Chapter 11
Blood pressure profile of prevalent patients receiving dialysis in the UK in 2007: national and centre-specific analyses

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Key Words
Blood pressure · Chronic kidney disease · Dialysis · End stage renal disease · Epidemiology · Haemodialysis · Peritoneal dialysis · Transplant

Abstract
Introduction: Blood pressure (BP) control is assessed annually from patients on Renal Replacement Therapy at renal centres in England, Wales and Northern Ireland by the UK Renal Registry. ***Methods:*** Patients alive and receiving RRT on 31st December 2007 with a BP reading in either the fourth or third quarter of 2007 were included. Summary statistics were calculated for each renal centre, nation and renal disease category. Linear regression analyses were performed for prevalent patients between 2000 and 2007. ***Results:*** Significantly more haemodialysis patients achieved the BP standard (44.6% pre-HD and 48.8% post-HD) than peritoneal dialysis (32.8%) or renal transplant patients (26.7%). Median BP fell significantly between 2000 and 2007 for each treatment modality. There was significant variability in BP control between renal centres ($p < 0.0001$) for haemodialysis and transplant patients. Hypertension was significantly more common in haemodialysis patients with vascular disorders such as diabetes and renovascular disease (56.8%) than in glomerulonephritis (51.0%) or tubular disorders (45.1%). The effect was less prominent in peritoneal dialysis and not evident in transplant patients where few achieved the BP standard. ***Conclusion:*** A minority of patients on RRT achieved BP standards in 2007. There remained a significant variation in achievement of standards between renal centres.

Introduction

This chapter reports on BP analyses carried out by the UK Renal Registry (UKRR) for data collected from 60 renal centres in England, Wales and Northern Ireland. The Renal Association (RA) Standards Committee sets BP guidelines for patients on renal replacement therapy (RRT) in the UK. In 2002 they recommended the BP target should be lowered to <140/90 mmHg pre-dialysis and <130/80 mmHg post-dialysis for haemodialysis patients (HD) and <130/80 mmHg for peritoneal dialysis (PD) and kidney transplant recipients [1]. The recommendations were based on grade C evidence and

to date there are no randomised controlled trials in this area. The targets were in line with other international organisations that set a low BP standard to reduce cardiovascular disease and mortality in the general population. Hypertension affects 90% of patients starting dialysis. Sustained over many years it leads to left ventricular hypertrophy and dilatation. Both cardiac failure and general poor health cause hypotension and these patients are likely to account for early deaths in blood pressure studies. The association between hypertension and mortality is lost unless comorbidity data identifying end organ damage is available but few studies in this field provide relevant comorbidity data.

Several large observational studies have reported U-shaped or reverse J-shaped relationships between systolic blood pressure (SBP) and mortality in HD patients [2, 3]. Higher baseline pre and post-dialysis SBP is associated with low mortality for the first two years and low baseline SBP (<110 mmHg) higher mortality. The reverse is true after three years with better survival rates for baseline SBP <120 mmHg and higher mortality for baseline SBP ⩾150 mmHg [4]. Since adverse effects of hypertension become apparent after three years, a low BP would be expected to benefit fit individuals with a longer life expectancy. It is likely patients with established comorbidity are dying early in these studies and there has been increasing concern that trying to achieve lower BP targets could precipitate hypotension in these high risk patients. Intradialytic hypotension reduces perfusion of the brain and myocardium and is an independent predictor of mortality [5]. An audit of a single dialysis week for 2,630 HD patients in London showed hypotensive episodes requiring saline resuscitation affected 15% of patients at least once and 2% of patients at each dialysis session [6]. Susceptible individuals had been prescribed fewer antihypertensive medications and hypotension occurred more frequently in individuals who were not receiving any antihypertensive medication. Patients with symptomatic hypotension were shown to have lower pre-dialysis diastolic blood pressure (DBP) and lower pulse pressure (PP) despite higher interdialytic weight gains. HD centres with excellent survival rates control BP by combining low salt intake (5 g/day) and reduced dialysate sodium (136–138 mmol/L) with slow ultrafiltration (prolonged or more frequent dialysis) [7, 8]. Currently it is not known whether patients prone to hypotension will benefit more from a higher BP target or from strict sodium balance and slow ultrafiltration.

BP varies over a 24-hour period and alterations in these patterns are associated with target organ damage and cardiovascular disease. HD patients have an attenuated fall in nocturnal BP (non-dippers) and this has been linked to increased left ventricular mass [9]. They also have marked fluctuations in pre-dialysis SBP that are linked to increased mortality [10]. Ambulatory readings are impractical for routine clinical use so statistical models are increasingly employed to help refine the prognostic value of BP measurements obtained in the dialysis unit. A retrospective study of 6,961 incident HD patients analysed pre-dialysis BP readings taken between day 91 and 180 [11]. Both SBP and DBP variability are linked to all cause mortality within the subsequent six months. Statistical modelling in BP survival analyses need to be validated before their findings can be adopted. This is an active area of research for the UKRR.

The association between baseline BP and survival for PD patients is not as clear as there are few large studies. A retrospective study of 1,053 PD patients in the USA showed mortality is increased in the first two years in patients with low SBP (<111 mmHg) [12]. Cardiac failure was reported in 32% of the cohort and may account for this early mortality. The UKRR reports the association of baseline BP and mortality for a cohort of 2,770 PD patients in England and Wales [13]. Change of treatment modality was incorporated as a time dependant variable in the statistical model to prolong the observation period. Higher SBP, DBP, mean arterial pressure (MAP) and PP are associated with low mortality within the first year. The adverse effects of high SBP and PP became apparent after six years. Activation on the renal transplant waiting list within six months of starting dialysis was used as a surrogate marker for low comorbidity. When these 598 listed patients were considered in isolation high SBP had no protective effect against early mortality. Also the adverse effects of high SBP and PP were apparent earlier (years 4 and 5) in these fit individuals than in the main study cohort. The association of BP and survival is more clear cut in transplant patients as several studies show hypertension is associated with increased mortality [14, 15]. One study shows a progressive improvement in graft and patient survival as SBP falls to <120 mmHg [16]. This relationship is also seen in individuals who had never suffered rejection, supporting a direct link between recipient BP and graft function.

Overall, the evidence supports a low BP target for fit individuals on RRT just as low BP benefits the general

population. The focus of this report is the compliance of UK renal centres with the RA BP guidelines.

Methods

All adult patients receiving RRT in the UK on 31st December 2007 were considered. The method of data extraction employed by the UK Renal Registry is described in chapter 15 of this report. The UKRR extracts quarterly laboratory, clinical and demographic data for all patients receiving RRT in England, Northern Ireland and Wales. Data on some variables are sent annually from the Scottish Renal Registry but BP is not currently sent. Therefore no summary statistics have been calculated for Scotland or Scottish renal centres.

Any patient alive and receiving RRT on 31st December 2007 with a valid BP reading in either the fourth or the third quarter of 2007 was included. This includes incident patients starting RRT during 2007 who were still alive on 31st December. The last recorded BP from quarter 4 was used in the analyses, if this was missing, the last recorded BP from quarter 3 was used instead. Patients with no recorded blood pressure readings in the last two quarters were excluded from the study.

All patients meeting the criteria above were included in the overall national analyses, but renal centres with less than 50% data completeness for any modality, or fewer than 20 patients with results were excluded from the centre-level analysis for that modality.

Analyses were performed on each RRT modality (HD, PD and transplant recipients). Patients on HD were analysed both by pre-dialysis and post-dialysis blood pressure. Patients were included if they had been on the same modality and at the same renal centre for three months. The blood pressure components analysed include SBP, DBP, MAP and PP. The data were analysed to calculate summary statistics (mean, median, maximum, minimum). Standard deviation and quartile ranges were also found. Median BP with inter-quartile ranges (IQRs) are presented for each analysis. In addition to this, the percentage of patients attaining RA Standards for BP (***Pre-haemodialysis BP <140/90 mmHg; Post-haemodialysis, peritoneal dialysis and renal transplant BP <130/80 mmHg***) in each renal centre and each nation was calculated. These are presented in caterpillar plots with 95% confidence intervals.

For the longitudinal analyses, prevalent patients receiving RRT on 31st December of each year between 2000 and 2007 with a BP reading in the final quarter of that year were included.

Finally, the BP analyses (both median BP and percentage attaining RA Standards) were studied by underlying primary renal disease (PRD). The list of primary renal diseases is shown in appendix G. These analyses were repeated after combining diabetic nephropathy and reno-vascular disease into a 'vascular' group, and combining pyelonephritis and polycystic kidney disease into a 'tubular' group. These two combination groups were compared with the existing glomerulonephritis group.

Chi-squared tests were used to test for statistically significant differences between renal centres, nations and primary renal disease groups. A linear regression analysis was used to test longitudinal changes over the last eight years. All statistical analyses were performed using SAS version 9.1.3.

Results

Data completeness

Blood pressure data extractions from 60 centres in England, Northern Ireland and Wales were performed. There were 16,070 BP readings available from a total of 37,720 patients (15,924 HD, 3,699 PD and 18,097 transplant (Tx)). Most centres managed patients treated with HD, PD and renal transplants and the completeness of data returns is listed in table 11.1. There were three centres (Bangor, Liverpool Aintree and Wirral) which did not manage transplant patients and one (Liverpool Aintree) without PD patient follow up. The number preceding the centre name in each figure indicates the percentage of missing data for that centre.

BP data was complete in 60% of haemodialysis patients (pre-HD), 56% post-HD, 40% of PD patients and 31% of transplant recipients. Consistently high levels (>80%) of BP data returns from the three modalities of RRT were obtained from only 12 centres and there were 12 centres where no BP data were available for analysis. The extent to which this is due to a lack of data entry locally in renal centres as opposed to failings in the transmission of recorded data to the UKRR is not known.

Summary of BP achievements

Figure 11.1 summarises the median SBP, DBP and PP readings (with IQRs) for all treatment modalities from renal centres in England, Wales and Northern Ireland.

BP readings from 16,070 out of 37,720 patients were analysed. The results shown for HD patients are post-dialysis readings. Median systolic and diastolic blood pressures were lower in HD patients than in PD and transplant patients (SBP: 128 (HD), 132 (PD) and 135 mmHg (Tx); DBP: 68 (HD), 78 (PD) and 79 mmHg (Tx)). Pulse pressure readings in HD patients were greater than in PD and transplant patients (60 (HD), 55 (PD) and 56 mmHg (Tx)).

Haemodialysis

Pre-HD readings from 9,478 out of 15,924 patients and post-HD readings from 8,978 out of 15,924 patients were available for analysis. Due to poor returns, 16 centres were excluded from the pre-HD centre-specific analyses and 18 centres from the post-HD analyses.

Figure 11.2 illustrates the performance of centres and nations in achieving the previous RA BP standard for pre-HD blood pressure (<140/90 mmHg). Overall, 45% of patients achieved this standard. There was significant variation in achievement between centres (range

Table 11.1. Percentage of patients with complete returns of blood pressure values by modality

Centre	% completed data				Centre	% completed data			
	Pre HD	Post HD	PD	Transplants		Pre HD	Post HD	PD	Transplants
Antrim	97	97	0	19	Liv Ain	3	93	n/a	n/a
B Heart	92	92	0	1	Liv RI	82	81	28	75
B QEH	0	0	0	1	M Hope	0	0	1	0
Bangor	93	93	97	n/a	M RI	0	0	0	0
Basldn	98	98	96	2	Middlbr	97	95	92	49
Belfast	94	92	28	87	Newc	0	0	0	1
Bradfd	2	1	92	90	Newry	99	99	0	2
Brightn	0	0	0	0	Norwch	86	86	0	1
Bristol	100	98	96	81	Nottm	98	98	99	95
Camb	52	52	0	1	Oxford	97	96	67	13
Cardff	7	0	3	94	Plymth	96	0	0	0
Carlis	95	95	0	0	Ports	99	99	78	10
Carsh	66	66	1	0	Prestn	0	0	0	0
Chelms	100	100	94	92	Redng	95	37	99	99
Clwyd	1	4	85	91	Sheff	99	97	100	97
Covnt	99	97	82	65	Shrew	100	98	33	19
Derby	99	99	1	6	Stevng	98	98	0	0
Derry	100	100	100	80	Sthend	97	97	6	0
Donc	11	11	3	0	Stoke	98	98	2	0
Dorset	99	99	91	8	Sund	96	96	0	1
Dudley	88	79	96	56	Swanse	97	97	16	3
Exeter	99	66	96	79	Truro	98	98	83	54
Glouc	96	96	0	0	Tyrone	97	96	100	85
Hull	95	95	55	0	Ulster	99	99	100	100
Ipswi	100	100	89	89	Wirral	89	30	21	n/a
L Barts	0	0	0	0	Wolve	99	98	98	96
L Guys	0	0	0	0	Wrexm	97	96	0	45
L Kings	0	0	1	0	York	100	97	100	85
L Rfree	0	0	0	0	**England**	**59**	**56**	**42**	**27**
L West	8	2	0	0	**N Ireland**	**96**	**95**	**28**	**74**
Leeds	96	93	96	83	**Wales**	**46**	**43**	**20**	**79**
Leic	99	97	97	27	**E, W & NI**	**60**	**56**	**40**	**31**

n/a not applicable

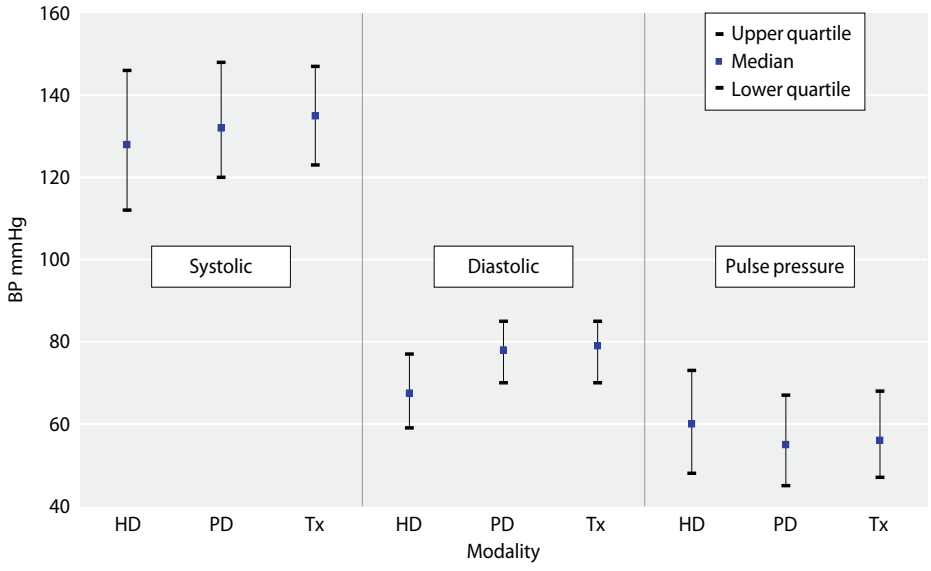

Fig. 11.1. Summary of BP achievements

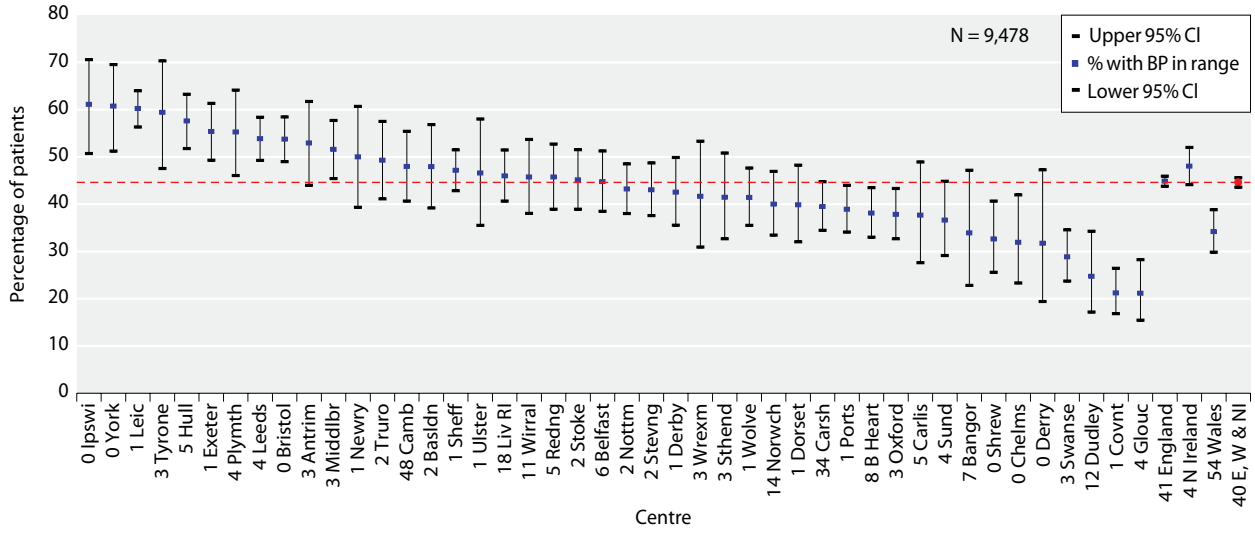

Fig. 11.2. Percentage of patients with BP <140/90 mmHg: pre-HD

21–61%, Chi-Squared test, $p < 0.0001$) and between nations (range 34–48%, $p < 0.0001$).

Figure 11.3 illustrates the performance of centres and nations in achieving the previous RA BP standard for post-HD blood pressure (<130/80 mmHg). Overall, 49% of patients achieved this standard. There was significant variation in achievement between centres (range 25–63%, $p < 0.0001$) and between nations (range 39–50%, $p < 0.0001$).

Figure 11.4 shows the median pre-HD systolic blood pressure by both centre and nation. The median pre-HD SBP for all patients was 141 mmHg. The median pre-HD SBP ranged from 128–158 mmHg between centres and from 141–148 mmHg between nations.

Figure 11.5 illustrates the performance of centres and nations in achieving the previous RA BP standard for pre-HD systolic blood pressure (<140 mmHg). Overall, 47% of patients achieved this standard. There was significant variation in achievement between centres (range 21–68%, $p < 0.0001$) and between nations (range 36–49%, $p < 0.0001$).

Figure 11.6 shows the median post-HD systolic blood pressure by both centre and nation. The median post-HD SBP for all patients was 128 mmHg. The median

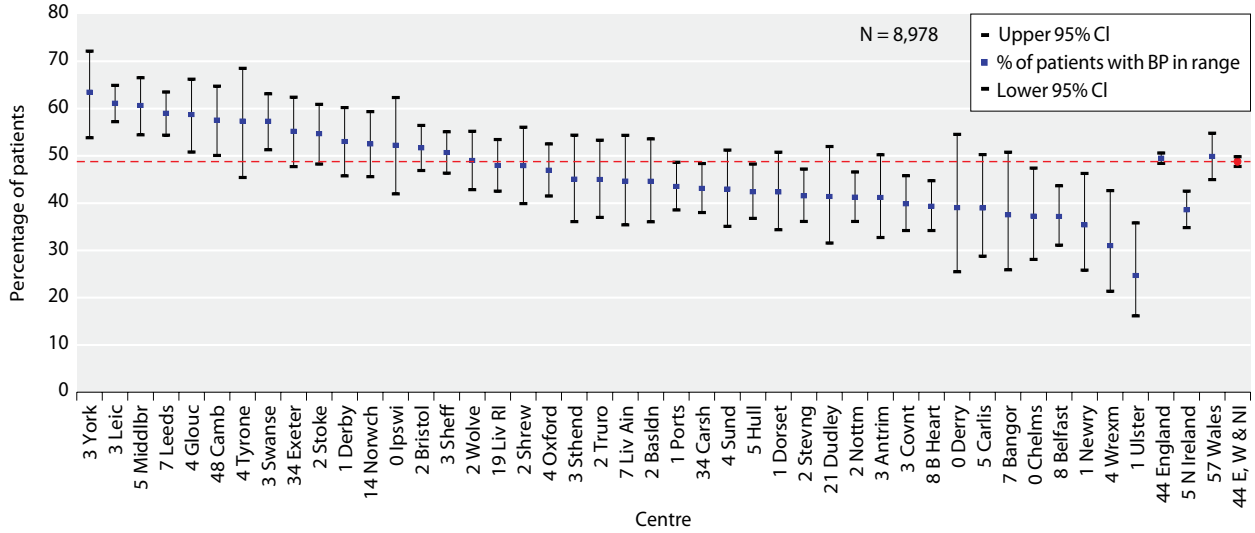

Fig. 11.3. Percentage of patients with BP <130/80 mmHg: post-HD

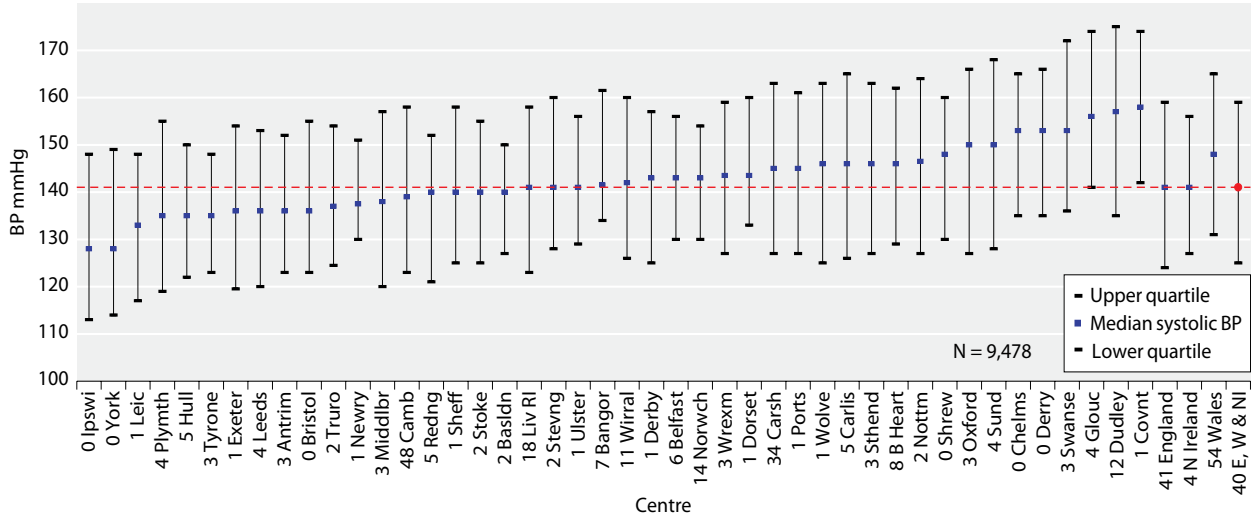

Fig. 11.4. Median systolic BP: pre-HD

post-HD SBP ranged from 119–144 mmHg between centres and from 128–134 mmHg between nations.

Figure 11.7 illustrates the performance of centres and nations in achieving the previous RA BP standard for post-HD systolic blood pressure (<130 mmHg). Overall, 52% of patients achieved this standard. There was significant variation in achievement between centres (range 26–66%, $p < 0.0001$) and between nations (range 41–54%, $p < 0.0001$).

Figure 11.8 shows the median pre-HD diastolic blood pressure by both centre and nation. The median pre-HD DBP for all patients was 74 mmHg. The median pre-HD DBP ranged from 66–81.5 mmHg between centres and from 73–74 mmHg between nations.

Figure 11.9 illustrates the performance of centres and nations in achieving the previous RA BP standard for pre-HD diastolic blood pressure (<90 mmHg). Overall, 85% of patients achieved this standard. There was significant variation in achievement between centres (range 68–98%, $p < 0.0001$) and between nations (range 82–91%, $p < 0.0001$).

Figure 11.10 shows the median post-HD diastolic blood pressure by both centre and nation. The median post-HD DBP for all patients was 67.5 mmHg. The

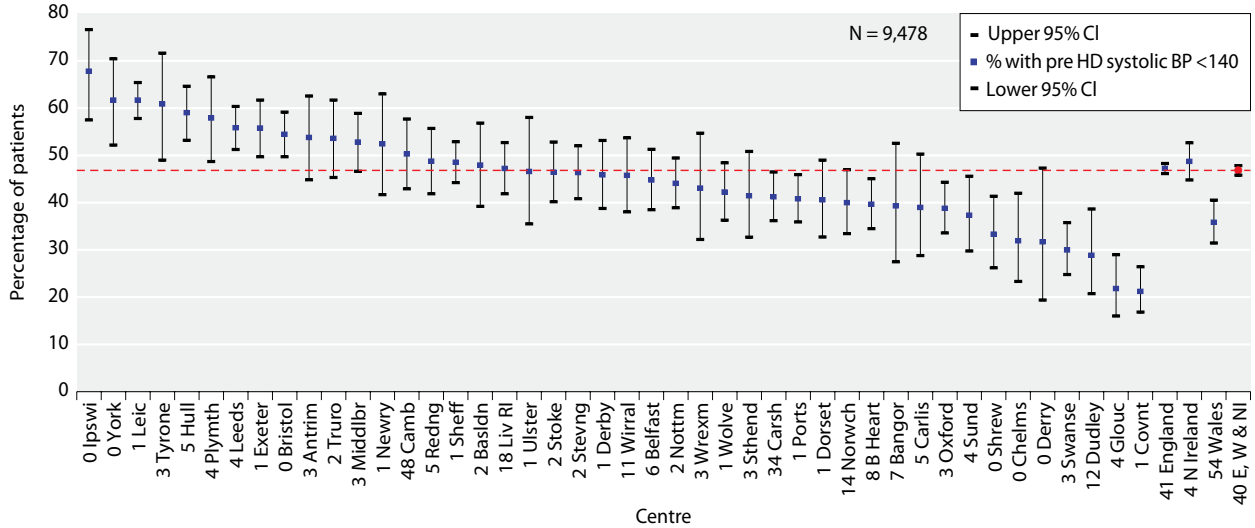

Fig. 11.5. Percentage of patients with systolic BP <140 mmHg: pre-HD

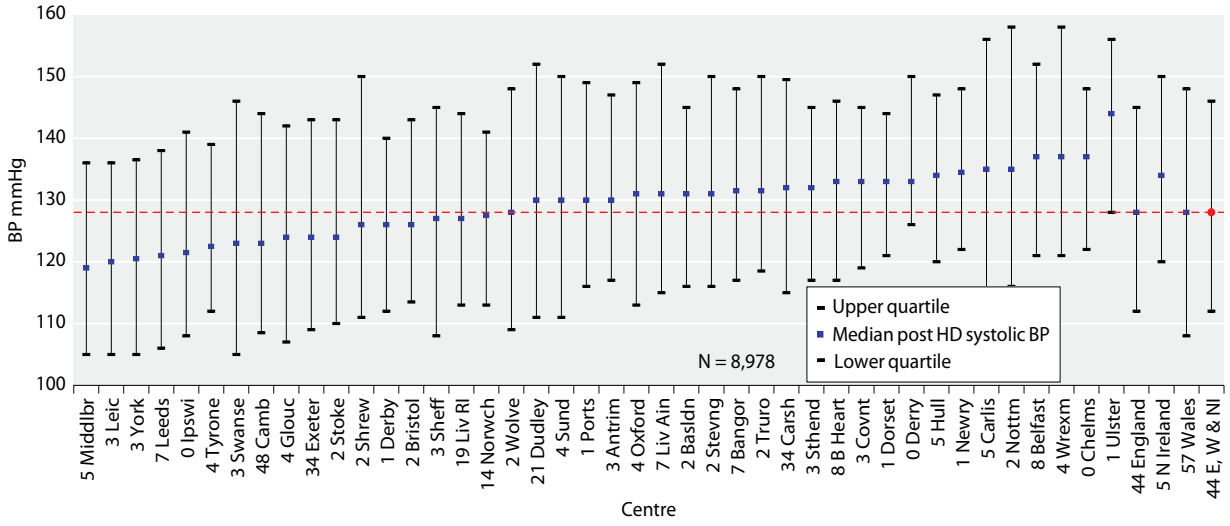

Fig. 11.6. Median systolic BP: post-HD

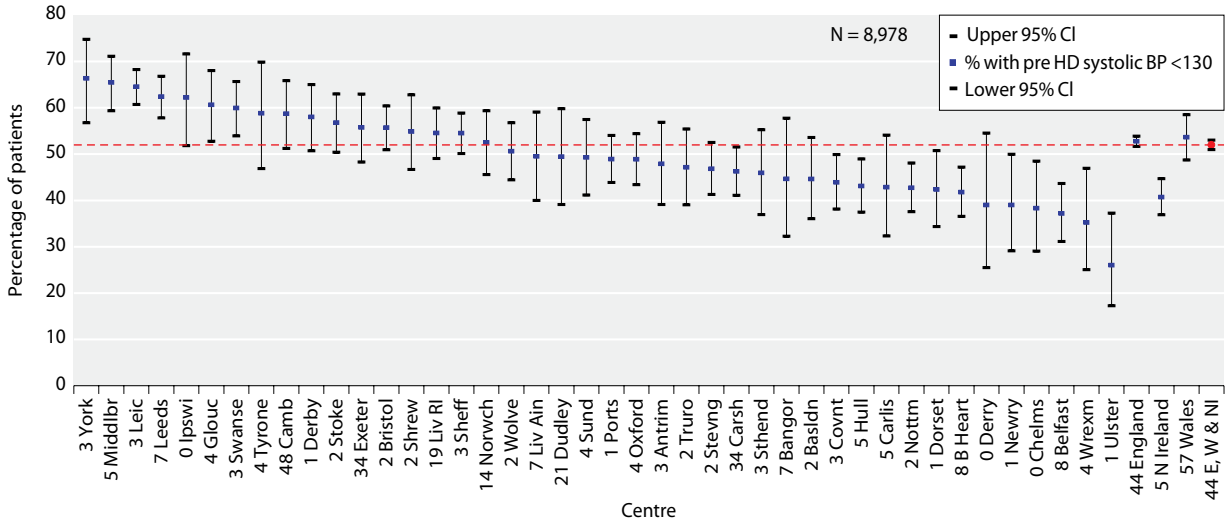

Fig. 11.7. Percentage of patients with systolic BP <130 mmHg: post-HD

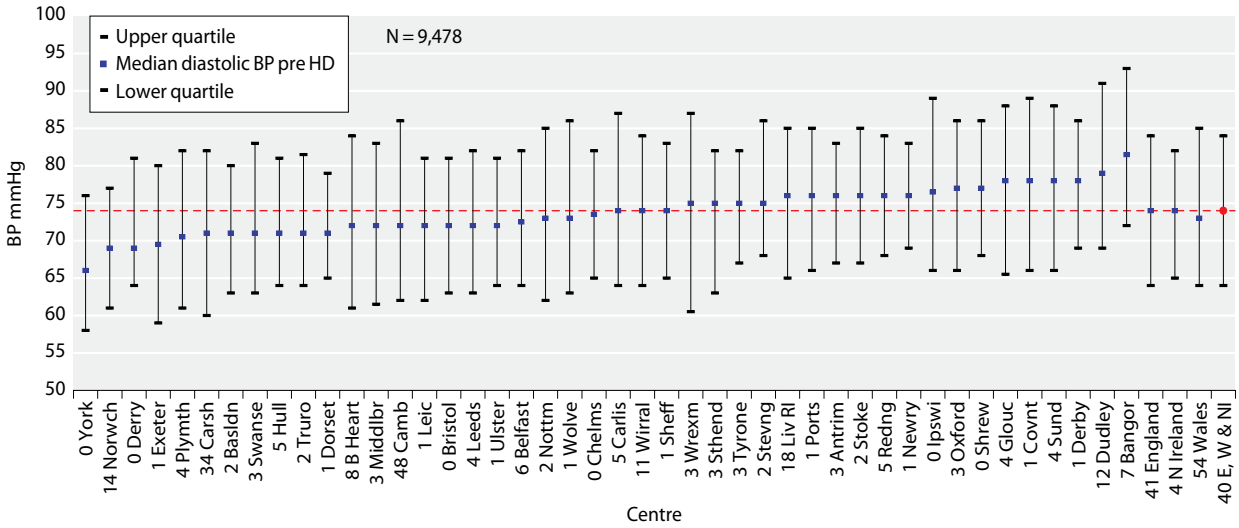

Fig. 11.8. Median diastolic BP: pre-HD

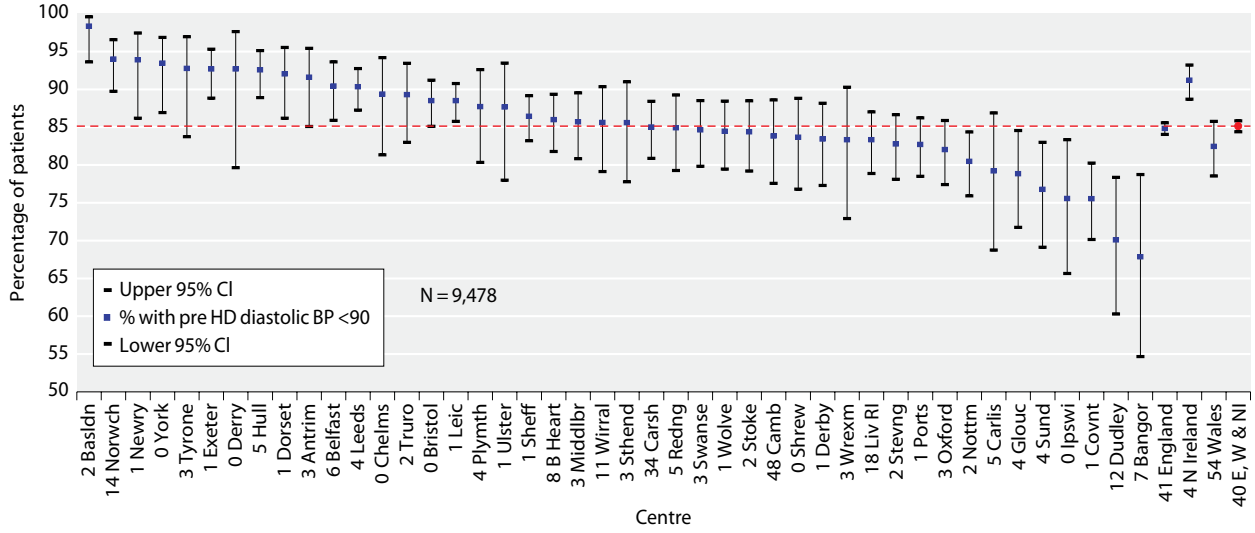

Fig. 11.9. Percentage of patients with diastolic BP <90 mmHg: pre-HD

median post-HD DBP ranged from 61–73.5 mmHg between centres and from 66–71 mmHg between nations.

Figure 11.11 illustrates the performance of centres and nations in achieving the previous RA BP standard for post-HD diastolic blood pressure (<80 mmHg). Overall, 79% of patients achieved this standard. There was significant variation in achievement between centres (range 66–90%, $p < 0.0001$) but not between nations (range 78–81%, $p = 0.55$).

Figure 11.12 shows the median pre-HD pulse pressure by both centre and nation. The median pre-HD PP for all patients was 66 mmHg. The median pre-HD PP ranged from 51–80 mmHg between centres and from 66–71 mmHg between nations.

Figure 11.13 shows the median post-HD pulse pressure by both centre and nation. The median post-HD PP for all patients was 60 mmHg. The median post-HD PP ranged from 49–72 mmHg between centres and from 59–62 mmHg between nations.

Peritoneal dialysis

A total of 1,461 blood pressure readings from 3,699 PD patients were analysed. Thirty eight centres with poor data returns were not included in the centre-specific analyses of PD patients.

Figure 11.14 illustrates the performance of centres and nations in achieving the RA standard for blood pressure control in patients on peritoneal dialysis (<130/

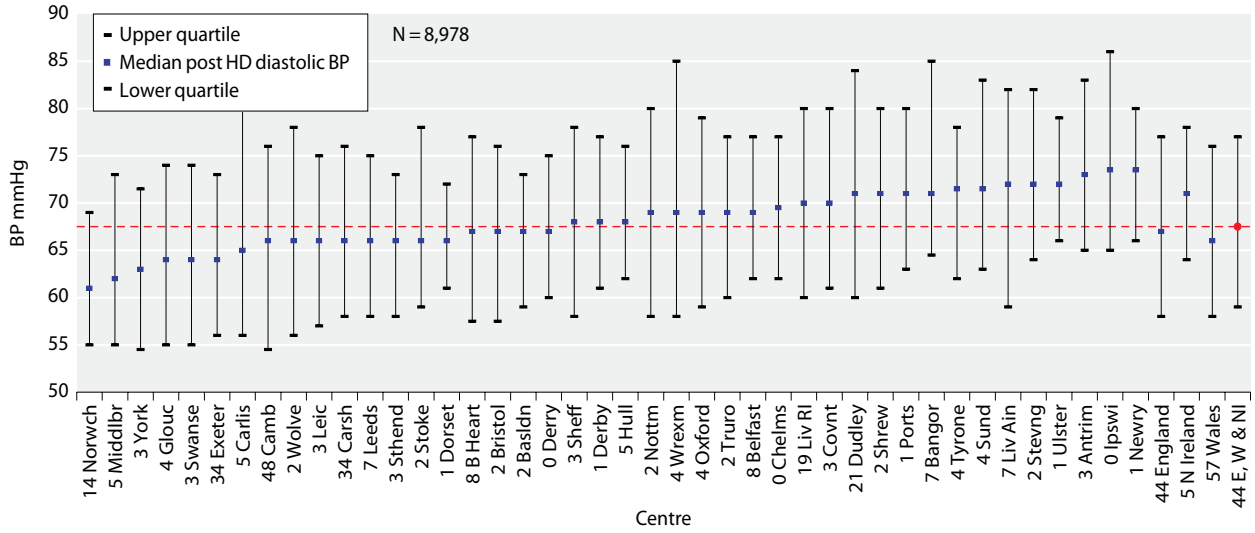

Fig. 11.10. Median diastolic BP: post-HD

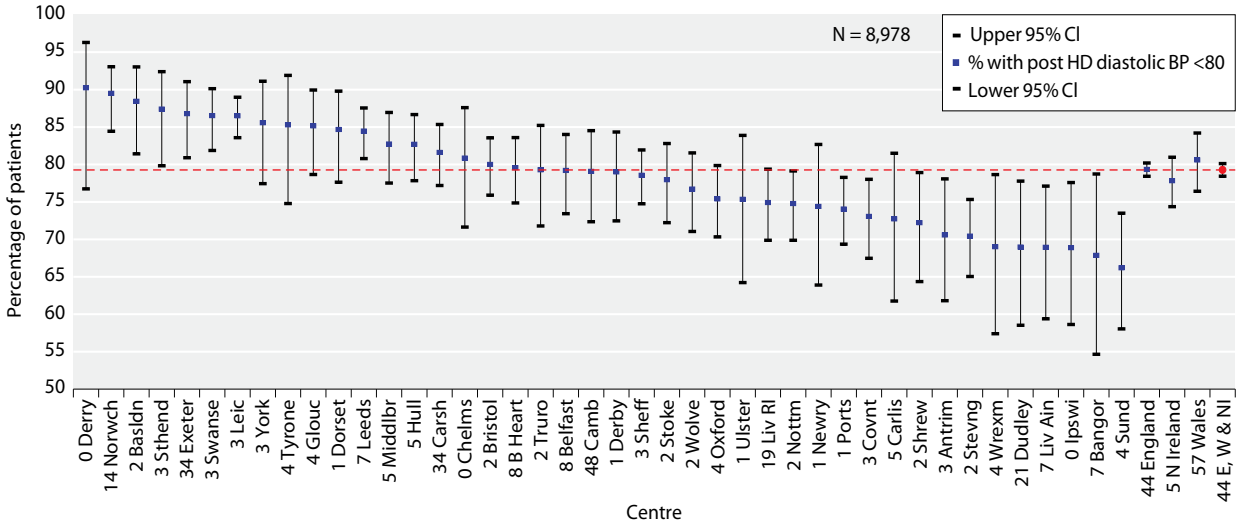

Fig. 11.11. Percentage of patients with diastolic BP <80 mmHg: post-HD

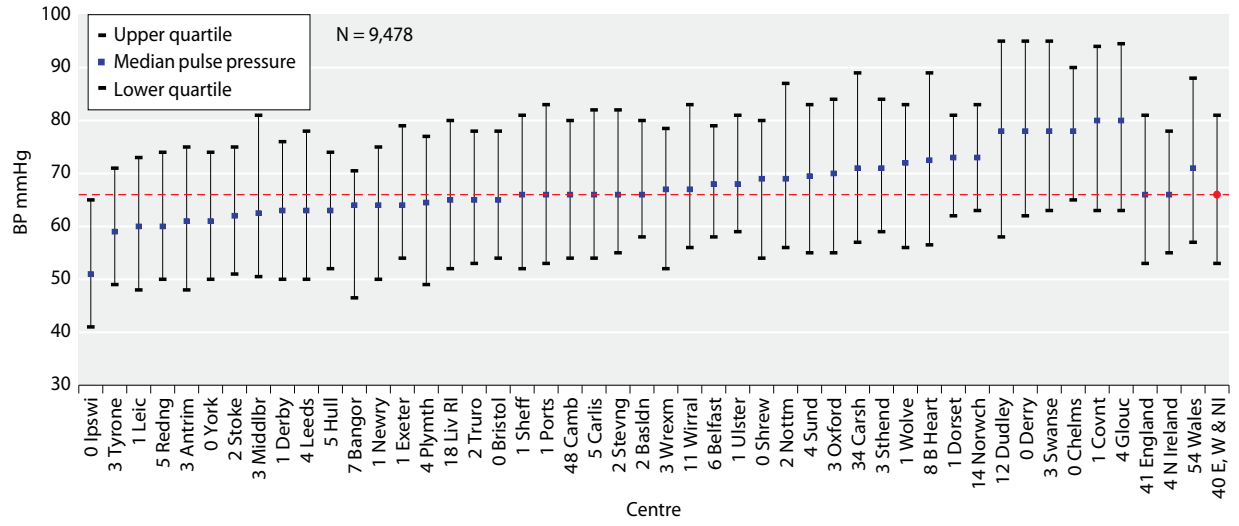

Fig. 11.12. Median PP: pre-HD

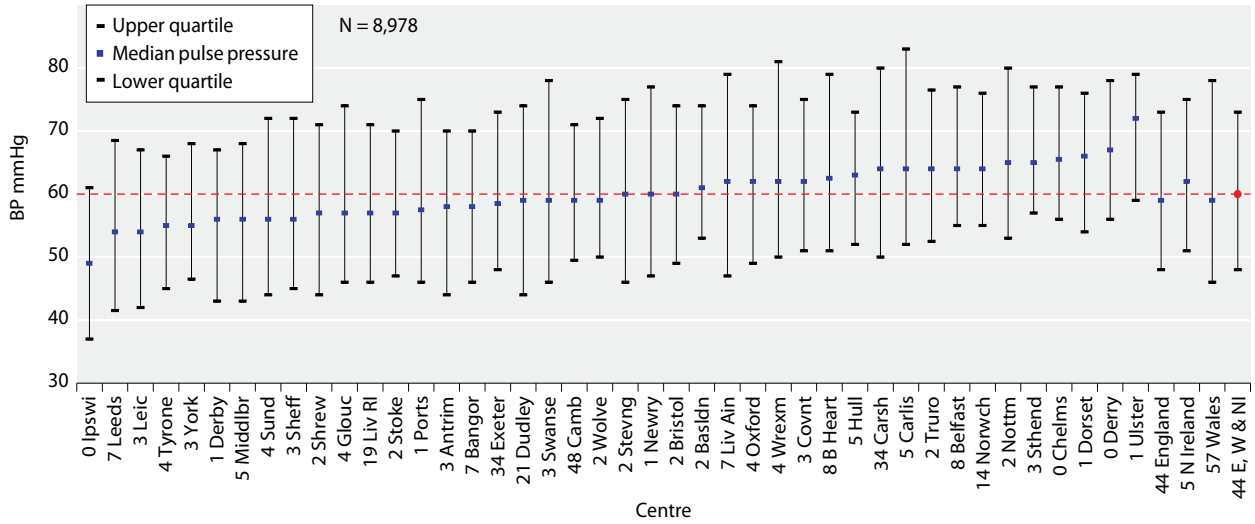

Fig. 11.13. Median PP: post-HD

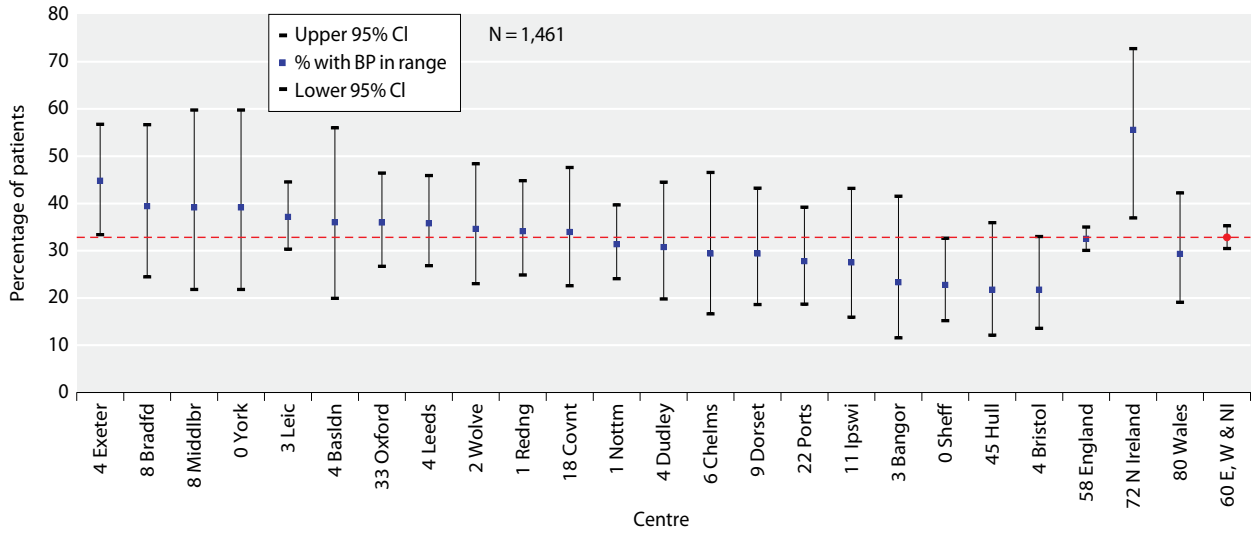

Fig. 11.14. Percentage of patients with BP <130/80: PD

80 mmHg). Overall, 33% of PD patients achieved this standard. There was no difference between renal centres achieving this standard (range 22–45%, p = 0.33).

Figure 11.15 shows the median systolic blood pressure in PD patients by both centre and nation. The median SBP for all PD patients was 132 mmHg and ranged from 122–146 mmHg between centres.

Figure 11.16 illustrates the performance of centres and nations in achieving the RA standard for systolic blood pressure control in patients on peritoneal dialysis (<130 mmHg). Overall, 42% of PD patients achieved this standard. The difference between centres in achieving this standard was of borderline significance (range 27–60%, p = 0.018).

Figure 11.17 shows the median diastolic blood pressure in PD patients by both centre and nation. The median DBP for all PD patients was 78 mmHg and ranged from 72–82 mmHg between centres.

Figure 11.18 illustrates the performance of centres and nations in achieving the RA standard for diastolic blood pressure control in patients on peritoneal dialysis (<80 mmHg). Overall, 53% of PD patients achieved this standard and there was no difference between individual centres (range 40–65%, p = 0.07).

Figure 11.19 shows the median pulse pressure in PD patients by both centre and nation. The median PP for all PD patients was 55 mmHg and ranged from 45–63 mmHg between individual centres.

Transplant

A total of 5,630 blood pressure readings from 18,097 transplant recipients were analysed. Thirty eight centres

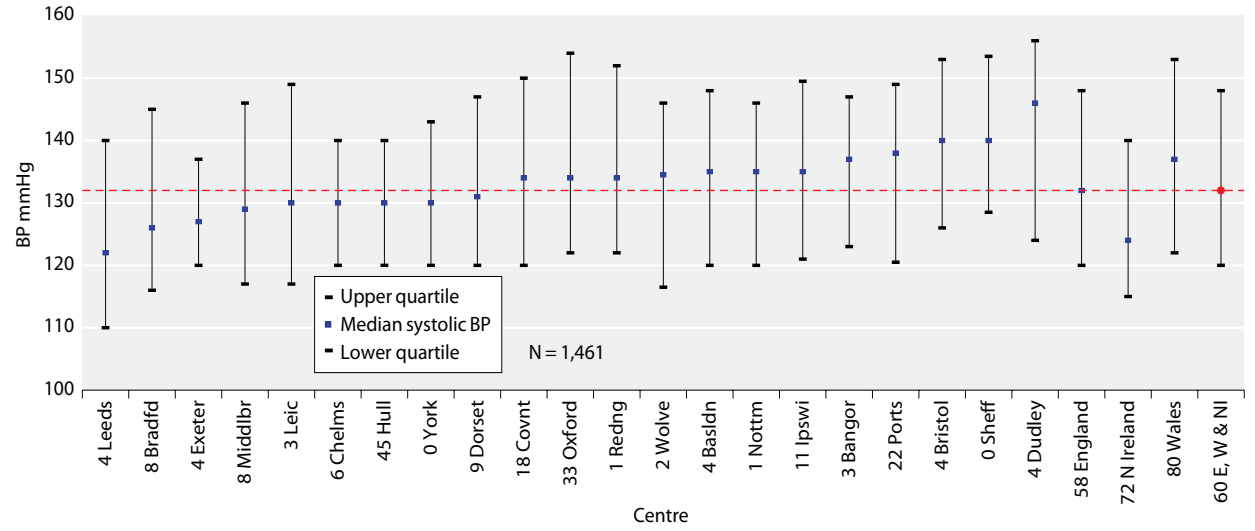

Fig. 11.15. Median systolic BP: PD

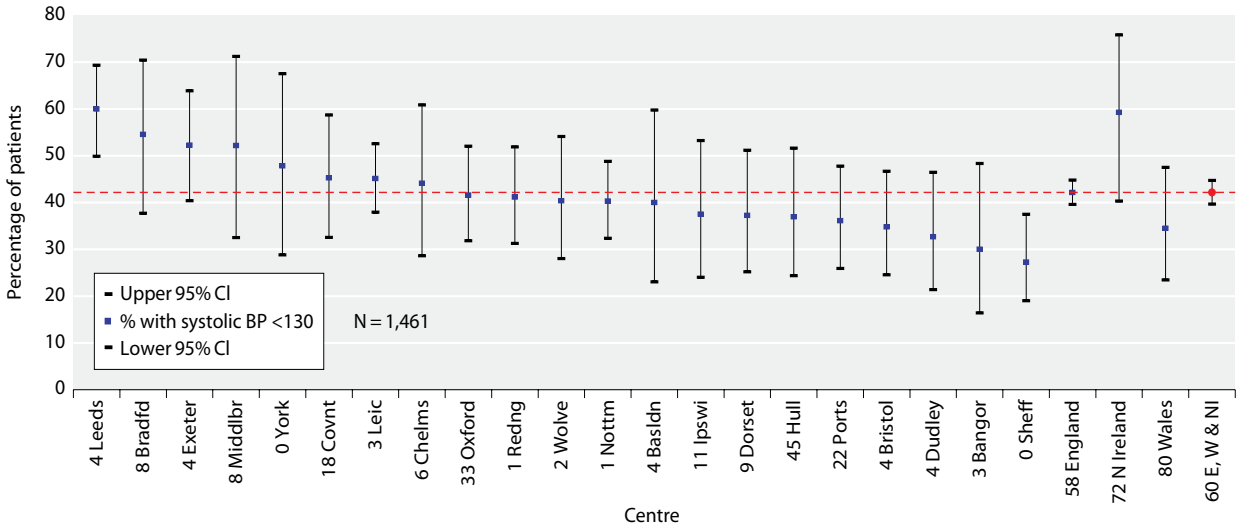

Fig. 11.16. Percentage of patients with systolic BP <130 mmHg: PD

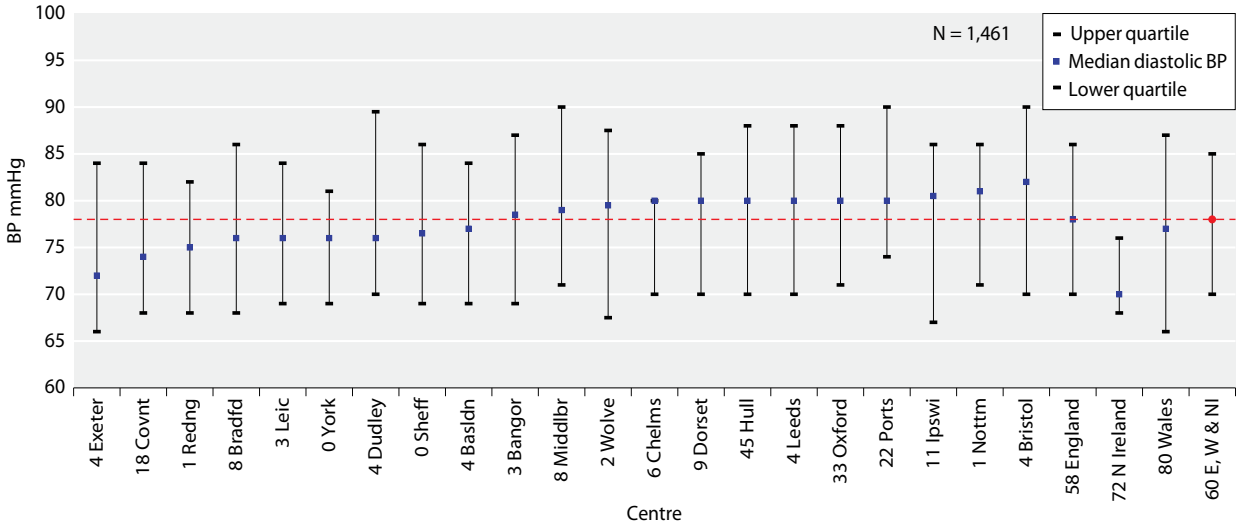

Fig. 11.17. Median diastolic BP: PD

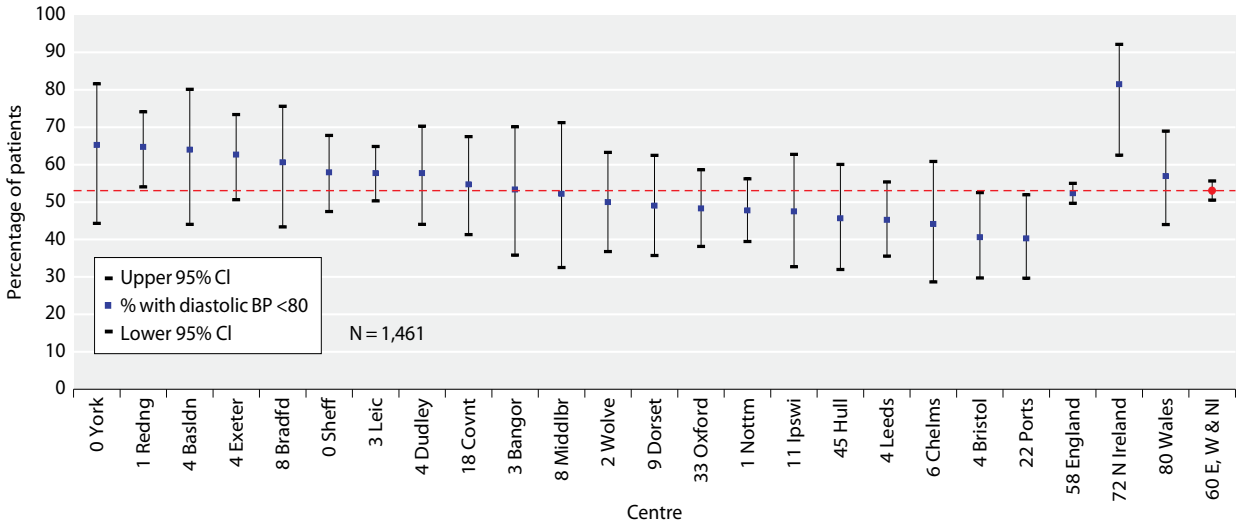

Fig. 11.18. Percentage of patients with diastolic BP <80 mmHg: PD

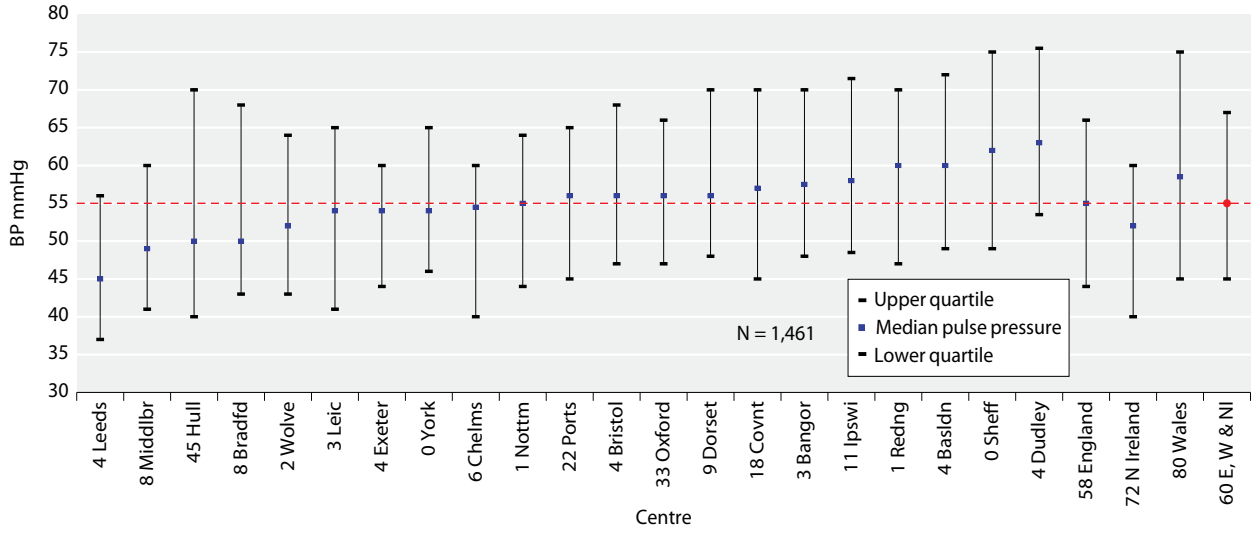

Fig. 11.19. Median PP: PD

with poor data returns have not been included in the centre-specific analyses of renal transplant recipients.

Figure 11.20 illustrates the performance of centres and nations in achieving the RA standard for blood pressure control in kidney transplant recipients (<130/80 mmHg). Overall, 27% of transplant patients achieved this standard but there was significant variation in achievement between centres (range 5–43%, $p < 0.0001$).

Figure 11.21 shows the median systolic blood pressure in transplant recipients by both centre and nation. The median SBP for all transplant patients was 135 mmHg and ranged from 124–142.5 mmHg between centres.

Figure 11.22 illustrates the performance of centres and nations in achieving the RA standard for systolic blood pressure control in kidney transplant recipients (<130 mmHg). Overall, 36% of transplant patients achieved this standard but there was significant variation in achievement between centres (range 21–59%, $p < 0.0001$).

Figure 11.23 shows the median diastolic blood pressure in transplant recipients by both centre and nation. The median DBP for all transplant patients was 79 mmHg and ranged from 70–84 mmHg between centres.

Figure 11.24 illustrates the performance of centres and nations in achieving the RA standard for diastolic blood pressure control in kidney transplant recipients (<80 mmHg). Overall, 51% of transplant patients

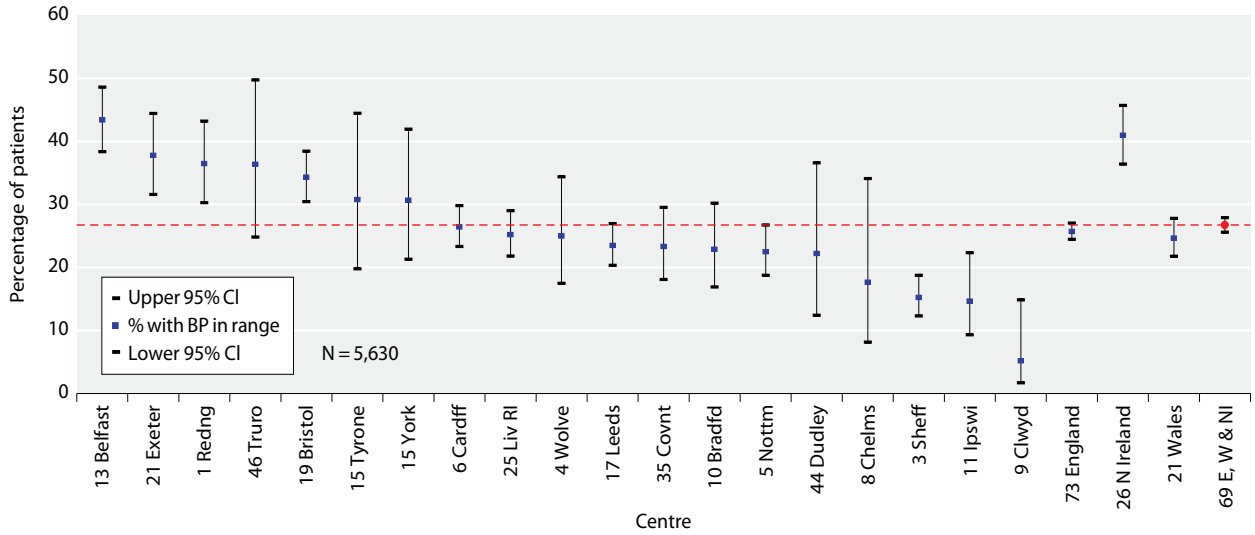

Fig. 11.20. Percentage of patients with BP <130/80: transplant

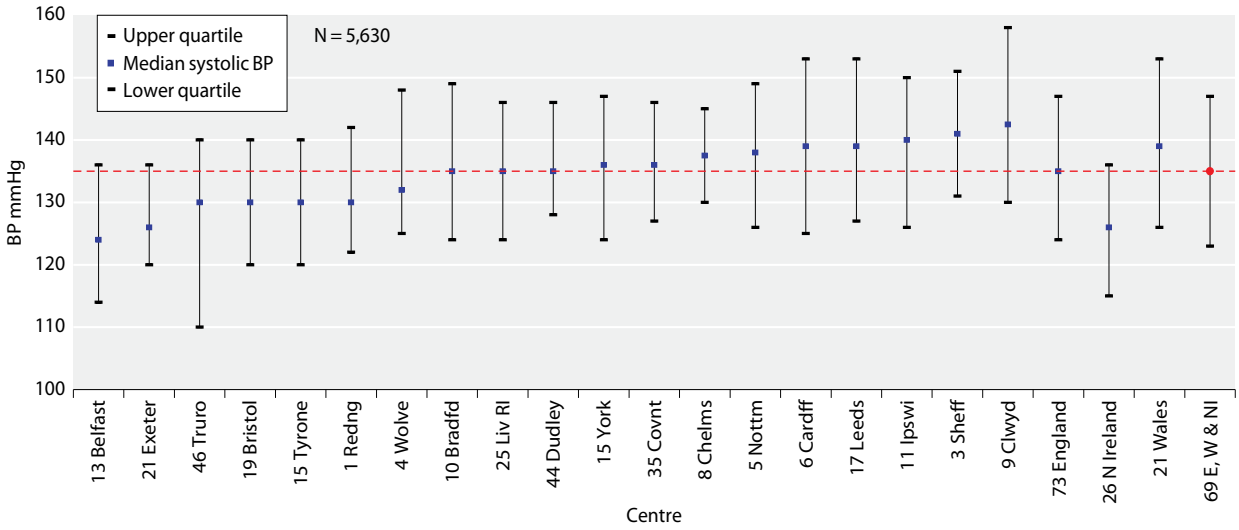

Fig. 11.21. Median systolic BP: transplant

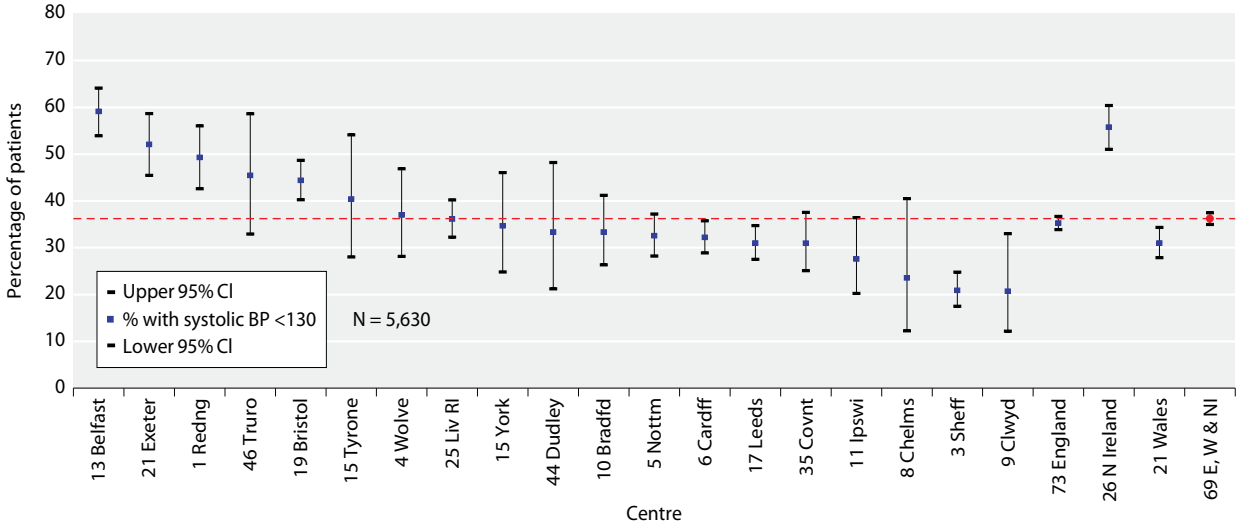

Fig. 11.22. Percentage of patients with systolic BP <130 mmHg: transplant

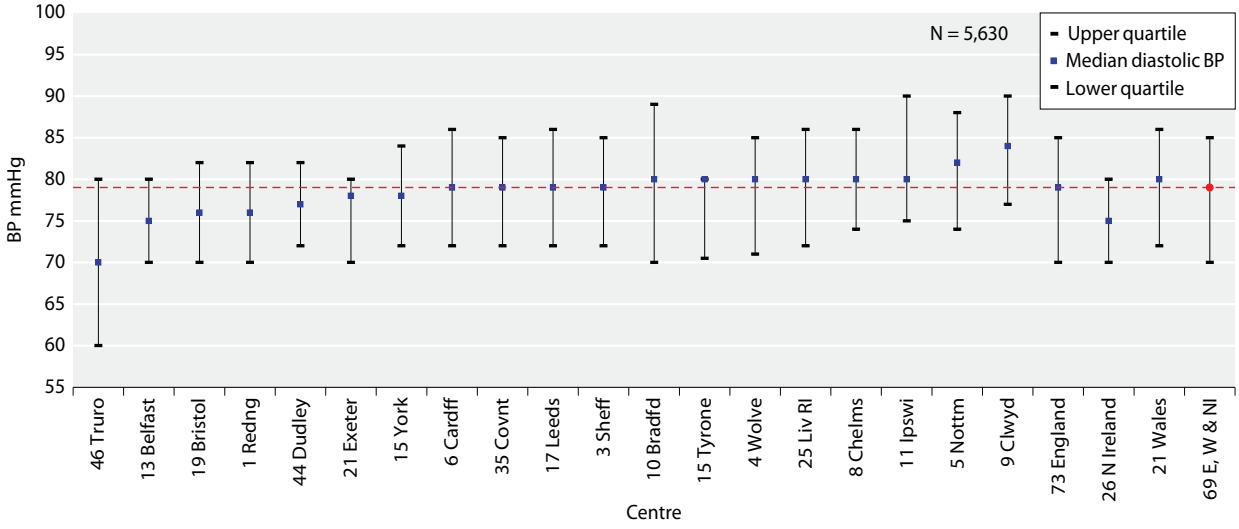

Fig. 11.23. Median diastolic BP: transplant

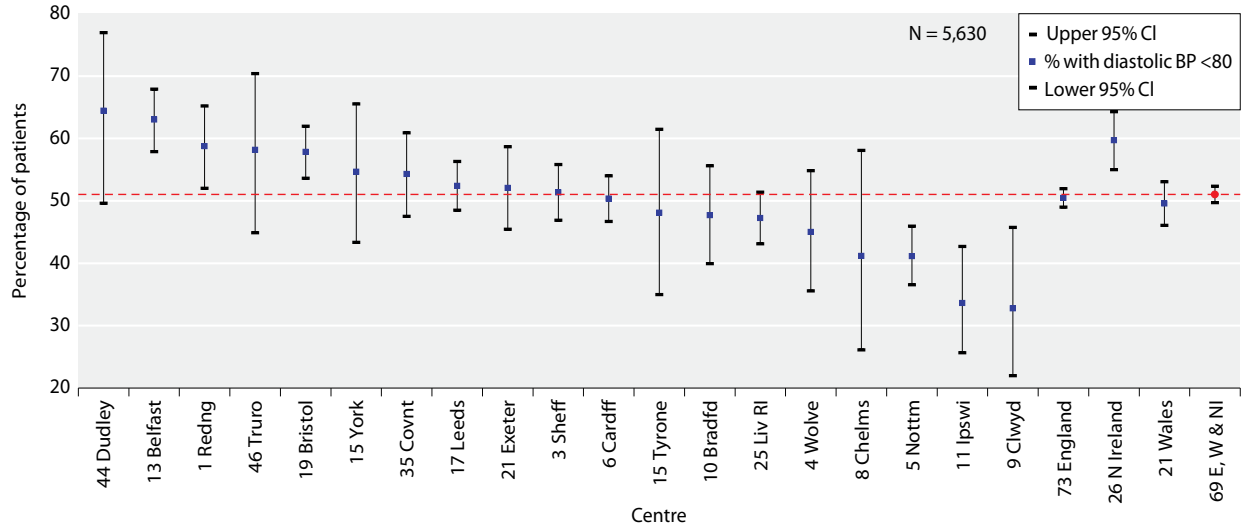

Fig. 11.24. Percentage of patients with diastolic BP <80 mmHg: transplant

achieved this standard but there was significant variation in achievement between centres (range 33–64%, $p < 0.0001$).

Figure 11.25 shows the median pulse pressure in transplant recipients by both centre and nation. The median PP for all transplant patients was 56 mmHg and ranged from 50–61 mmHg between centres.

Blood pressure by primary renal diagnosis

The prevalence of hypertension was assessed for each renal diagnostic category. A renal diagnosis was not available for 5.1% of cases and an uncertain diagnosis recorded for 22.3%. The main diagnostic groups included diabetes (12.9%), glomerulonephritis (15.2%), polycystic kidney disease (9.2%), pyelonephritis (11.9%), renovascular disease (8.8%) and other conditions (14.6%). BP readings within the last two quarters of 2007 were available for between 40 and 47% of patients in each diagnostic category but for only 19.5% of cases with no recorded renal diagnosis.

Figure 11.26 describes the attainment of BP <130/80 mmHg by diagnostic category and RRT modality (post-HD data shown). Significantly more HD patients (than PD or transplant) achieved the BP standard across all diagnostic groups (Chi Squared test, $p < 0.0001$). More PD than transplant patients achieved the BP standard in each diagnostic category except glomerulonephritis ($p < 0.0001$). There was significant

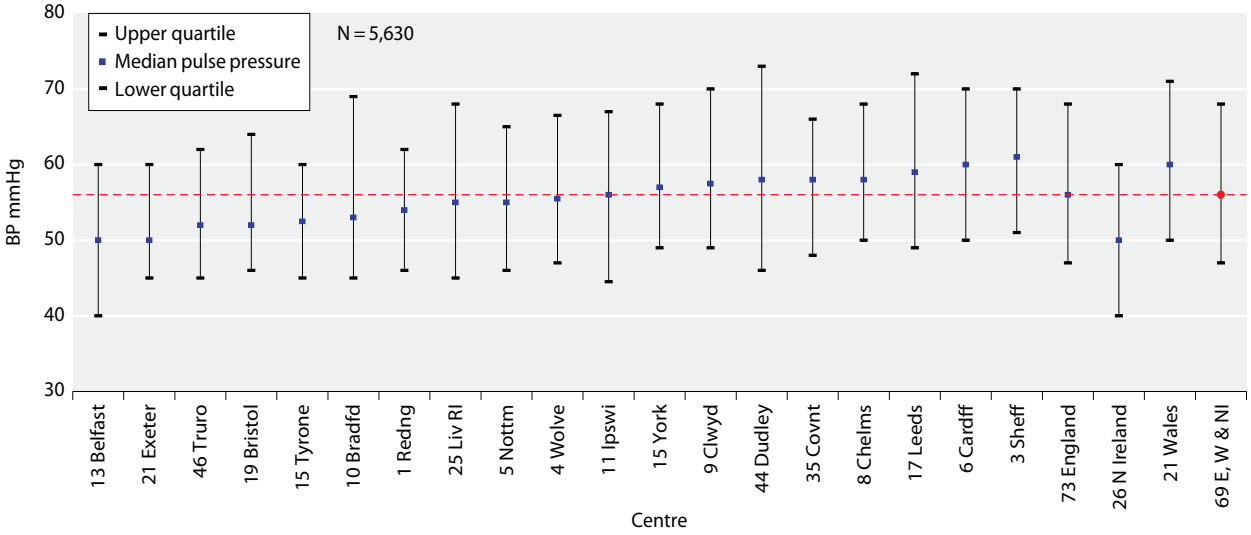

Fig. 11.25. Median PP: transplant

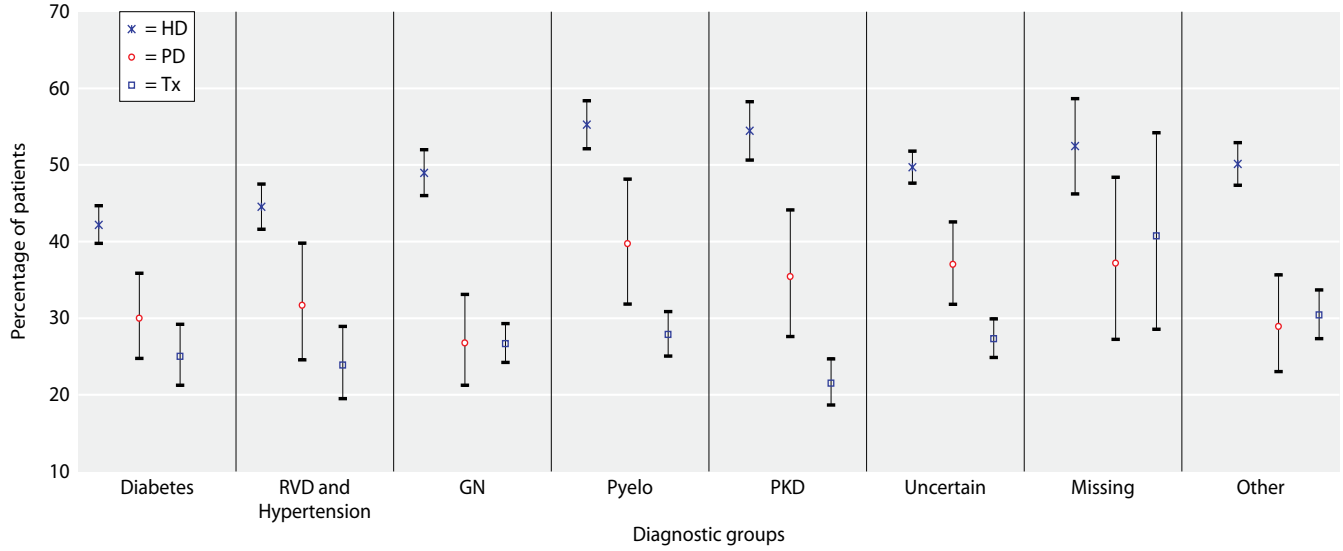

Fig. 11.26. Percentage of patients with BP <130/80 mmHg by primary diagnosis

variation between the individual PRD groups ($p < 0.002$) for HD and transplant patients, although no difference between PRD groups for patients on PD ($p = 0.08$). These patterns are shown in figures 11.26 to 11.31. SBP and PP are significantly higher in vascular disorders (diabetes and renovascular) than glomerulonephritis or tubular disorders.

Longitudinal changes in BP control

All BP recordings from the final quarter of years 2000 to 2007 collected by the UKRR were analysed by RRT modality. The annual median pre-HD, post-HD, PD and transplant readings are shown. Any significance in trend was calculated using a linear regression analysis.

Haemodialysis

47,174 pre-HD BP readings over an eight-year period were analysed. The median SBP fell from 151 mmHg in 2000 (IQR 133–169) to 142 mmHg in 2007 (IQR 125–159). The median DBP fell in the same period from 80 mmHg (IQR 70–90) to 73 mmHg (IQR 64–84). Linear regression analysis showed a significant trend for both SBP and DBP ($p < 0.0001$) (figure 11.32).

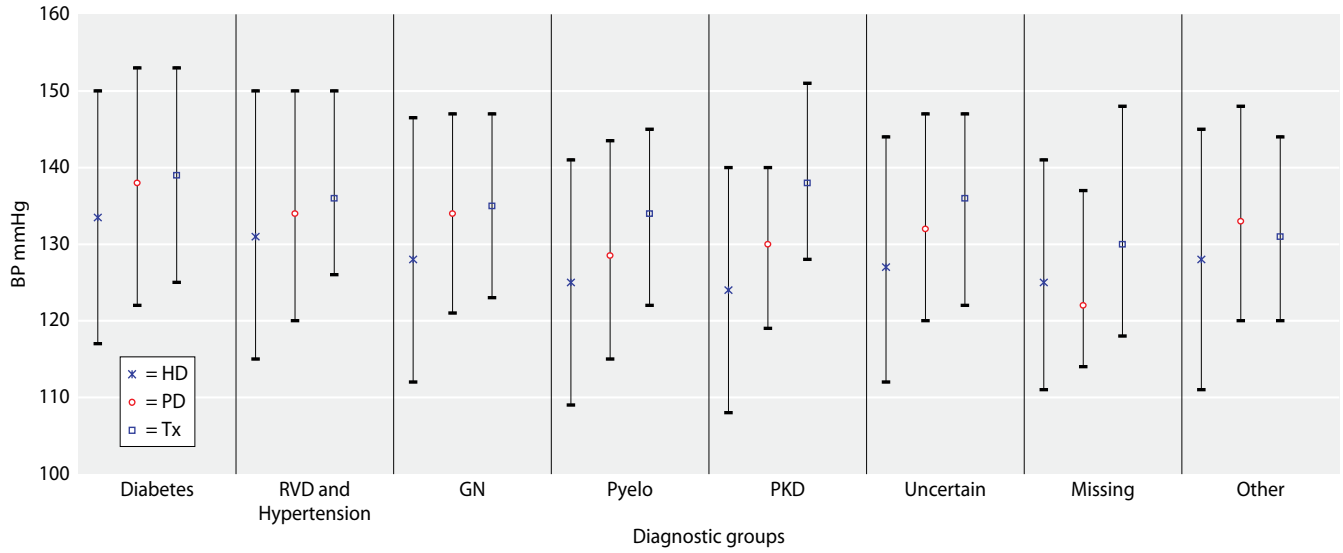

Fig. 11.27. Median systolic BP (IQR) by primary diagnosis

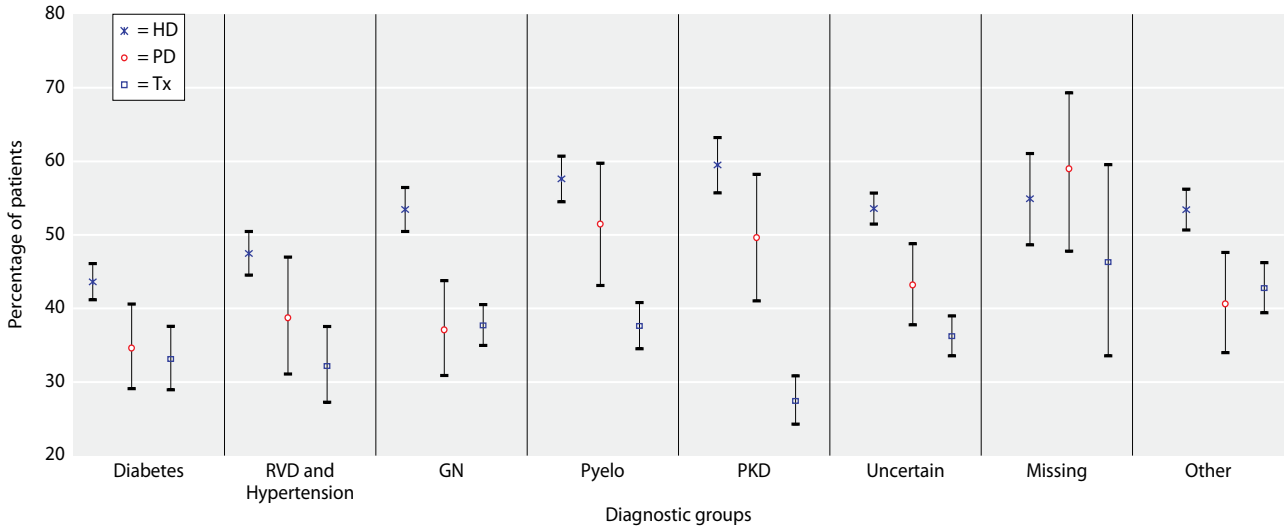

Fig. 11.28. Percentage of patients with systolic BP <130 mmHg by primary diagnosis

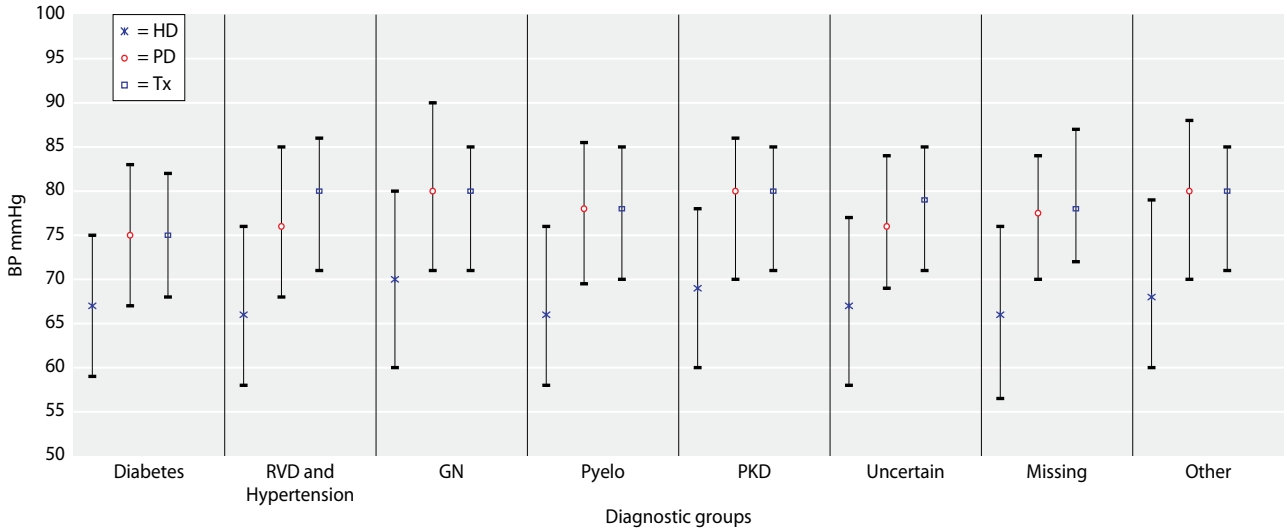

Fig. 11.29. Median diastolic BP (IQR) by primary diagnosis

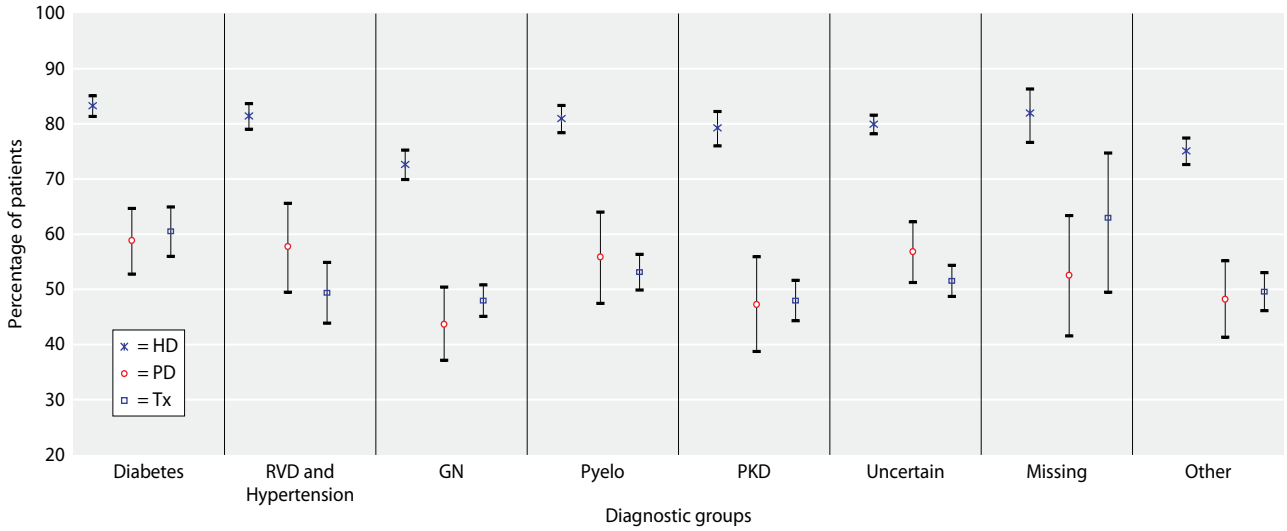

Fig. 11.30. Percentage of patients with diastolic BP <80 mmHg by primary diagnosis

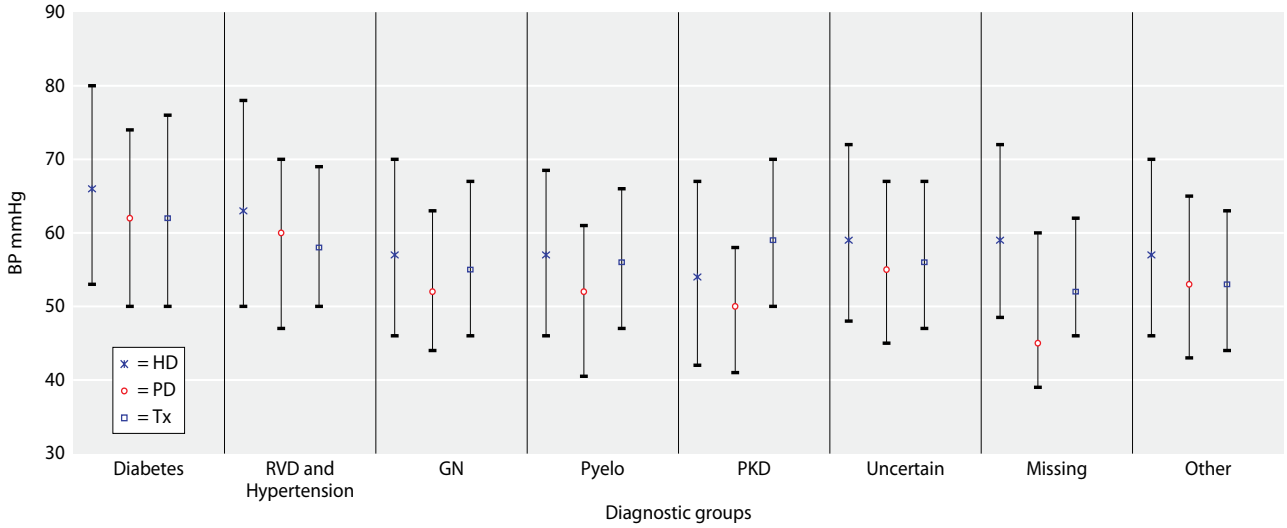

Fig. 11.31. Median PP by primary diagnosis

43,123 post-HD BP readings over an eight year period were analysed. The median SBP fell from 133 mmHg in 2000 (IQR 114–153) to 128 mmHg (IQR 112–146) in 2007. The median DBP fell in the same period from 73 mmHg (IQR 64–83) to 67 mmHg (IQR 59–77). Linear regression analysis showed a significant trend for both SBP and DBP ($p < 0.0001$) (figure 11.33).

Peritoneal dialysis

9,630 prevalent PD patients' BP readings were analysed. The median SBP fell from 141.5 mmHg (IQR 124–160) in 2000 to 132 mmHg (IQR 120–148) in 2007. The median DBP fell in the same period from 80 mmHg (IQR 71–88) to 78 mmHg (IQR 70–86). Linear regression analysis showed a significant trend for both SBP and DBP ($p < 0.0001$) (figure 11.34).

Transplant

26,632 BP readings from transplant patients were analysed. The median SBP fell from 140 mmHg (IQR 128–156) in 2000 to 136 mmHg (IQR 123–148) in 2007. The median DBP fell in the same period from 81 mmHg (IQR 75–88) to 79 mmHg (IQR 70–85). Linear regression analysis showed a significant trend for both SBP and DBP ($p < 0.0001$) (figure 11.35).

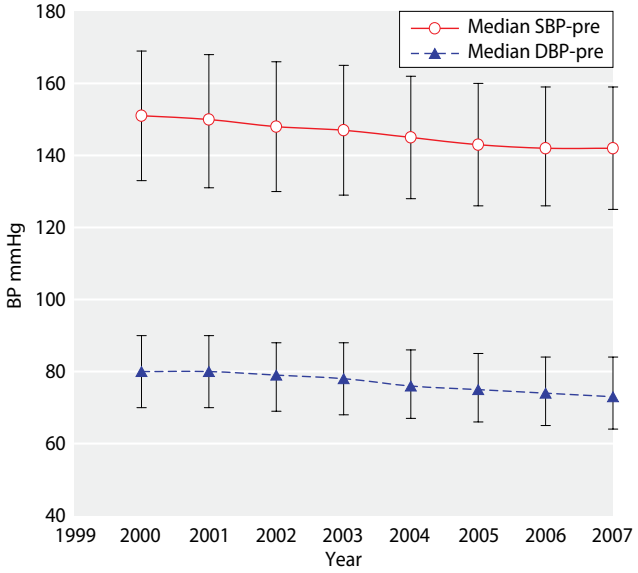

Fig. 11.32. Annual change in median blood pressure 2000–2007: pre-HD

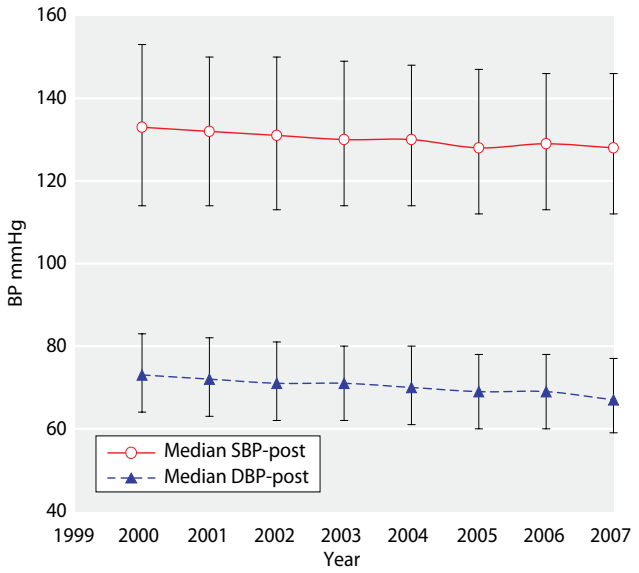

Fig. 11.33. Annual change in median blood pressure 2000–2007: post-HD

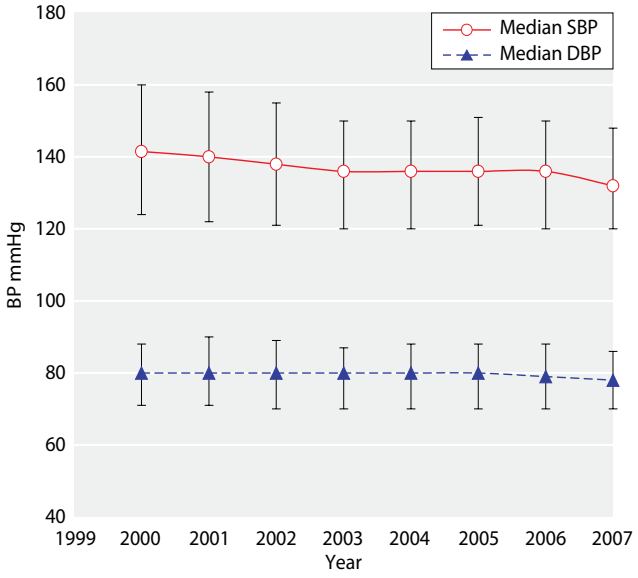

Fig. 11.34. Annual change in median blood pressure 2000–2007: PD

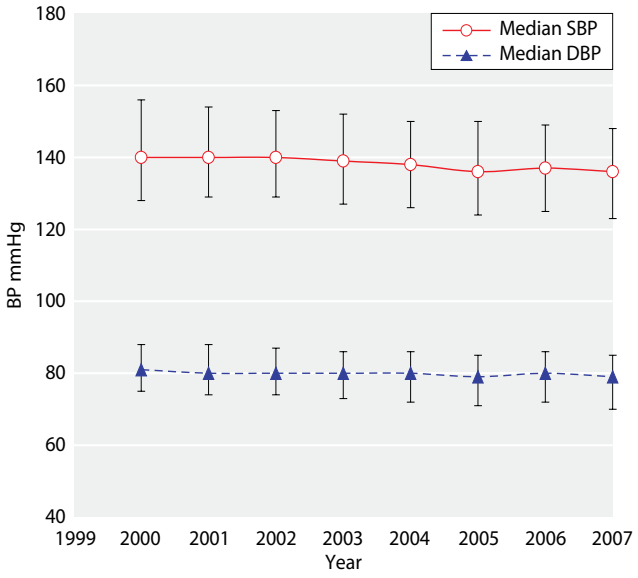

Fig. 11.35. Annual change in median blood pressure 2000–2007: transplant

Discussion

The current study demonstrates that only a minority of patients on RRT in England, Wales and Northern Ireland achieved the RA BP standard in 2007. Significantly more HD patients achieved the standard (on average 44.6% pre-HD and 48.8% post-HD) than PD (32.8%) or transplant patients (26.7%). Although few achieved the recommended BP target, median BP has fallen significantly between 2000 and 2007 for each modality. The incremental changes have been similar each year without additional change following the introduction of new BP standards in 2002. Despite overall improvements there remained significant variability in BP control between different renal centres. This applied only to HD and transplant patients and variations in clinical practice may account for this difference. Blood pressure control was also influenced by the underlying renal disease. In HD patients, hypertension was significantly more common in vascular disorders such as diabetes and renovascular disease than it was in glomerulonephritis and was least common in tubular disorders such as polycystic kidney disease and pyelonephritis. A similar pattern was evident but less pronounced in PD patients whereas the influence of PRD was absent in transplant patients in whom few achieved the BP standard.

Several limitations of this study should be noted. Blood pressure measurements were obtained by various healthcare workers as part of routine patient care rather than using a standardised protocol across renal centres. Manual data entry into IT systems may introduce transcription errors. Missing data may introduce bias although this appeared to occur randomly as significant variability in BP control between centres persisted whether centres with poor returns for PD and transplanted patients were included or excluded from the analysis. Extraction of data that has been entered into local IT systems can also cause problems. An example is highlighted with Liverpool Aintree, as 93% of post-HD BP data and only 3% of pre-HD data were available. Similar problems affected Wolverhampton and Portsmouth while no BP data was available at all for Liverpool Royal Infirmary for several years. Data returns from these centres now exceed 80% following discussions and organizational changes in the centres and UKRR data extraction systems. Adjustments for comorbidity or use of antihypertensive medication could not be performed in this study. Finally, although BP readings were available for less than 50% of patients in each renal diagnostic category, the prevalence of hypertension across diagnostic groups was similar to that previously reported [17].

Blood pressure control is a performance measure that is assessed annually for all UK renal centres. These data show that the BP standard is hard to achieve in the majority of patients using current UK practices. This is not a unique problem for the UK and in line with other epidemiological studies and randomised controlled trials. In Finland 28% of dialysis patients and 23% of renal transplant patients achieve a BP <130/85 mmHg [18] while only 30% of patients achieved this BP at the

start of the HEMO study [19]. The Finnish Registry reports significant variation in BP control across healthcare districts for transplant but not dialysis patients. Some 88% of transplant patients are prescribed antihypertensive medication with no difference in drug use between healthcare districts ($p = 0.366$). By contrast 68% of dialysis patients are prescribed antihypertensive medication with significant variation in drug use ($p < 0.001$). The data do not explain the variation in BP control but do suggest it is not related to drug use.

Revised KDOQI guidelines and the 4th edition of the RA guidelines have dropped specific BP targets for HD patients [20, 21]. In the UK the BP target for PD and transplant patients remains <130/80 mmHg. For HD patients there is evidence that fluid overload increases mortality so both sets of guidelines emphasise control of volume status to optimise BP and survival. The propensity for fluid overload may explain why primary renal disease determines hypertension and survival on dialysis. Restriction of sodium and water intake, use of diuretics and optimising ultrafiltration and sodium removal is emphasised in KDOQI guidelines for HD and PD patients. The RA guidelines indicate similar goals but are less specific about how these might be achieved. If variations in BP control become more marked across UK centres in future the UKRR may need to start auditing dialysis practices. Sodium balance does not feature in BP standards for transplant patients as there is little evidence to support it other than one small study that suggests that dietary sodium restriction may have a dramatic effect [22]. The UKRR has data extending to 10 years of follow up for dialysis and transplant patients. It has moved from solely reporting observational data to statistical modelling in order to map changes that lead to improved survival outcomes. All UK renal centres are encouraged to improve their data returns to facilitate this process.

Conflict of interest: none

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