KRT was observed by Ward,[29] suggesting that SLE might not increase the risk of CV complications beyond the CV risk of patients receiving KRT in general. This notion could in part be explained by "burned-out" SLE in patients receiving dialysis,[30,31] whereby SLE does not contribute to an inflammatory environment that could enhance the progression of atherosclerosis. Similar proportions of CV- and infection-related deaths were observed by Zhang et al,[20] demonstrating that SLE patients were more prone to die of infections than the comparator group, but less likely to die of CV complications. The higher risk of infectious diseases associated with immunosuppressive therapy might partly explain this increased mortality in SLE patients receiving KRT.

To our knowledge, this is the largest European study thus far on the outcomes of SLE patients receiving KRT, with almost 100% coverage in selected regions. An important strength of the study is matching of the SLE cohort to the comparator group to reduce possible confounding factors at the time of KRT initiation. Only a few registry studies have attempted to match comparator groups,[12,32] in some cases with certain shortcomings.[19] Other studies used adjustment methods to eliminate the effect of known confounding factors at the onset of KRT.

This study has certain limitations that are related to the registry-based nature of the data. The unavailability of information regarding the disease course, including duration before KRT, kidney biopsy results, severity of extrarenal involvement, and treatment choices, as well as the lack of data on comorbidities, vascular access, race, and socioeconomic status precludes the possibility of adjusting for these probable confounding factors. In addition, data were unavailable on transplant-related characteristics that are possible confounders, such as time on the waiting list, presence of panel-reactive antibodies, cold ischemia time, and immunosuppressive regimen.

In conclusion, data from the ERA Registry show a plateau in the incidence of KRT for kidney failure due to SLE in this large European cohort. Our findings also suggest that the prognosis of SLE patients receiving KRT has improved over recent decades. Finally, we show that SLE as an underlying cause of kidney failure has minimal effect on overall patient survival after starting KRT, although it does have an unfavorable effect on overall patient survival after kidney transplant. This may be caused by disease-specific complications but may also be due in part to complications arising from long-term immunosuppressive burden. Therapeutic advances resulting from better understanding of these complications have the potential to improve survival after kidney transplant in patients with SLE.

Supplementary Material

Supplementary File (PDF)

Figure S1: Flow diagram of patients selected for the analysis of the overall KRT and kidney transplant cohorts.

Figure S2: Competing risk analysis comparing the time to first kidney transplant with death as competing event between SLE and non-SLE comparator group patients starting KRT during 1992-1996, 1997-2001, and 2002-2006.

Table S1: Survival of patients with SLE after KRT initiation overall and dialysis initiation and patient and graft survival after a first kidney transplant in 1992-2006, analyzed for different subgroups

Table S2: Patient survival after KRT initiation overall or dialysis initiation and patient and graft survival after a first kidney transplant in patients with SLE and comparator patients without SLE compared for 3 time periods (1992-1996, 1997-2001, 2002-2006) according to year of KRT initiation or year of first transplant

Table S3: Patient and graft survival after a first kidney transplant from a living or deceased donor in 1992-2006 among SLE patients versus patients in the non-SLE comparator group.

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References

1. Feldman CH, Hiraki LT, Liu J, et al. Epidemiology and sociodemographics of systemic lupus erythematosus and lupus nephritis among US adults with Medicaid coverage, 2000-2004. *Arthritis Rheum*. 2013;65(3):753-763. doi:10.1002/art.37795
2. Coresh J, Astor B, Sarnak MJ. Evidence for increased cardiovascular disease risk in patients with chronic kidney disease. *Curr Opin Nephrol Hypertens*. 2004;13(1):73-81. doi:10.1097/00041552-200401000-00011
3. Cervera R, Khamashta MA, Font J, et al. Morbidity and mortality in systemic lupus erythematosus during a 10-year period: a comparison of early and late manifestations in a cohort of 1, 000 patients. *Medicine (Baltimore)*. 2003;82:299-308. doi:10.1097/01.md.0000091181.93122.55
4. Rovin BH, Stillman I. *Systemic Lupus Erythematosus*. 5th ed. Academic Press; 2011.
5. Ingvarsson RF, Bengtsson AA, Jönsen A. Variations in the epidemiology of systemic lupus erythematosus in southern Sweden. *Lupus*. 2016;25(7):772-780. doi:10.1177/0961203316635288
6. Bastian HM, Roseman JM, McGwin G Jr, et al. Systemic lupus erythematosus in three ethnic groups. XII. Risk factors for lupus nephritis after diagnosis. *Lupus*. 2002;11(3):152-160. doi:10.1191/0961203302lu158oa
7. Hanly JG, O'Keeffe AG, Su L, et al. The frequency and outcome of lupus nephritis: results from an international inception cohort study. *Rheumatology (Oxford)*. 2016;55(2):252-262. doi:10.1093/rheumatology/kev311
8. Tektonidou MG, Dasgupta A, Ward MM. Risk of end-stage renal disease in patients with lupus nephritis, 1971-2015: a systematic review and Bayesian meta-analysis. *Arthritis Rheumatol*. 2016;68(6):1432-1441. doi:10.1002/art.39594
9. Nee R, Martinez-Osorio J, Yuan CM, et al. Survival disparity of African American versus non-African American patients with ESRD due to SLE. *Am J Kidney Dis*. 2015;66(4):630-637. doi:10.1053/j.ajkd.2015.04.011
10. Jorge A, Wallace ZS, Lu N, Zhang Y, Choi HK. Renal transplantation and survival among patients with lupus nephritis: a cohort study. *Ann Intern Med*. 2019;170(4):240-247. doi:10.7326/M18-1570
11. Jorge A, Wallace ZS, Zhang Y, Lu N, Costenbader KH, Choi HK. All-cause and cause-specific mortality trends of end-stage renal disease due to lupus nephritis from 1995 to 2014. *Arthritis Rheumatol*. 2019;71(3):403-410. doi:10.1002/art.40729
12. Sexton DJ, Reule S, Solid C, Chen SC, Collins AJ, Foley RN. ESRD from lupus nephritis in the United States, 1995-2010. *Clin J Am Soc Nephrol*. 2015;10(2):251-259. doi:10.2215/CJN.02350314
13. Costenbader KH, Desai A, Alarcón GS, et al. Trends in the incidence, demographics, and outcomes of end-stage renal disease due to lupus nephritis in the US from 1995 to 2006. *Arthritis Rheum*. 2011;63(6):1681-1688. doi:10.1002/art.30293
14. Sule S, Fivush B, Neu A, Furth S. Increased risk of death in pediatric and adult patients with ESRD secondary to lupus. *Pediatr Nephrol*. 2011;26(1):93-98. doi:10.1007/s00467-010-1640-9
15. Sule S, Fivush B, Neu A, Furth S. Increased risk of death in African American patients with end-stage renal disease secondary to lupus. *Clin Kidney J*. 2014;7(1):40-44. doi:10.1093/ckj/sft157
16. Chelamcharla M, Javaid B, Baird BC, Goldfarb-Rumyantzev AS. The outcome of renal transplantation among systemic lupus erythematosus patients. *Nephrol Dial Transplant*. 2007;22(12):3623-3630. doi:10.1093/ndt/gfm459
17. Chang YS, Liu CJ, Wu TH, et al. Survival analysis in systemic lupus erythematosus patients on maintenance dialysis: a

nationwide population-based study in Taiwan. *Rheumatology (Oxford)*. 2013;52(1):166-172. doi:10.1093/rheumatology/kes325
18. Chen HA, Wang JJ, Chou CT, et al. Predictors of longterm mortality in patients with and without systemic lupus erythematosus on maintenance dialysis: a comparative study. *J Rheumatol*. 2011;38(11):2390-2394. doi:10.3899/jrheum.110311
19. Levy B, Couchoud C, Rougier JP, Jourde-Chiche N, Daugas E. Outcome of patients with systemic lupus erythematosus on chronic dialysis: an observational study of incident patients of the French National Registry 2002-2012. *Lupus*. 2015;24(10):1111-1121. doi:10.1177/0961203315578763
20. Zhang L, Lee G, Liu X, et al. Long-term outcomes of end-stage kidney disease for patients with lupus nephritis. *Kidney Int*. 2016;89(6):1337-1345. doi:10.1016/j.kint.2016.02.014
21. ERA-EDTA Registry. *ERA-EDTA Registry Annual Report 2016*. Amsterdam UMC; 2018.
22. Joinpoint Regression Program. Version 4.6.0. Statistical Research and Applications Branch, National Cancer Institute. 2018. https://surveillance.cancer.gov/joinpoint
23. Ward MM. Changes in the incidence of endstage renal disease due to lupus nephritis in the United States, 1996-2004. *J Rheumatol*. 2009;36(1):63-67. doi:10.3899/jrheum.080625
24. Rees F, Doherty M, Grainge M, Davenport G, Lanyon P, Zhang W. The incidence and prevalence of systemic lupus erythematosus in the UK, 1999-2012. *Ann Rheum Dis*. 2016;75(1):136-141. doi:10.1136/annrheumdis-2014-206334
25. Ames PR, Merashli M, Bucci T, Gentile F, Delgado-Alves J. Antiphospholipid antibodies and renal transplant: a systematic review and meta-analysis. *Semin Arthritis Rheum*. 2019;48(6):1041-1052. doi:10.1016/j.semarthrit.2018.10.016
26. Fuentes L, Hernandez D, Ruiz P, et al. Survival of lupus nephritis patients after renal transplantation in Malaga. *Transplant Proc*. 2012;44(7):2067-2068. doi:10.1016/j.transproceed.2012.07.063
27. Cheigh JS, Stenzel KH. End-stage renal disease in systemic lupus erythematosus. *Am J Kidney Dis*. 1993;21(1):2-8. doi:10.1016/s0272-6386(12)80712-8
28. Contreras G, Mattiazzi A, Guerra G, et al. Recurrence of lupus nephritis after kidney transplantation. *J Am Soc Nephrol*. 2010;21(7):1200-1207. doi:10.1681/ASN.2009101093
29. Ward MM. Cardiovascular and cerebrovascular morbidity and mortality among women with end-stage renal disease attributable to lupus nephritis. *Am J Kidney Dis*. 2000;36(3):516-525. doi:10.1053/ajkd.2000.9792
30. Mojcik CF, Klippel JH. End-stage renal disease and systemic lupus erythematosus. *Am J Med*. 1996;101(1):100-107. doi:10.1016/s0002-9343(96)00074-5
31. Mattos P, Santiago MB. Disease activity in systemic lupus erythematosus patients with end-stage renal disease: systematic review of the literature. *Clin Rheumatol*. 2012;31(6):897-905. doi:10.1007/s10067-012-1957-9
32. Contreras G, Pagan J, Chokshi R, et al. Comparison of mortality of ESRD patients with lupus by initial dialysis modality. *Clin J Am Soc Nephrol*. 2014;9(11):1949-1956. doi:10.2215/CJN.02500314