Published in final edited form as:

Semin Arthritis Rheum. 2019 February ; 48(4): 678–685. doi:10.1016/j.semarthrit.2018.05.014.

Methodological Considerations in Comparing Access to Pre-emptive Renal Transplantation between SLE and other ESRD causes in the USRDS

Anna Broder, MD, MSc^{*,†},

Division of Rheumatology, Department of Medicine, Albert Einstein College of Medicine/
Montefiore Medical Center, Bronx, New York

Wenzhu B. Mowrey, PhD[†],

Division of Biostatistics, Department of Epidemiology and Population Health, Albert Einstein
College of Medicine, Bronx, NY, wenzhu.mowrey@einstein.yu.edu

Ladan Golestaneh, MD, MSc,

Division of Nephrology, Department of Medicine, Albert Einstein College of Medicine/Montefiore
Medical Center, Bronx, New York, lgolesta@montefiore.org

Chaim Putterman, MD,

Division of Rheumatology, Department of Medicine, Albert Einstein College of Medicine, Bronx,
NY, chaim.putterman@einstein.yu.edu

Karen H. Costenbader, MD, MPH, and

Division of Rheumatology, Immunology and Allergy, Department of Medicine, Harvard Medical
School, Brigham and Women's Hospital, Boston, MA, kcostenbader@partners.org

Mimi Kim, ScD

Division of Biostatistics, Department of Epidemiology and Population Health, Albert Einstein
College of Medicine, Bronx, NY, mimi.kim@einstein.yu.edu

Abstract

^{*}**Correspondence author:** Anna Broder, MD, MSc, Division of Rheumatology, Albert Einstein College of Medicine, F103N, 1300
Morris Park Ave, Bronx, NY 10461, Phone: (718) 430-8582, Fax: (718) 430-8789, abroder@montefiore.org.

[†]Dr. Broder and Dr. Mowrey contributed equally to this manuscript, and are co-first authors

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customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of
the resulting proof before it is published in its final citable form. Please note that during the production process errors may be
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Authors' Contributions:

Anna Broder, Wenzhu B. Mowrey: Conception and design, analysis and interpretation of data; drafting the article or revising it;
providing intellectual content of critical importance to the work described; final approval of the version to be published.

Ladan Golestaneh, Chaim Putterman, Karen H. Costenbader, Mimi Kim: design, analysis and interpretation of data; drafting the
article or revising it; providing intellectual content of critical importance to the work described; final approval of the version to be
published.

Conflict of interest:

No conflict of interest to declare

The results presented in this paper have not been published previously in whole or part, except in abstract format

Background—We compared pre-emptive transplant rates between SLE and non-SLE end-stage renal disease (ESRD) from the U.S. Renal Data System (USRDS) and investigated the potential influence of frequency matching and primary ESRD causes in the non-SLE group.

Methods—4,830 adult SLE patients with incident ESRD from USRDS 2005-2009 were frequency matched by age, sex and race to 4,830 patients with incident non-SLE ESRD. Multivariable logistic regression models were used to estimate the odds of pre-emptive transplantation in SLE and non-SLE, and with the non-SLE subgroups by primary ESRD cause.

Results—The odds ratios (OR) of receiving a pre-emptive transplant were similar among non-SLE and SLE (referent group): OR = 1.18 (95% CI: 0.92, 1.50; p=0.20). However, the ORs for receiving a pre-emptive transplant were 0.19 (95% CI: 0.08, 0.42) in type 2 diabetes ESRD, 0.42 (95% CI: 0.23, 0.75) for hypertension-associated ESRD, 1.67 (95% CI: 1.10, 2.54) in type 1 diabetes ESRD, and 2.06 (95% CI: 1.55, 2.73) for “other” ESRD. In contrast to non-SLE, younger SLE patients were less likely to receive a pre-emptive transplant than older SLE patients.

Conclusion—The results of this study provide compelling evidence that major improvements need to be made in optimizing access to pre-emptive transplantation in SLE by addressing sociodemographic disparities and the unique challenges faced by SLE patients. Applying careful matching and selecting appropriate comparison groups in future studies may facilitate the development of effective strategies to address these barriers and to increase the number of pre-emptive renal transplants among SLE patients.

Keywords

Systemic lupus erythematosus; lupus nephritis; end-stage renal disease; renal transplantation; diabetes mellitus

Introduction

Systemic lupus erythematosus (SLE)-related end-stage renal disease (ESRD) develops in 10-30% of patients with lupus-related kidney disease [1-3] and is associated with a 4-fold risk of death compared with lupus nephritis alone [4]. Therefore, it is important to develop effective interventions to improve mortality in SLE ESRD. It is well established, that in SLE, similar to non-SLE, renal transplantation offers significantly improved survival and quality of life compared with hemodialysis or peritoneal dialysis [5, 6]. Pre-emptive transplantation, defined as direct transplantation without any intervening dialysis, is associated with the best outcomes in those with ESRD, whereas longer waiting times while on dialysis have been associated with less favorable transplantation outcomes [7, 8].

However, only 4% of SLE patients receive pre-emptive transplantation in the US [9], and it is not known how these rates compare in SLE and other causes of the ESRD. Therefore, it is unknown whether the low pre-emptive transplantation rates observed among SLE patients reflect the rates in the overall ESRD population or indicate that SLE patients face unique barriers with regards to pre-emptive transplantation, including allograft loss and recurrence of lupus nephritis [10]. Understanding differential access to pre-emptive transplantation between SLE and various other ESRD causes may result in safely increasing the number of pre-emptive transplants.

Only one recent study compared pre-emptive transplantation rates across different subtypes of glomerulonephritis: O'shaughnessy et al. utilized data from the U.S. Renal Data System (USRDS) to compare initial renal replacement modalities in patients with 6 subtypes of glomerulonephritis, including lupus nephritis, vasculitis, focal segmental glomerulosclerosis, and IgA nephropathy, as well as patients with diabetes [11]. In that study, patients with IgA nephropathy had significantly higher odds of pre-emptive transplantation compared to other types of secondary glomerulonephritis and diabetes. While an SLE ESRD group was included, SLE-related ESRD was not the focus of that analysis and no age, sex or race-adjusted analyses were reported, even though SLE patients were disproportionately younger and more were women and Black or African American. In addition, that study did not differentiate between type 1 and type 2 diabetes, even though it has been shown previously that patients with type 2 diabetes are less likely to be referred for pre-emptive transplantation than type 1 diabetes patients [12].

We hypothesized that a non-SLE comparison group including patients with various causes of ESRD may be too heterogeneous to illuminate the differences in the pre-emptive transplantation rates. Therefore, important differences in access to pre-emptive transplantation between SLE and non-SLE may be uncovered by using a study design in which SLE and non-SLE groups were matched *a priori* on key confounders, as well as by investigating the potential influence of primary ESRD cause in the non-SLE patients on pre-emptive transplantation rates. Methodologically, it is important to identify appropriate comparison groups for future studies to improve access to transplantation among SLE patients. Clinically, understanding where SLE falls within the spectrum may lead to changes in clinical practice and result in improved quality of life and mortality in SLE ESRD.

Methods

Data source

We analyzed data from the USRDS between 2005 and 2009. USRDS is an NIH-funded national data registry that was created for outcomes research for patients with chronic ESRD (www.usrds.org). Briefly, the USRDS database captures almost all individuals in the US receiving renal replacement therapy, including dialysis and kidney transplantation. Baseline demographic and diagnostic information were collected through the Centers for Medicare Services (CMS) Medical Evidence Report (F2728 form) that nephrologists are required to submit for each new ESRD patient. This report also includes information on comorbid conditions, employment status, race, ethnicity, body mass index (BMI), and biochemical data (albumin, creatinine, estimated GFR, hemoglobin) at ESRD onset. In addition to data from CMS, the USRDS registry combines information from the United Network for Organ Sharing (UNOS), the ESRD networks, and the USRDS special studies. This study was approved by the Institutional Review Board at Albert Einstein College of Medicine and in accordance with the Helsinki Declaration. Data were obtained from the USRDS through a data use agreement in compliance with USRDS reporting policies.

Study Population

SLE cohort—We identified all patients 18 years and older with SLE as a primary cause of ESRD (International Classification of Diseases, 9th Revision (ICD9) diagnostic code 710.0) who developed ESRD on or after January 1st, 2005 and before December 31st, 2009. Since age and race were important for matching we excluded patients who were missing these (148 for missing age and 115 for missing race). We have shown previously that the diagnosis of SLE as the primary cause of ESRD in the USRDS has good sensitivity, and excellent specificity, positive predictive value and negative predictive value [13]

Comparison group (non-SLE)—The comparison group included non-SLE patients 18 years and older with incident ESRD during the same time period. To minimize potential misclassification bias [13] and to compare SLE patients to patients without autoimmune diseases, we excluded patients with the following primary causes of renal failure: Goodpasture's (ICD9 446.21, n=596), granulomatosis with polyangiitis (Wegener's) (ICD9 446.4, n=1,638), hemolytic uremic syndrome (ICD9 283.11, n=657), Henoch Schonlein purpura (ICD9 287.0, n=115), polyarteritis (ICD9 446.0, n=266), and scleroderma (ICD9 710.1, n=579). In addition, we excluded individuals with non-specific or missing diagnoses of the primary cause of ESRD: "glomerulonephritis, histology not examined" (ICD9 582.9, n=12,502), "other vasculitis" (ICD9 446.20, n=1,161), "chronic glomerulonephritis" (ICD9 583.*, n=29,215), "etiology unclear" (ICD9 799.9, n=21,333), and those with missing diagnoses (n=45,896).

Frequency matching—Because of the significant differences in the distributions of age, sex and race, SLE and non-SLE patients were frequency-matched according to these variables. We stratified subjects into 18 subgroups defined by age (three categories: 18–30, 31–60, and >60 years old), sex (two categories: female and male), and race (three categories: Black or African American, White and Asian), in accordance with the NIH definitions of race [14]. Then, we frequency-matched these 18 subgroups of SLE subjects by randomly sampling the same number of subjects from the corresponding non-SLE subgroups.

Outcome (dependent variable)—The main outcome was pre-emptive transplantation as the initial renal replacement modality. Pre-emptive transplantation is defined as direct transplantation without any intervening dialysis. Initial renal replacement modality is recorded in the USRDS as in-center hemodialysis, self-hemodialysis, peritoneal dialysis, pre-emptive transplant, or unknown, based on the information collected in the 2728 Medical Evidence form.

Covariates—Ethnicity was recorded separately as Hispanic/non-Hispanic. Employment status at the time of ESRD onset was defined as employed, retired or disabled, student, and unemployed. Insurance at the time of ESRD was defined as private, Medicare and/or Medicaid, none, and other or Veterans Affairs (VA). Geographical regions were defined as Northeast, Midwest, South, West, and US Islands. Additional data obtained from the USRDS at ESRD onset included serum albumin, body mass index (BMI), functional status (ability to ambulate and/or transfer out of bed), smoking, drug and alcohol use, and nephrologist care prior to ESRD. For patients who received a kidney transplant,

transplantation data, including the date, donor information (deceased or living), and the total number of transplants was obtained by the USRDS from the UNOS.

Statistical methods

Student's t-tests were used to compare continuous variables between SLE and non-SLE groups. ANOVA was performed for comparisons involving more than two groups. Variables that were non-normally distributed were analyzed with non-parametric Wilcoxon rank sum test (for 2-group comparison) and Kruskal-Wallis test (for comparing 3 groups). Categorical variables were evaluated by means of Chi-square and Fisher's exact tests.

The overall difference in pre-emptive transplantation rates between the SLE and non-SLE groups was first evaluated. The non-SLE ESRD group was then subdivided by the primary ESRD cause as follows: diabetes type 1, diabetes type 2, hypertension, and "other", to assess whether transplantation rates differed across these subgroups. The three largest groups by ESRD cause, diabetes mellitus type 1 (ICD9 250.41), diabetes mellitus type 2 (ICD9 250.40), and unspecified hypertension (ICD9 403.91) comprised 11.7%, 35.6%, and 28.6% of the non-SLE group, respectively. All other causes of ESRD in the non-SLE group were less frequent, less than 7% each, and were analyzed as one subgroup. The most common diseases in the "other" group were focal segmental glomerulosclerosis, polycystic kidney disease, and AIDS nephropathy, 6.5%, 3.3%, and 2.4% of the non-SLE group, respectively.

Multivariable logistic regression models were fit to the data to estimate odds ratios for pre-emptive transplantation comparing SLE and non-SLE ESRD patients, adjusting for BMI, comorbidities, insurance status, employment status, and geographical region. These covariates were selected based on both statistical and clinical significance. All models were further adjusted for age, sex and race. Because serum albumin concentration and nephrologist care information were missing for a significant proportion of the USRDS participants (22.0% missing albumin data, and 11.0% missing nephrologist care data), these variables were not included in the main models. Instead, additional models were fit with these variables added onto the main model in sensitivity analyses.

To identify potentially unique barriers to pre-emptive transplantation in both SLE and non-SLE patients, we also fit separate multivariable logistic regression models to each group to assess whether sociodemographic and comorbidities variables associated with pre-emptive transplantation differed by SLE status. Statistical analyses were performed using the SAS 9.3 statistical software package (SAS Institute Inc., Cary, NC, U.S.A.).

Results

This was a cross-sectional study that included 561,038 individuals in the US with new-onset ESRD of any cause between January 1, 2005 and December 31, 2009. Using exclusion criteria described in the Methods section, we identified 4,830 SLE subjects and 423,713 non-SLE subjects eligible for matching. Overall, SLE patients were disproportionately younger than unmatched non-SLE at the time of ESRD onset (40.4 ± 15.0 vs. 63.5 ± 14.8 years old, $p < 0.01$). The SLE group included a much higher percentage of women (81.3% vs. 43.7%, $p < 0.01$) and Black or African Americans (51.5% vs. 30.2%, $p < 0.01$) than did the

unmatched non-SLE group. These differences in age, sex and race further underscore the importance of frequency matching on these variables when selecting a comparison group to study SLE related outcomes.

Pre-emptive transplantation rates were significantly higher among unmatched SLE patients compared with non-SLE patients, 3.7% and 1.8%, respectively ($p<0.01$). However, there was significant variation in transplantation rates by ESRD cause in the unmatched non-SLE subgroups: 0.6% in the type 2 diabetes subgroup, 1.0% in the hypertension subgroup, 5.7% in the type 1 diabetes subgroup, and 6.6% in the “other” subgroup.

After frequency matching based on age, sex and race, 4,830 SLE subjects and 4,830 matched non-SLE subjects were included in the final analysis (**Table 1**). The SLE group included a lower proportion of obese patients compared to all non-SLE subgroups, and a higher proportion of patients with pre-ESRD nephrology care. Congestive heart failure was less prevalent among SLE (14.3%) compared to type 2 diabetes (36.0%), hypertension (19.8%) and type 1 diabetes (16.9%), but more common than in the “other” group (8.5%). Similarly, the prevalence of atherosclerotic heart disease was lower in SLE (5.3%) compared with type 2 diabetes (19.4%), hypertension (7.0%), and type 1 diabetes (6.9%), but more common than in the “other group” (3.5%).

Pre-emptive transplantation rates were similar in the two groups: 3.7% in the SLE group and 3.2% in the non-SLE group ($p=0.18$) (**Table 2**). As in the unmatched analyses, however, among the matched non-SLE patients, there was still significant variability in transplantation rates across subgroups defined by primary cause of ESRD: 0.4% in the type 2 diabetes group, 1.2% in the hypertension subgroup, 5.8% in the type 1 diabetes group, and 8.7% in the “other” group. Overall, the rates of the living donor pre-emptive transplants were similar between SLE and non-SLE groups, 78.0% and 70.0% of all pre-emptive transplants, respectively, $p=0.10$. However, living donor pre-emptive transplants were much less frequent among patients with type 1 and type 2 diabetes (41.0% and 29.0%, respectively) compared with SLE patients.

Given the severity of SLE and renal involvement in Hispanics, as well as good transplantation outcomes in this patient population [15], transplantation rates were compared between Hispanics and non-Hispanics among SLE and non-SLE patients. Among SLE, pre-emptive transplantation rates were similar between the two ethnic groups, 3.0 vs. 3.3%, $p=0.75$. Likewise, in the matched non-SLE group, pre-emptive transplantation rates were similar between Hispanic and non-Hispanic patients, 3.0% vs. 3.9%, $p=0.18$. In addition, pre-emptive transplantation rates were similar between these two ethnic groups within each of the four non-SLE comparison groups.

To determine if our findings were consistent across different time periods, we compared yearly pre-emptive transplantation rates among SLE and 4 non-SLE comparison groups (**Figure 1**). While there was some variation in the pre-emptive transplantation rates across the years within each comparison group, the relative rates among the comparison groups remained unchanged with the highest rates being seen in the “other” group, followed by DM1, SLE, HTN, and DM2.

Multivariable analyses of pre-emptive transplantation

In a multivariable logistic regression model adjusted for age, sex, race, BMI, comorbidities, insurance status, employment status and geographic region, the odds of receiving a pre-emptive transplant were similar among non-SLE compared to SLE patients (referent group): OR= 1.18 (95% CI: 0.92, 1.50; $p=0.20$). (**Table 3**). However, when the non-SLE group was further categorized by specific ESRD cause, the ORs for receiving a pre-emptive transplant were 0.19 (95% CI: 0.08, 0.42) in type 2 diabetes ESRD, 0.42 (95% CI: 0.23, 0.75) for hypertension-associated ESRD, 1.67 (95% CI: 1.10, 2.54) in type 1 diabetes ESRD, and 2.06 (95% CI: 1.55, 2.73) for “other causes” of ESRD compared to the reference SLE group, after adjusting for the same set of covariates. Additional models adjusted for serum albumin, GFR, hemoglobin, and pre-ESRD nephrologist care, did not significantly change these conclusions.

Parallel comparisons of factors associated with receiving a pre-emptive kidney transplant among SLE and non-SLE groups

There were both similarities and differences between SLE and non-SLE groups with respect to factors associated with pre-emptive transplantation. Factors associated with higher odds of pre-emptive transplantation were similar between SLE and non-SLE patients and included white race, early access to nephrology care, being employed, having private insurance, and residing in the Northeast (**Table 4**).

Congestive heart failure and atherosclerotic heart disease were associated with lower pre-emptive transplant rates in both SLE and non-SLE. Although the presence of diabetes as a comorbidity in the SLE group was associated with the lower odds of pre-emptive transplantation, the association did not reach statistical significance, OR (95% CI): 0.48 (0.22, 1.05), $p=0.07$. Other comorbidities including alcohol use, drug use, cancer, cerebrovascular accident/transient ischemic attack, and hypertension were not significantly associated with pre-emptive transplantation in either group.

The associations between age and pre-emptive transplantation were divergent in SLE ESRD compared to non-SLE ESRD. In non-SLE, older age was associated with lower odds of pre-emptive transplantation, OR 0.86, 95% CI (0.82, 0.95), $p<0.01$, for every 5-year increase in age. In the SLE group, however, older age at ESRD onset was associated with higher odds of pre-emptive transplantation, OR 1.1, 95% CI (1.05, 1.16), $p<0.01$, for every 5-year increase in age.

Discussion

Pre-emptive transplantation offers a significant survival benefit to patients of all ages and ESRD causes. However, based on the results of this study and prior studies of other forms of glomerulonephritis [11, 16], there are substantial variations in access to pre-emptive transplantation. Similar to prior studies on the topic of renal transplantation in SLE and non-SLE, [1, 10, 17-20] we have found that socio-demographic factors including race, geographic region, insurance and employment play an important role in determining the odds of pre-emptive transplantation. The novel finding of our study is that pre-emptive

transplantation rates vary widely between various disease groups, and that SLE patients have significantly lower pre-emptive transplantation rates compared to patients other ESRD causes.

Methodologically, this study demonstrates the importance of matching and careful selection of the comparison groups for further studies looking at renal transplantation in SLE patients. Prior studies have reported better or comparable overall transplantation rates in SLE compared to non-SLE patients, suggesting that patients with SLE ESRD were as likely as other ESRD patients to be eligible for transplantation [15, 18, 19]. But these studies did not account for the significant heterogeneity within the non-SLE group, and, therefore, important differences between SLE and other primary ESRD causes may have been overlooked. In a recent study from a French registry of patients on chronic dialysis, access to the renal transplant waiting list and to renal transplantation at one, three and five years after starting dialysis was higher in SLE patients than in age and sex-matched diabetic patients, but lower than in matched polycystic kidney disease patients [16]. In that study, DM1 and DM2 were grouped together, no SLE patients received pre-emptive renal transplantation, and only 8.8% of SLE patients had been listed for transplantation before initiation of dialysis compared to 30.0% of patients with polycystic kidney disease.

The results of the current study show that SLE patients have significantly lower odds of pre-emptive transplantation compared to type 1 diabetes, even though the two groups were comparable with respect to comorbidities, nephrology care and demographic characteristics. The nephrology literature recommends that diabetic patients should be referred for kidney transplant evaluation when their eGFR reaches 25-30 mL/min [21-23]. The reason for this recommendation is that patients who are referred early can be evaluated and treated more thoroughly for cardiovascular comorbidities. Similarly, since cardiovascular disease is also highly prevalent among SLE patients [24, 25], these patients may also benefit from early referrals for kidney transplant evaluation, and new guidelines for early referrals may need to be developed. It is also possible that younger SLE patients without cardiovascular risk factors may have the highest survival benefit with regards to pre-emptive transplantation. For example, among patients with type 1 diabetes, the largest survival benefit has been demonstrated in patients who are in their 40s at the time of developing ESRD [22, 26, 27].

However, we have found that, in contrast to non-SLE patients, younger SLE patients were less likely to receive a pre-emptive kidney transplant. Although small in magnitude, for every 5-year increase in age, there was a 10% decrease in likelihood of pre-emptive transplant in SLE, clearly in the opposite direction as among non-SLE patients. These findings were similar to the findings of two prior studies in which younger patient with SLE were less likely to receive a transplant compared to non-SLE patients [18, 28]. On the one hand, younger patients may have higher ESRD-related mortality and more severe SLE than older patients [29-31]. However, younger SLE patients may be more likely to recover their renal function up to a year from initiating dialysis [32, 33]. The potential reasons for the decreased odds of a pre-emptive transplantation at younger age, as well as the impact on outcomes, need to be further investigated.

One limitation of this study is that due to the insufficient sample sizes, we were not able to frequency match the individual non-SLE subgroups (type 1 diabetes, hypertension, type 2 diabetes) to the SLE group by age, sex and race. Nevertheless, the distributions of these variables were reasonably comparable across groups. Specifically, the percentage of Black or African Americans did not differ by more than 12%, and the maximum difference between the mean ages of the non-SLE subgroups and the SLE group was 13 years, much smaller than the age ranges used in frequency-matching the overall non-SLE group to the SLE group. Furthermore, we further adjusted for these factors and other patient characteristics in the multivariable models. Another limitation is that the comparisons to the “other” subgroup are difficult to interpret because of the significant heterogeneity within that subgroup. Nonetheless, the information gained from these analyses lays the groundwork for more specific comparisons in the future studies.

Several limitations related to the nature of the data collected in USRDS need to be acknowledged. First, we were not able to account for attrition rates from death and palliative care referrals prior to initiating renal replacement. Therefore, the findings of this study only apply to individuals who started renal replacement after developing ESRD. Second, a large proportion of the F2728 forms had incomplete information on sex and race, and patients with missing information were excluded from the final analysis. However, the findings of this study are not likely to be affected by this missing information, because SLE and non-SLE groups were well matched with respect to age, sex and race. Third, although we did not have information past 2009, transplantation rates did not change significantly between 2009 and 2014 [34].

Although we could not assess the impact of SLE activity, organ damage, or presence of antiphospholipid antibodies on pre-emptive transplant eligibility due to limitations of the collected data, only 2.8% of individuals with SLE ESRD were considered medically unfit by their nephrologist to discuss renal transplantation. Therefore, medical eligibility does not appear to be the major issue affecting pre-emptive transplantation rates. Furthermore, based on the recent systematic review by Yep et al, serologic abnormalities at the time of renal transplantation were not associated with graft failure [35].

Although prior studies have shown that the overall rates of renal translation are comparable between SLE and non-SLE ESRD, estimates of the relative rates of pre-emptive transplantation are significantly affected by whether study designs and analyses properly account for potential confounders and causes of ESRD. The results of this study provide compelling evidence that major improvements need to be made in optimizing access to pre-emptive transplantation in SLE by addressing sociodemographic disparities and the unique challenges faced by SLE patients. Applying careful matching and selecting appropriate comparison groups in future studies may facilitate the development of effective strategies to address these barriers and to safely increase the number of pre-emptive renal transplants among SLE patients.

Acknowledgements

The data reported here have been supplied by the United States Renal Data System (USRDS). The interpretation and reporting of these data are the responsibility of the author(s) and in no way should be seen as an official policy or interpretation of the U.S. government.

Funding: Rheumatology Research Foundation K Bridge Award and NIH/NIAMS K23 AR068441 (A Broder), NIH/NIAMS R01 AR 057327 and K24 AR 066109 (KH Costenbader)

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Figure 1.
Yearly pre-emptive transplantation rates among SLE and non-SLE comparison groups

Table 1

Baseline Characteristics of New Onset non-SLE and SLE End-Stage Renal Disease Patients in the U.S., 2005-2009.

	SLE (n=4,830)	Non-SLE (n=4,830)	Non-SLE Subgroups**			
			Type 2 Diabetes (n=1,719)	Hypertension (n=1,381)	Type 1 Diabetes (n=567)	Other (n=1,163)
Age at ESRD onset, years, mean (SD)	40.4 (15.0)	44.9 (16.0)	52.7 (12.5)	45.2 (16.7)	35.4 (12.1)	37.5 (15.4)
Female ^a , %	81.3	81.3	83.9	78.1	85.4	79.2
Race ^a , %						
White	43.2	43.2	44.6	29.6	51.5	53.1
Black or African American	51.5	51.5	50.6	64.4	43.9	41.4
Asian	5.3	5.3	4.9	6	4.6	5.5
Hispanic ethnicity, %	18.3	13.8	17.9	11.2	13.6	10.8
Underweight (BMI < 18), %	4.8	3.4	1.3	3.6	1.4	7.1
Normal weight (18 ≤ BMI < 25), %	42.5	30	19.6	32.0	39.6	38.0
Overweight (25 ≤ BMI < 30), %	26.6	24.5	24.3	24.8	27.7	22.7
obese (BMI ≥ 30), %	26	42.2	54.8	39.6	31.3	32.3
Nephrologist care prior to ESRD, %	71.6	63.8	66.8	54.1	69.9	67.4
Laboratory values at ESRD						
GFR, mean (SD)	10.3 (4.8)	9.8 (4.7)	10.5 (4.6)	9.0 (4.8)	10.7 (4.8)	9.3 (4.7)
Albumin, mean (SD)	2.9 (0.8)	3.1 (0.8)	3.0 (0.7)	3.2 (0.7)	2.8 (0.8)	3.3 (0.9)
Hemoglobin, mean (SD)	9.6 (1.7)	9.7 (1.8)	9.8 (1.6)	9.6 (1.8)	9.8 (1.7)	9.7 (1.9)
Comorbidities, %						
Alcohol use	0.6	1.4	0.8	2.2	0.5	1.6
Atherosclerotic heart disease	5.3	10.6	19.4	7.0	6.9	3.5
Cancer	1.6	3.4	2.4	2.8	0.7	6.7
CHF	14.3	22.5	36.0	19.8	16.9	8.5
COPD	2.4	4.6	6.5	4.9	3.2	2.1
CVA/TIA ^a	5.3	6.1	9.1	6.2	4.4	2.2
Diabetes	10.2	8.3	-	21.0	-	9.7
Drug use	1.1	2.5	1.1	4.3	1.8	2.8
Hypertension	84.0	58.6	88.8	-	84.7	70.9
Inambulatory	6.3	9.1	12.9	6.8	8.3	6.6
Peripheral vascular disease	3.2	7.4	13.0	4.2	8.6	2.3
Smoking	4.4	6.8	5.3	8.3	7.4	7.0
Insurance at the time of ESRD onset, %						
Private	36.4	28.2	24.3	25.9	29.1	36.4

	SLE (n=4,830)	Non-SLE (n=4,830)	Non-SLE Subgroups ^{**}			
			Type 2 Diabetes (n=1,719)	Hypertension (n=1,381)	Type 1 Diabetes (n=567)	Other (n=1,163)
Medicare or Medicaid	44	49.7	57.5	47.3	52.7	39.7
Other or VA	8.0	7.4	7.0	6.4	6.2	9.5
None	11.6	14.7	11.2	20.4	12	14.4
US regions, %						
Northeast	16.4	14.5	13.2	12.0	16.1	18.6
Midwest	18	18.6	17.4	19.3	19.6	19.1
West	18.6	17.3	17.6	16.2	18.5	17.4
South	45.8	48.5	49.6	52.3	44.8	44.2
US Islands	1.2	1.2	2.2	0.4	1.1	0.7
Employment status at ESRD onset, %						
Employed	20.5	16.6	10.2	18.1	16.4	24.6
Retired or disabled	35.5	36.9	50.6	32.2	29.7	25.7
Student	3.9	2.7	0.1	1.8	1.9	7.9
Unemployed	40.1	43.8	39.2	47.9	51.9	41.8

^aNon-significant statistical differences between SLE and matched non-SLE (p>0.05).

^{**} All of the variables in Table 1 were significantly different for the non-SLE subgroup comparisons.

Table 2

Renal Replacement Therapies among New Onset ESRD patients with and without SLE in the U.S., 2005-2009.

	SLE (n=4,830)	Non-SLE (n=4,830)	SLE vs. non-SLE p-value	Non-SLE Subgroups			
				Type 2 Diabetes (n=1,719)	Hypertension (n=1,381)	Type 1 Diabetes (n=567)	Other (n=1,163)
Pre-emptive Transplant, n(%)	179.0 (3.7)	155.0 (3.2)	0.18	7.0 (0.4)	16.0 (1.2)	32.0(5.6)	100.0 (8.6)
Pre-emptive living donor, n(%)	138.0 (78.0)	108.0 (70.0)	0.10	2.0 (29.0)	12.0 (75.0)	13.0 (41.0)	81.0 (81.0)
Initial dialysis modality, %							
Hemodialysis	81.4	83.5		90.1	87.3	78.5	71.8
Self Hemodialysis	0.4	0.4	0.09	0.2	0.5	0.4	0.3
Peritoneal Dialysis	9.1	8.2		4.8	7.0	12.2	12.6
Pre-emptive transplant	3.7	3.2		0.4	1.2	5.6	8.6
Unknown	5.4	4.8		4.5	4	3.4	6.7
Discussed transplant, %	84.1	80	<0.01	77.5	77.6	86.2	82.2
Reasons transplant not discussed:							
Patient declined, %	0.2	0.1	0.80	0.2	0.1	0.2	0.0
Medically unfit, %	2.8	4.0	<0.01	4.9	3.2	1.4	4.7
Psychologically unfit, %	0.2	0.6	<0.01	1.0	0.3	0.7	0.5
Unsuitable due to age, %	0.6	1.3	<0.01	1.9	1.7	0.0	0.6
Not evaluated, %	10.3	12.8	<0.01	13.6	15.9	10.6	9.0
Unspecified, %	1.7	1.7	0.94	2.0	1.7	0.5	2.0

Table 3

Adjusted Odds Ratios (OR) and 95% Confidence Intervals (95% CI) from the Logistic Regression Model for Pre-emptive Transplantation among ESRD patients with and without SLE.

Variable	OR	95% CI		p value
Primary cause of ESRD				
SLE	1.00			
Type 1 diabetes	1.67	1.10	2.54	0.02
Type 2 diabetes	0.19	0.09	0.42	<0.01
Hypertension	0.42	0.23	0.75	<0.01
Other	2.06	1.55	2.74	<0.01
Age at ESRD onset, per year increase	1.00	0.99	1.01	0.76
Sex				
Men	1.00			
Women	1.38	1.00	1.89	0.05
Race				
White	1.00			
Asian	0.45	0.27	0.76	<0.01
Black or African American	0.18	0.13	0.24	<0.01
BMI				
Normal weight	1.00			
Obese	0.96	0.71	1.31	0.80
Overweight	1.44	1.08	1.91	0.01
Underweight	1.44	0.82	2.52	0.20
Comorbidities				
Atherosclerotic heart disease	0.26	0.08	0.84	0.02
Cancer	0.20	0.06	0.66	<0.01
CHF	0.06	0.01	0.24	<0.01
COPD	0.73	0.22	2.48	0.62
CVA/TIA	1.40	0.76	2.58	0.28
Diabetes	0.57	0.31	1.04	0.07
Drug abuse	0.47	0.06	3.61	0.47
Hypertension	0.75	0.56	1.00	0.05
Inambulatory	0.28	0.10	0.78	0.01
PVD	0.59	0.21	1.66	0.31
Smoking	0.51	0.23	1.12	0.09
Insurance				
Private	1.00			
Medicare/Medicaid	0.36	0.27	0.50	<0.01
None	0.15	0.07	0.30	<0.01
Other	0.84	0.56	1.25	0.39
Employment				
Employed	1.00			

Variable	OR	95% CI		p value
retired	0.59	0.43	0.81	<0.01
Student	0.78	0.45	1.33	0.36
Unemployed	0.44	0.32	0.61	<0.01
Geographic region *				
Northeast	1.00			
Midwest	0.78	0.55	1.11	0.17
South	0.59	0.42	0.82	<0.01
West	0.50	0.35	0.71	<0.01

* Exclusions: Excluded region "US Islands" since there was no pre-emptive case in the group

Table 4

Factors associated with access to pre-emptive transplantation stratified by SLE status in patients with incident ESRD^{*}.

Variable	SLE				Non-SLE			
	OR	95% CI		p value	OR	95% CI		p value
Primary cause of ESRD								
Type 2 diabetes					1.00			
Type 1 diabetes					5.91	2.44	14.30	<0.01
Hypertension					1.67	0.62	4.49	0.31
Other					7.01	3.05	16.12	<0.01
Age at ESRD onset, per 5-year increase in age	1.10	1.05	1.16	<0.01	0.86	0.82	0.95	<0.01
Sex								
Men	1.00				1.00			
Women	1.42	0.92	2.19	0.12	1.37	0.85	2.21	0.20
Race								
White	1.00				1.00			
Asian	0.49	0.24	1.01	0.05	0.41	0.19	0.90	0.03
Black or African American	0.18	0.12	0.27	<0.01	0.17	0.11	0.29	<0.01
BMI								
Normal	1.00				1.00			
Obese	0.88	0.57	1.36	0.55	1.07	0.67	1.68	0.78
Overweight	1.65	1.14	2.39	<0.01	1.28	0.81	2.02	0.29
Underweight	1.12	0.49	2.56	0.79	1.77	0.79	3.99	0.17
Comorbidities								
Atherosclerotic heart disease	0.22	0.05	0.92	0.04	0.26	0.03	1.96	0.19
Cancer	0.17	0.02	1.24	0.08	0.25	0.06	1.09	0.06
CHF	0.05	0.01	0.34	<0.01	0.07	0.01	0.51	<0.01
COPD					2.29	0.57	9.15	0.24
CVA/TIA	1.50	0.74	3.04	0.27	1.16	0.33	4.05	0.82
Diabetes	0.48	0.22	1.05	0.07	0.76	0.29	2.00	0.57
Hypertension	0.78	0.52	1.17	0.23	0.73	0.47	1.12	0.15
Inambulatory	0.15	0.02	1.10	0.06	0.36	0.11	1.24	0.11
PVD	1.60	0.54	4.74	0.40				
Smoking	0.77	0.30	1.97	0.58	0.23	0.05	1.02	0.05
Insurance								
Private	1.00				1.00			
Medicare/Medicaid	0.39	0.25	0.59	<0.01	0.29	0.18	0.47	<0.01
None	0.17	0.06	0.48	<0.01	0.12	0.05	0.30	<0.01
Other	1.14	0.68	1.90	0.61	0.53	0.27	1.02	0.06
Employment								
Employed	1.00				1.00			
Retired	0.52	0.34	0.79	<0.01	0.63	0.38	1.04	0.07

Variable	SLE				Non-SLE			
	OR	95% CI		p value	OR	95% CI		p value
Student	0.33	0.10	1.10	0.07	0.90	0.45	1.77	0.75
Unemployed	0.42	0.27	0.64	<0.01	0.46	0.28	0.75	<0.01
Geographic Region								
Northeast	1.00				1.00			
Midwest	0.91	0.57	1.47	0.70	0.57	0.33	1.00	0.05
South	0.63	0.41	0.97	0.04	0.52	0.31	0.85	<0.01
West	0.59	0.37	0.95	0.03	0.38	0.22	0.67	<0.01

* OR: Odds Ratios, 95% CI: 95% Confidence Intervals.