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Survival and transplantation in end-stage renal disease: a prospective study of a multiethnic population

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Abstract

Introduction. Accurate assessment of determinants of patient survival in end-stage renal disease is important for counselling, clinical management and resource planning. To address this we have analysed survival and risk factors for survival for patients treated for end-stage renal disease in a multi-ethnic UK population.

Methods. A multicentre prospective observational cohort study was performed in four teaching hospital renal units serving a total population of four million people. A total of 884 consecutive patients treated with renal replacement therapy were studied. Cox proportional hazard modelling and adjusted survival curves were used to assess the impact of a range of variables on patients surviving dialysis for more than 90 days. Further analysis was undertaken to determine the likelihood of transplantation in different ethnic groups.

Results. Survival was 29% after a mean and median follow up of 4.6 and 4.2 years, respectively. Factors associated with worse survival included the following: age; for each decade of life the relative risk (RR) of death was 1.52 (95% confidence intervals 1.41–1.65, $p < 0.0001$); comorbidity, one or two comorbid conditions, RR = 1.56 (95% CI 1.24–1.95, $p < 0.001$) and three or more comorbid conditions, RR = 2.34 (1.68–3.27, $p < 0.001$). Factors associated with better survival included the following: south-Asian ethnicity, RR = 0.6 (0.46–0.80, $p < 0.001$); renal transplantation, RR = 0.20 (95% CI 0.11–0.59, $p < 0.0001$) and glomerulonephritis as the primary renal disease, RR = 0.70 (0.50–0.97, $p = 0.04$). Factors associated with likelihood of transplantion were having a functioning fistula/peritoneal dialysis catheter at start of dialysis (RR 1.91, 95% CI 1.24–2.94, $p = 0.003$) and glomerulonephritis (RR 9.54, 95% CI 2.43–37.64, $p = 0.001$). Patients were less likely to receive if they were black (RR 0.10, 95% CI 0.02–0.34, $p < 0.001$), South Asian (RR 0.64, 95% CI 0.42–0.97, $p = 0.037$), diabetic (RR 0.06, 95% CI 0.01–0.23, $p < 0.001$) and had one or two comorbid conditions (RR 0.51, 95% CI 0.32–0.82, $p = 0.06$). Every decade increase in age was also associated with a lesser likelihood of transplantation (RR 0.55, 95% CI 0.49–0.61, $p < 0.001$).

Discussion. Risk stratification at commencement of chronic dialysis may predict long-term survival in different patient groups. As expected ethnic minorities are less likely to receive a transplant and this should be addressed by the new waiting list prioritization. The better survival on dialysis in this population of patients with south-Asian ethnicity is unexplained and this requires further investigation.

Keywords: comorbidity; end-stage renal disease; ethnicity; survival; transplantation

Introduction

The prevalence of patients with end-stage renal disease in the UK has increased by 50% in the past 10 years and will continue to grow for the foreseeable future in the UK [1] and in other developed countries [2]. The increased numbers of patients requiring treatment with dialysis and renal transplantation will be highest in areas with multiethnic populations [3]. In patients of South Asian or of black ethnicity, the unadjusted relative risk of end-stage renal disease is at least three times that of people of white ethnicity and increases with age [4].

Long-term survival with end-stage renal disease is poor and; most deaths are caused by accelerated cardiovascular disease [5]. However, there are limited prospective data regarding the factors that predict survival for patients with end-stage renal disease in multiethnic UK populations. Such information is important: (i) to enable appropriate counselling for patients with advanced and end-stage renal

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disease, (ii) for assessment and management of modifiable risk factors associated with worse survival and (iii) for modelling the provision of dialysis and renal transplantation services.

To analyse the factors that predict the length of survival in dialysis patients, we performed a prospective multi-centre observational cohort study in a multiethnic population. Demographic and clinical details were collected to correct for independent factors that may influence patient survival and access to transplantation.

Methods

Study population

All patients commencing dialysis treatment for end-stage renal disease at four renal units serving a multiethnic population were included in the study. Recruitment commenced November 1996 until the following dates: Birmingham Heartlands Hospital (BHH), February 2000; University Hospital Birmingham (UHB), February 1999 and New Cross Hospital, Wolverhampton (NEWX), April 1999. Walsgrave Hospital, Coventry (WAL), August 1998. The periods of recruitment were different because the centres stopped prospective registration of all patients who fulfilled criteria for entry at different times; this related to differences in the resources available in different units to commit to the study. This step was taken to limit bias inherent in incomplete recruitment. The demographics of the geographical area covered by the Units changed only by 0.7% between 1991 and 2001 according to the West Midlands Census 2001 [6] and is therefore unlikely to influence the demographics of patients starting renal replacement therapy.

Data collection

We collected the following data set at commencement of dialysis: age, sex, ethnicity, primary renal diagnosis, comorbidity, dialysis modality (haemodialysis or peritoneal dialysis), time of referral to renal services and type of access for dialysis. The ethnic groups were divided into white, South Asian (patients from or originating from India, Pakistan, Bangladesh and Sri Lanka), black (patients originating from Africa or the West Indies) and other (all remaining patients). The primary renal diagnosis was modified from the European Dialysis and Transplantation Association (EDTA) coding system and comprised diabetic nephropathy, hypertensive/vascular nephropathy, glomerulonephritis, pyelonephritis, unknown or other. This system is based on histological or clinical criteria.

Comorbidity

This was analysed by the Stoke comorbidity score, a clinically verified index that is a useful tool for risk stratification in end-stage renal disease [7]. It is defined by the presence or absence of comorbid non-renal diseases at the onset of chronic dialysis. These diseases are ischaemic heart disease, diabetes (type 1 or type 2), peripheral vascular disease, left ventricular dysfunction, malignancy, systemic collagen/vascular disease and other significant pathology.

Other clinical factors: dialysis modality was collected as the initial modality a patient received, i.e. intention to treat. This was grouped as haemodialysis or peritoneal dialysis (continuous ambulatory peritoneal dialysis or automated peritoneal dialysis). Referral to renal services was classified as early, patients with more than 3 months follow-up at the renal unit prior to starting dialysis or late and patients with less than 3 months follow-up. Patients who did not have permanent access at commencement of dialysis (i.e. a mature functioning arteriovenous fistula or graft, or a peritoneal dialysis catheter *in situ*) were classified as requiring temporary access by definition of commencing haemodialysis treatment via a temporary central venous catheter.

Exclusion criteria

Patients who died within 90 days of commencing dialysis ($n = 98$). The study was designed to exclude patients who did not dialyse for >90 days; no data returns were required from participating centres on patients who died or recovered renal function before this time-point.

Other exclusion criteria comprised patients who recovered renal function after 90 days ($n = 4$), patients who were commencing dialysis for renal transplant failure ($n = 15$) and patients where no hospital numbers (identifiers for subsequent outcomes) were included on the returns ($n = 12$). In total, 129 patients were excluded from our analysis.

Outcome measures and statistical analysis

The primary outcome measure was patient death by 1 August 2006. Patients were censored if they were alive and still on dialysis at the end of the follow-up period. Patients were grouped by ethnicity, and the differences between these groups were analysed by the chi-square test and one-way ANOVA depending upon whether the data were continuous or a categorical variable. Cox proportional-hazard model was used to identify independent predictors of survival, with transplantation included as a separate time-dependent covariate. A separate model then examined independent predictors for transplantation. The data were analysed using an SPSS 16.0.00 software package.

Results

Eight hundred and eighty-four new incident end-stage renal disease patients commenced dialysis in the study period. After exclusion, data were analysed on 755 patients. As ethnic groups other than white, South Asian or black only constituted 1% ($n = 8$) of the study population and had no significant difference in outcomes, as they are not shown in the analysis. The mean and median follow-up periods were 4.6 and 4.2 years, respectively. The study population characteristics, separated by ethnicity, are summarized in Table 1. Thirty-nine percent of patients presented within 3 months of commencing dialysis, and 81% of these commenced treatment by temporary dialysis access. In patients who were known to renal units for greater than 3 months, 59% commenced treatment by temporary access.

At the end of the study period, 68.4% of the patients had died, 28.8% were alive and 2.8% were lost to follow-up; these patients had been transferred to other units outside the study group and were therefore censored at analysis. A total of 7.3% had received a renal transplant, of whom 86.6% were alive, 8.9% had died and 4.5% were lost to follow up. Amongst transplant recipients, 7% had sustained graft failure requiring re-commencement of dialysis. Black patients (not adjusted for age) had lower rates of transplantation compared to the other ethnic groups (5.9% transplanted, $P = 0.02$). Patients of South Asian origin were significantly younger than whites and patients of black ethnicity. South Asians and blacks were on dialysis for longer when compared to whites. There was no difference in Ethnic mix within the Renal Units. The most common causes of renal disease were diabetes mellitus (19.8%), glomerulonephritis (15.3%), hereditary nephropathy (12.2%), renal vascular disease/hypertension (11%) and pyelonephritis/interstitial nephritis (7.1%). In 19.6%, the diagnosis was unknown. The primary renal disease was more likely to be diabetes mellitus in patients of black ethnicity (43.1%) and South Asians (32.5%) than whites (15.1%), whereas whites were more likely to have a hereditary nephropathy than other ethnic groups. This difference remained when diabetes was excluded from the analysis. The prevalence of comorbid factors are identified in Table 2. Diabetes mellitus was more common amongst South Asians and patients of black ethnicity, and ischaemic heart disease was more common in South Asians. However, the burden of comorbidity was similar across ethnic groups.

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Table 1. The demographic and clinical details of study population stratified by race

	White (576)	Black (51)	South Asian (120)	Total (755)	*P*-value
Median age (years)	63 (16–86)	63 (28–80)	53 (19–79)	62 (16–86)	<0.001
Gender M:F	1.8:1	1:1	1.7:1	1.7:1	NS[a]
Dialysis duration (years)	3.3 ± 2.6	4.6 ± 2.9	4.6 ± 2.6	3.6 ± 2.6	<0.001
Mean follow-up (years)	4.3 ± 3.1	4.9 ± 3.0	5.6 ± 2.9	4.6 ± 3.1	<0.001
Dialysis modality *HD:PD*[b]	2.6:1	2.9:1	2.5:1	2.6:1	NS
Temporary access[c]	59%	57%	60%	59%	NS
Pre-dialysis follow-up <3 months	40.2%	45.1%	29.2%	38.9%	NS
Renal unit[d]					NS
UHB(334)	74.3%	8.1%	15.8%		
NEWX(104)	77.6%	7.5%	14.9%		
WAL(68)	83.8%	2.9%	13.2%		
BHH (218)	76.1%	5.5%	17.4%		
Percentage transplated	21%	5.9%	25%	20.8%	0.02

[a]Not significant.
[b]HD:PD is the ratio of haemodialysis patients to peritoneal (continuous ambulatory or automated) dialysis patients.
[c]The proportion of patients who commenced dialysis on temporary vascular access.
[d]The percentage of that ethnic group present in the renal unit.

Table 2. Study populations stratified by comorbid conditions and stoke comorbidity score

	White (576)	Black (51)	South Asian (120)	Total (755)	*P*-value
Comorbidity					
Malignancy	9.2%	3.9%	4.2%	8.1%	NS
Ischaemic heart disease	24.8%	11.8%	28.3%	24.2%	0.044
Peripheral vascular disease	12.2%	5.9%	5.0%	10.5%	NS
Left ventricular dysfunction	16.5%	13.7%	20.0%	16.8%	NS
Diabetes mellitus	20.8%	45.1%	40.0%	25.4%	<0.001
Collagen/vascular disorders	5.7%	7.8%	1.7%	5.1%	NS
Other	43.2%	43.1%	40.8%	42.9%	NS
Comorbid score					
0	43.8%	39.2%	38.3%	42.8%	NS
1–2 comorbidities	47.5%	51.0%	51.7%	48.3%	NS
>2 comorbidities	8.7%	9.8%	10.0%	8.9%	NS

Excluded patients

As shown in Table 3, the median age was higher in excluded patients 63 (16–88) years, and this was significantly higher than our analysed cohort ($P = 0.01$). The patients were more likely to have cancer (54.4%, $P < 0.01$), ischaemic heart disease (67.9%, $P < 0.01$), peripheral vascular disease (60.2%, $P < 0.01$), left ventricular disease (62.9%, $P < 0.01$), diabetes mellitus (55.3%, $P < 0.01$) and systemic collagen disorder/vasculitis (46.6%, $P < 0.01$). Hence, the burden of comorbidity was much higher with 66.2% of patients having three or more comorbidities ($P < 0.01$). These patients were less likely to have diabetic nephropathy, hereditary nephropathy and glomerulonephritis (9.0%, 4.5%, 9.1%, respectively, $P = 0.01$). The patients were more likely to present with acute renal failure (63%, $P = 0.01$), require temporary access (74.8%, $P = 0.01$), have a pre-dialysis follow-up less then 3 months (50.8%, $P < 0.01$) and start on haemodialysis (85.0%, $P < 0.01$). However, the ethnic mix was the same in both groups (whites 86.3%, blacks 3.1% and South Asians 10.6%, $P = 0.06$).

Multivariate analysis

End-stage renal disease model. Cox-proportional hazard analysis was used to determine independent risk factors for survival. Patients were only excluded from analysis if lost to follow-up. Transplantation was included in the analysis as a time-dependent covariate. A summary of results of the analysis is shown in Table 4. There was no difference in outcome between renal units (data not shown).

A major determinant of survival was age; for each increased decade of chronological age, the relative risk of death was 1.52 (95% CI 1.41–1.65, $P < 0.0001$). Determinants of better survival were renal transplantation (RR = 0.20, 95% CI 0.11–0.34, $P < 0.0001$) and glomerulonephritis as a primary renal disease (RR = 0.70, 95% CI 0.50–0.97, $P = 0.04$). Non-significant factors included dialysis modality, length of pre-dialysis follow-up and the presence of a functioning fistula or a peritoneal dialysis catheter on commencing dialysis.

Individual comorbid conditions such as malignancy, ischaemic heart disease, peripheral vascular disease, diabetes mellitus and systemic collagen/vascular disorders had a significant negative impact upon survival. There was no significant association with left ventricular dysfunction (RR = 1.21, 95% CI 0.96–1.52). However, the degree of comorbidity was a more significant predictor of survival than individual comorbid conditions, with a stepwise increase in relative risk with an increasing comorbid score (Figure 1).

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Table 3. Excluded patients: clinical and demographical details

		p-value
Median age (years)	63(16–88)	<0.01
Ethnic group		0.06
White	86.3%	
Black	3.1%	
South Asian	10.6%	
Pre dialysis follow-up <3 months	50.8%	<0.01
Temporary access[a]	74.8%	0.01
Dialysis modality HD:PD[b]	5.7:1	<0.01
Acute renal failure	63%	0.01
Comorbidity		
Malignancy	54.4%	<0.01
Ischaemic heart disease	67.9%	<0.01
Peripheral vascular disease	60.2%	<0.01
Left ventricular dysfunction	62.9%	<0.01
Diabetes mellitus	55.3%	<0.01
Collagen/vascular disorders	46.6%	<0.01
Comorbid score		<0.01
0	14.6%	
1–2 comorbidities	38.6%	
>2 comorbidities	66.2%	

The third column represents a comparison between the analysed and excluded cohort.
[a]The proportion of patients who commenced dialysis on temporary vascular access.
[b]HD:PD is the ratio of haemodialysis patients to peritoneal (continuous ambulatory or automated) dialysis patients.
Continuous variables compared via *t*-test and categorical variables compared via chi-square test.

Table 4. Multivariate analysis of the study population: likelihood of death

Risk factor	Relative risk	95% Confidence interval	*P*-value
Age (for every increase in 10 years)	1.52	1.40–1.60	<0.0001
Transplantation	0.20	0.11–0.34	<0.0001
Haemodialysis compared to peritoneal dialysis	1.03	0.79–1.34	0.815
Pre-dialysis follow-up <3 months	1.06	0.86–1.30	0.46
Temporary access[a]	1.21	0.93–1.56	0.15
Glomerulonephritis compared to an unknown PRD.	0.70	0.55–0.97	0.035
Individual comorbidity[b]			
Malignancy	1.93	1.40–2.64	<0.0001
Ischaemic heart disease	1.25	1.01–1.55	0.04
Left ventricular dysfunction	1.20	0.94–1.54	0.10
Peripheral vascular disease	1.35	1.02–1.79	0.035
Diabetes mellitus	1.47	1.06–2.04	0.02
Systemic collagen/vascular disease	1.54	1.00–2.38	0.048
Comorbid score[c]			
1–2 comorbidity	1.56	1.24–1.95	<0.001
>2 comorbidities	2.34	1.68–3.27	<0.001
South Asian (compared to whites)	0.61	0.46–0.80	0.0004

[a]This is a comparison of patients who require temporary vascular access at commencement of dialysis versus patients who have a functioning fistula/graft or peritoneal dialysis catheter.
[b]Reference is those without that comorbidity.
[c]Reference group is zero comorbidities. In this analysis individual comorbid conditions were not entered. i.e. the individual comorbid conditions were entered separately to the stoke comorbid score.

South Asian patients had better survival; their relative risk of death was 0.60 (95% CI 0.46–0.80, $P < 0.001$) when compared to whites. The adjusted survival rates separated by ethnicity are shown in Figure 2.

If transplantation was removed from the analysis and the survival was censored for patients who received transplants and patients alive on dialysis, the risk factors in the original model still remained significant. In addition, patients who had no permanent access for dialysis on commencement on renal replacement therapy had worse survival (RR 1.29, 95% CI 1.01–1.63, $P = 0.04$).

Transplantation model. The median age at the start of the study for transplanted white patients was 41 (17–75) years, black patients was 36 (28–52) years and South Asian patients was 38.5 (19–67) years. The ages were not significantly different ($P = 0.165$). The median waiting time was 2.7 (0.32–9.2), 3.2 (0.47–8.1) and 3.6 (1.1–9.13) years for white, black and South Asian patients, respectively, and the differences were not statistically significant ($P = 0.099$, Kruskal–Wallis test). There was no difference in comorbidity scores or diabetes (data not shown).

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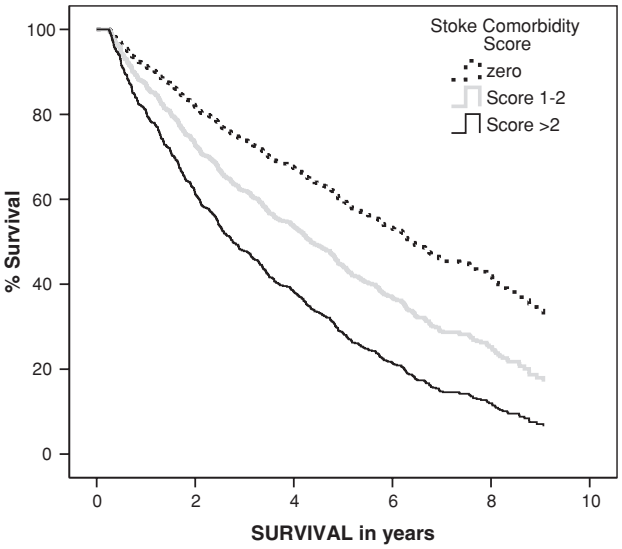

Fig. 1. Adjusted survival curves for comorbidity.

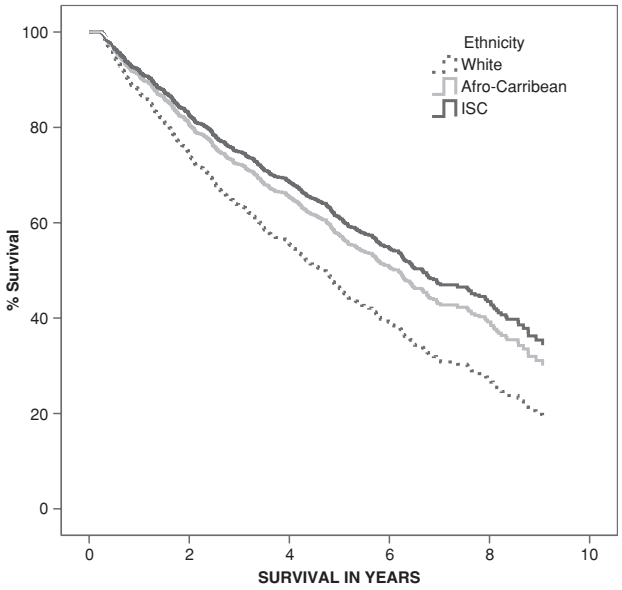

Fig. 2. Adjusted survival curves for ethnicity.

Patients who had either a functioning fistula or a peritoneal dialysis catheter at commencement of dialysis (RR 1.91, 95% CI 1.24–2.94, $P = 0.003$) and glomerulonephritis (RR 9.54, 95% CI 2.43–37.64, $P = 0.001$) had an increased likelihood of receiving a renal transplant (Table 5). Patients were less likely to receive a transplant if they were black (RR 0.10, 95% CI 0.02–0.34, $P < 0.001$), South Asian (RR 0.64, 95% CI 0.42–0.97, $P = 0.037$), had left ventricular dysfunction (RR 0.37, 95% CI 0.17–0.85, $P = 0.02$), diabetes mellitus (RR 0.06, 95% CI 0.01–0.23, $P < 0.001$) or had one or two comorbid conditions (RR 0.51, 95% CI 0.32–0.82, $P = 0.03$). Every decade increase in age was also associated with a lesser likelihood of transplantation (RR 0.55, 95% CI 0.49–0.61, $P < 0.001$). Dialysis modality, pre-dialysis follow-up, any malignancy, ischaemic heart disease, systemic collagen/vascular disease and having more than two comorbities did not impact upon transplantation likelihood.

Discussion

This study analysed outcomes in patients who survived the first 90 days of dialysis. This was consistent with the UK and USRDS definition of end-stage renal disease [8]. Data from the UK renal registry for 2004 showed a mortality (unadjusted) of 9.2% in the first 90 days of dialysis [9].

Table 5. Multivariate analysis: likelihood of transplantation

Risk factor	Relative risk	95% Confidence interval	*p*-value
Age (for every increase in 10 years)	0.55	0.49–0.61	<0.001
Ethnic group (in comparison to white race)			
Black	0.10	0.03–0.34	<0.001
South Asian	0.64	0.42–0.97	0.037
Haemodialysis compared to peritoneal dialysis	1.18	0.80–1 72	0.40
Pre-dialysis follow-up <3 months	1.10	0.72–1.65	0.66
Permanent access[a]	1.91	1.24–2.94	0.003
Glomerulonephritis compared to an unknown PRD	9.54	2.43–37.64	0.001
Individual comorbidity[b]			
Malignancy	0.93	0.11–1.19	0.35
Ischaemic heart disease	0.78	0.38–1.61	0.51
Left ventricular dysfunction	0.37	0.17–0.85	0.02
Peripheral vascular disease	0.74	0.26–2.14	0.58
Diabetes mellitus	0.06	0.01–0.23	<0.001
Systemic collagen/vascular disease	1.81	0.81–4.02	0.15
Comorbid score[c]			
1–2 comorbidity	0.51	0.32–0.82	0.03
>2 comorbidities	0.18	0.02–1.31	0.09

[a]This is a comparison of patients who have a functioning fistula/graft or peritoneal dialysis catheter versus who require temporary vascular access at commencement of dialysis.
[b]Reference is those without that comorbidity.
[c]Reference group is zero comorbidities. In this analysis, individual comorbid conditions were not entered, i.e. the individual comorbid conditions were entered separately to the stoke comorbid score.

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Patients who die in this period have heterogeneous characteristics and are not uniform amongst different centres [10]. Any study that includes patients who die in the first 90 days of dialysis is further confounded by patients with acute kidney injury (AKI). In a prospective study, 75% of patients requiring dialysis for presumed AKI had known CKD (as assessed by a previous creatinine of >150 μmol/l) [11]. The mortality of this group in the first 90 days was 50%. In the patients still alive at 90 days, 12.8% remained dialysis dependent, indicating that a significant number of patients with AKI will need long-term dialysis.

The study confirms the poor long-term survival for patients with end-stage renal disease who receive treatment with dialysis. The average unadjusted survival for patients who survive the first 90 days of dialysis is 50% at 3 years. Age and comorbidity at commencement of dialysis are major determinants of survival. Ethnicity is associated with differential survival, with South Asians having better survival than whites. In transplantation, the likelihood of receiving a renal transplant was lower with increasing age, comorbidity with diabetes, left ventricular dysfunction, a total medium comorbid score and South Asian and black ethnicity.

End-stage renal disease outcomes

Previous UK-based studies have enrolled smaller populations and focused on the relationship of survival with age, comorbidity and functional status. In a single-centre study, Chandna and colleagues showed better survival in patients in whom dialysis was planned compared to patients with late presentation and unplanned commencement [12]. In a study of 221 patients over the age of 70, Lamping and colleagues showed that mortality at 1 year was significantly associated with age and peripheral vascular disease, although not with other comorbidities [13]. In this study, we have used the Stoke comorbidity score, which provides ease of use, and has been validated as a robust tool for assessment of outcome in patients with end-stage renal disease [14].

These data show that comorbidity at the time of commencement of dialysis is associated with worse outcome. Diabetes and peripheral vascular disease directly represent cardiovascular risk and are independently associated with worse survival. Ischaemic heart disease and left ventricular dysfunction were not significantly associated with worse survival in this study; this differs from the DOPPS study [15] and other observational studies [16,17]. This may reflect both the size of study and the way left ventricular failure was recorded. However, this present study is consistent with previously published data showing that diabetes and peripheral vascular disease are powerful predictors of mortality [15]. We also show, consistent with other studies, that individual comorbidities are less important than cumulative comorbidity; a patient with diabetes, peripheral vascular disease, cerebrovascular disease and left ventricular dysfunction has a relative risk of death five times that of a patient with no comorbidity. Although the survival of elderly patients with high comorbidity scores is particularly poor, this analysis was not designed to assess a threshold level of risk that indicates a low survival benefit for dialysis treatment against conservative management. The studies of Lamping and Chandna were not supportive of not proceeding to dialysis in elderly patients in end-stage renal failure and with a high comorbid load.

This study did not include dialysis adequacy as a variable. In a separate UK study that has addressed ethnicity and patient survival [18], the West London Group examined survival amongst South Asian, black and white patients in two centres in London and collected data from similar ages (mean age in our cohort was 58.2 years versus a mean age of 57.1 in the cited cohort) time periods to our study (1996–2001) and with comparable numbers of South Asians (143 versus 120). They found no survival differences in South Asians or blacks but found that a mean pooled Kt/V of 1.4 or more was associated with a higher survival and this was present in a greater proportion of South Asians. However, they did not adjust for detailed comorbidity and the degree of comorbidity. Furthermore, prospective studies have failed to show any benefit of higher dialysis dose [19], and rather than dose of dialysis more rigorous adjustment for incident comorbidity, nutrition, biochemical and haematological markers for these ethnic groups may be required [20]. Incident comorbidity may be especially important as African Americans and Hispanics in the USA have lower rates of severe ischaemic heart disease [21], and this may translate to the South Asian population. One potential confounder is that South Asians presented earlier to nephrologists (though not statistically significant); however, they had the same incidence of temporary dialysis access as other ethnic groups in the cohort. This may reflect the low incidence of people starting dialysis in the UK with permanent access during the time period this study recruited and is consistent with the data from the UK centres that contributed to the DOPPS study (1997–2001) [22].

Transplantation outcomes

We confirm the inequity of transplantation amongst ethnic minorities demonstrated in other UK [23,24] and North American series [25,26]. The possible reasons are underrepresentation of cadaveric donors and reduced live organ donation from ethnic minorities, difficulty in completing pre-transplant work-up [27], significant variation in transplantation work up [28] and differences between donors and potential recipients in the representation of ABO blood groups and HLA tissue types.

Potentially, transplantation could have introduced bias into these analyses. However, censoring for or accounting for transplantation did not affect covariates. As South Asians were less likely to get transplanted than white patients, this may have meant that healthier individuals remained in the study population and produced survival bias. However, the age at which Asian patients were transplanted was similar to Caucasians, their time on dialysis was not different and there was rigorous adjustment for comorbidity. However, further studies are required that adjust both for the proportion of patients who are on the transplant waiting list and for the time they wait before they receive a transplant.

Despite these potential biases, this study comprehensively shows better survival in mixed cohort of South Asian patients when all other factors that were corrected and incorporated over a long study period. These data are consistent

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with an analysis from Canada that showed worse survival for white patients with end-stage renal disease compared to other ethnic groups [29]. Why South Asians have better survival is not yet known. The potential explanations include better nutrition status, an optimal body mass index, genetic factors and bias against listing people who are otherwise fit for a transplant. Non-biological factors such as deprivation and access to health care may also have a role, although in the UK health care is free at the point of access. All these factors require further investigation.

In conclusion, end-stage renal failure treated by dialysis is associated with a poor outcome. A number of variables influence survival including comorbid load and ethnicity. In this UK population on dialysis treatment, South Asians have better survival than whites.

Conflict of interest statement. None declared.

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