Chapter 11
Blood Pressure Profile of Prevalent Patients receiving Renal Replacement Therapy in England, Wales and Northern Ireland in 2009: national and centre-specific analyses

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Key Words
Diastolic blood pressure · Epidemiology · Established renal failure · Haemodialysis · Peritoneal dialysis · Pulse pressure · Systolic blood pressure · Transplant

Summary

- Data completeness was better for HD patients (67% for pre-HD measurements) than for PD patients (44%) or transplant recipients (37%).
- In 2009, the median pre- and post-HD SBP were 142 mmHg and 129 mmHg respectively. The median SBP of patients on PD was 137 mmHg. Transplant recipients had a median SBP of 134 mmHg. Median DBP were 74 mmHg (pre-HD), 68 mmHg (post-HD), 79 mmHg (PD) and 79 mmHg (transplant).
- In England, Wales and Northern Ireland, only 26.7% of PD patients achieved the Renal Association guideline of SBP <130 mmHg **and** DBP <80 mmHg.
- In England, Wales and Northern Ireland, only 27.2% of transplant patients achieved the Renal Association guideline of SBP <130 mmHg **and** DBP <80 mmHg.

Introduction

The controversies over the management of blood pressure (BP) amongst patients on renal replacement therapy (RRT) have been extensively discussed in previous reports from the UKRR [1, 2] and elsewhere [3–6]. Uncertainty in how best to manage fluid balance and BP, particularly in haemodialysis (HD) patients, stems from several factors:

- the association between low BP and premature mortality [7–11], almost certainly the result of pre-existing conditions that cause both low BP and a high risk of subsequent mortality, e.g. cardiac failure;
- the complex, non-linear relationship between volume status and BP [12–14];
- the fact that BP varies markedly during the dialysis cycle, and that neither pre-dialysis nor post-dialysis BP gives reliable estimates of inter-dialytic mean BP [15];
- the fact that calcification of conduit arteries causes decreased arterial compliance, changing the relationship between peripheral and central pressure and increasing the risk of sub-endocardial ischaemia at low diastolic pressures;
- the linkage between nutritional intake and inter-dialytic weight gain, confounding analyses of inter-dialytic fluid overload and outcome [16, 17];
- the complex balance between the harm associated with extracellular volume expansion and the risk of acute dialysis-related hypotension [18] and associated myocardial stunning [19, 20] with rapid ultrafiltration [21];
- the balance between the contribution of BP-lowering drugs to the risk of intra-dialytic hypotension and their possible cardio-protective effects.

Some of these problems also contribute to uncertainty about the optimal management of BP in peritoneal dialysis (PD) [22, 23] and transplant patients.

Since the last UKRR Report, two meta-analyses of the effects of BP lowering treatment in dialysis patients have been published [24, 25]. Both studies concluded that there is clear evidence of better outcomes amongst patients randomised to receive BP lowering drug treatment, but do not give reliable evidence on the appropriate 'target' BP range amongst patients on dialysis.

The utility of the UKRR database to inform practice in this area is limited by the absence of reliable and complete information on the use of BP lowering drugs and in HD patients, on intra-dialytic weight gain and the frequency of intra-dialytic hypotension. Analyses are therefore limited to systolic and diastolic BP (measured pre-dialysis and post-dialysis in HD patients).

Due to these uncertainties, the Renal Association currently does not set an audit standard for BP in HD patients. The guideline in operation during the period during which the audit data in this chapter were collected [26] stated:

Guideline 1.8 C-CVD: Hypertension in dialysis patients

Pre- and post-dialysis blood pressure (measured after completion of dialysis, including washback) should be recorded and intra-dialytic blood pressure measured to enable management of the haemodialysis session.

Measurement of inter-dialytic blood pressure should be encouraged as a routine aid to management in haemodialysis patients (Good Practice).

Blood pressure in peritoneal dialysis patients should be <130/80 mmHg (Good Practice).

Hypertension on dialysis should be managed by ultrafiltration in the first instance (Good practice).

Guideline 1.9 C-CVD: Hypertension in renal transplant patients

The target blood pressure for renal transplant patients is <130/80 mmHg (Good practice).

These guidelines are consistent with international guidelines [6, 27].

In previous UKRR annual reports, the BP chapter contained numerous separate analyses of pre-dialysis and post-dialysis systolic BP (SBP), diastolic BP (DBP), and pulse pressure (PP), together with analyses of the proportion of patients in each centre meeting BP 'goals'. There was considerable overlap in centre performance against each of these measures. For this report the relationship between these various measures using Rose-Day plots have been analysed, reducing the number of 'caterpillar' plots depicting centre performance.

Methods

All adult patients in England, Wales and Northern Ireland receiving RRT (HD, PD and transplant recipients) on 31st December 2009 were considered for inclusion in the analyses.

The method of data extraction employed is described in chapter 15 of the 11th UKRR Annual Report [28]. The UKRR extracts quarterly laboratory, clinical and demographic data for all patients receiving RRT in the 63 renal centres in England, Northern Ireland and Wales. Data on some variables from the nine Scottish renal centres are sent annually from the Scottish Renal Registry. However, BP measurements are not received from Scotland and therefore Scottish renal centres are excluded from all BP analyses.

Patients who had been on the same modality and at the same renal centre for 3 months and with a valid BP reading in either the fourth or the third quarter of 2009 were included. This included incident patients starting RRT during 2009 who were still alive on 31st December 2009. Analyses used the last recorded BP from quarter 4, however, if this was missing, the last recorded BP from quarter 3 was used instead.

Analyses were performed on each RRT modality (HD, PD and transplant). Most UK renal centres manage HD, PD and transplant patients. However, Colchester had no PD patients and four centres (Bangor, Colchester, Liverpool Aintree, Wirral) had no transplant patients under their care.

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. The number preceding the centre name in each figure corresponds to the percentage of missing data in each centre.

Patients on HD were analysed both by pre-dialysis and post-dialysis BP. The BP components analysed included SBP, DBP and PP. The data were analysed to produce summary statistics (mean, median, maximum, minimum). Standard deviation and quartile ranges were also calculated. Median BP and inter-quartile ranges (IQRs) are presented for each analysis as caterpillar plots. In addition to this, the percentage of PD and transplant patients attaining Renal Association Standards for BP (***<130/80 mmHg***) in individual renal centres and each nation were calculated and are presented with 95% confidence intervals in caterpillar plots.

For the pre- and post-dialysis BP in HD patients, Rose-Day plots are used to show the relationship between the BP mean (SBP and DBP) and the percentage of patients below a given threshold (***pre-HD BP <140/90 mmHg and post-HD <130/80 mmHg***) in each centre. Squared correlation coefficients (R^2), indicating the strength of the relationship between the two measurements are given. The value of R^2 can be between 0 and 1 (the better the correlation, the closer the value of R^2 to 1).

Chi-squared tests were used in the analyses of the 2009 BP data to test for statistically significant differences between renal centres and between nations. All statistical analyses were performed using SAS version 9.2.

Results

Data completeness

Data extracts were received from all 63 centres in England, Wales and Northern Ireland, four of which do not manage any transplant patients and one centre does not manage PD patients. Data completeness is summarised in table 11.1. Overall, completeness is very similar to that in the previous UKRR Report. However, there were large improvements in data completeness for HD from three centres (Cambridge, London West, Oxford), for PD patients from four centres (Gloucester, Hull, Newry, Swansea) and for transplant patients from seven centres (Derby, Gloucester, Newry, Southend, Sunderland, Swansea, Truro).

BP on each modality

Figure 11.1 gives the median and IQR for SBP, DBP and PP in prevalent HD patients (pre- and post-dialysis), PD and transplant patients.

In 2009, the median pre- and post-HD SBP were 142 mmHg and 129 mmHg respectively. The median SBP of patients on PD was 137 mmHg. Transplant recipients had a median SBP of 134 mmHg. Median DBP were 74 mmHg (pre-HD), 68 mmHg (post-HD), 79 mmHg (PD) and 79 mmHg (Transplant).

Relationship between the centre mean and the proportion above a threshold BP in that centre

Rose and Day observed in 1990 that, with a normally distributed variable, the population mean will predict the number of 'deviant' individuals in the population – for instance, the number of people with a serum cholesterol >5 mmol/L within a given population is a linear function of the mean cholesterol within that population (29). If this is true for BP amongst patients on RRT, then plots of centre-specific mean BP will give very similar information to plots of the proportion of patients in each centre with BP above a certain threshold, for instance SBP>140 mmHg. The distribution of BP in each centre was close to a normal distribution (data not shown).

Figure 11.2 demonstrates that the mean pre-dialysis SBP in a given centre accurately predicted the proportion of individuals in that centre whose pre-dialysis BP was <140 mmHg. Figure 11.3 shows a very similar relationship between mean SBP and the proportion of individuals with pre-dialysis SBP <140 mmHg **and** DBP <90 mmHg.

Figure 11.4 shows the relationship between mean pre-dialysis DBP and the proportion of individuals with DBP <90 mmHg.

Figures 11.5, 11.6 and 11.7 give the equivalent analyses for post-dialysis BP measurements. Again, there was a close relationship between mean achieved BP in a given centre and the proportion of patients whose BP was below a given threshold value.

Table 11.1. Percentage of patients in each renal centre for whom BP readings were extracted by the UKRR, by modality

Centre	% completed data				Centre	% completed data			
	Pre-HD	Post-HD	PD	Transplant		Pre-HD	Post-HD	PD	Transplant
Antrim	88	69	93	95	Leic	99	98	93	37
B Heart	93	93	0	0	Liv Ain	97	97	0	n/a
B QEH	0	0	0	2	Liv RI	91	91	18	71
Bangor	97	97	100	n/a	M Hope	62	62	0	0
Basldn	99	99	100	2	M RI	22	28	0	0
Belfast	97	93	29	56	Middlbr	98	95	75	51
Bradfd	9	0	94	74	Newc	0	0	0	0
Brightn	0	0	0	0	Newry	99	99	100	98
Bristol	100	100	100	74	Norwch	97	77	5	63
Camb	94	93	100	97	Nottm	100	100	99	92
Cardff	4	1	8	97	Oxford	98	97	53	16
Carlis	100	100	0	0	Plymth	1	0	0	0
Carsh	77	77	1	1	Ports	100	100	62	10
Chelms	100	100	94	88	Prestn	19	0	0	0
Clwyd	96	96	71	82	Redng	96	0	99	98
Colchr	100	100	n/a	n/a	Sheff	100	97	100	98
Covnt	99	99	95	73	Shrew	99	98	30	29
Derby	100	98	100	99	Stevng	98	96	4	0
Derry	97	95	100	91	Sthend	97	97	0	76
Donc	100	94	100	97	Stoke	97	97	0	0
Dorset	99	98	100	89	Sund	99	98	4	97
Dudley	80	78	8	44	Swanse	100	100	100	99
Exeter	99	99	100	75	Truro	98	98	33	96
Glouc	100	100	97	99	Tyrone	99	99	82	85
Hull	5	5	94	0	Ulster	99	98	50	100
Ipswi	100	100	100	97	Wirral	89	35	35	n/a
Kent	98	95	16	11	Wolve	100	100	100	93
L Barts	0	0	0	0	Wrexm	97	96	0	2
L Guys	0	0	0	0	York	95	69	100	81
L Kings	0	0	0	0	**England**	**67**	**63**	**44**	**32**
L Rfree	0	0	0	0	**N Ireland**	**96**	**91**	**63**	**70**
L St.G	2	3	2	0	**Wales**	**55**	**54**	**45**	**87**
L West	90	90	0	0	**E, W & NI**	**67**	**64**	**44**	**37**
Leeds	98	96	99	84					

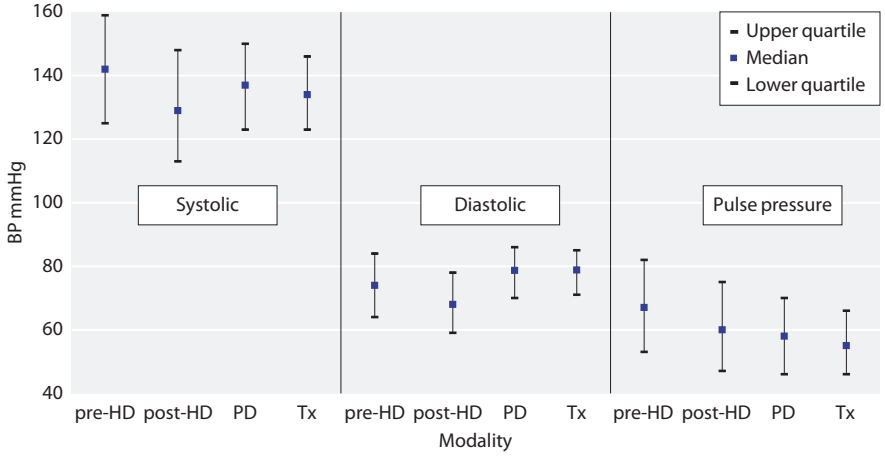

Fig. 11.1. Summary of BP achievements

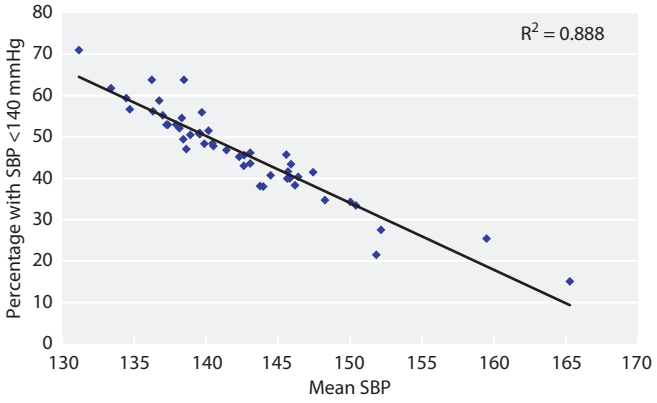

Fig. 11.2. Plot of mean SBP and percentage with SBP<140 mmHg by centre: pre-HD

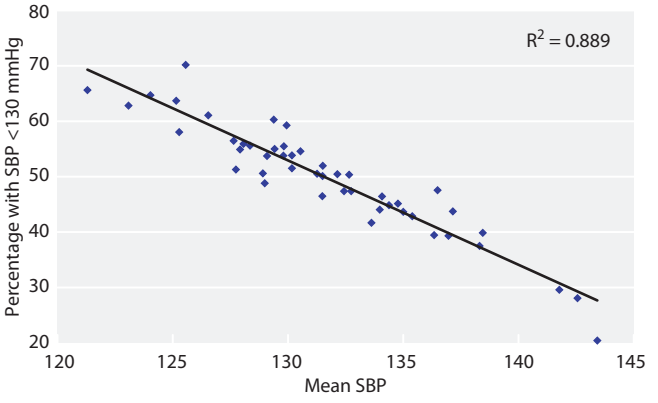

Fig. 11.5. Plot of mean SBP and percentage with SBP <130 mmHg by centre: post-HD

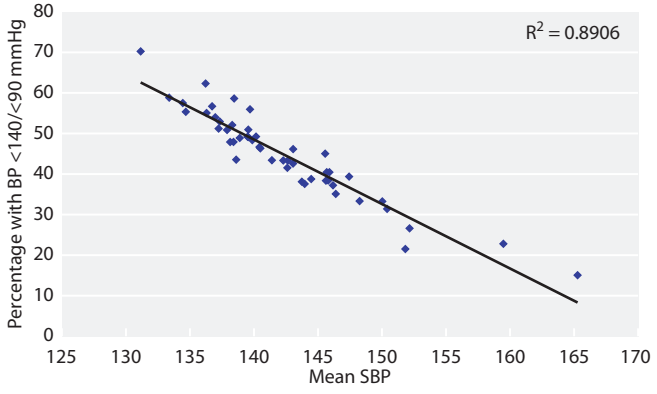

Fig. 11.3. Plot of mean SBP and percentage with BP <140 mmHg systolic and <90 mmHg diastolic by centre: pre-HD

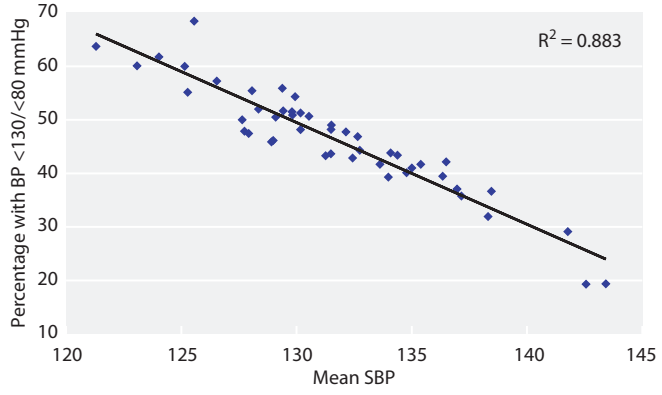

Fig. 11.6. Plot of mean SBP and percentage with BP <130 mmHg systolic and <80 mmHg diastolic by centre: post-HD

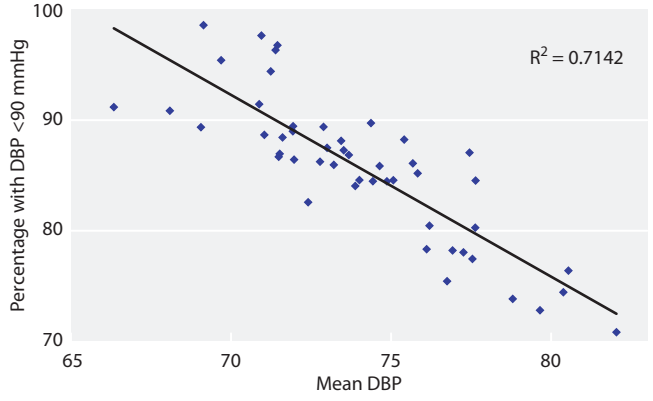

Fig. 11.4. Plot of mean DBP and percentage with DBP <90 mmHg by centre: pre-HD

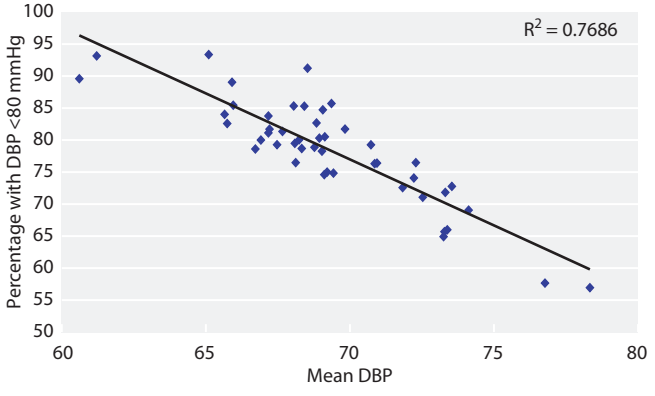

Fig. 11.7. Plot of mean DBP and percentage with DBP <80 mmHg by centre: post-HD

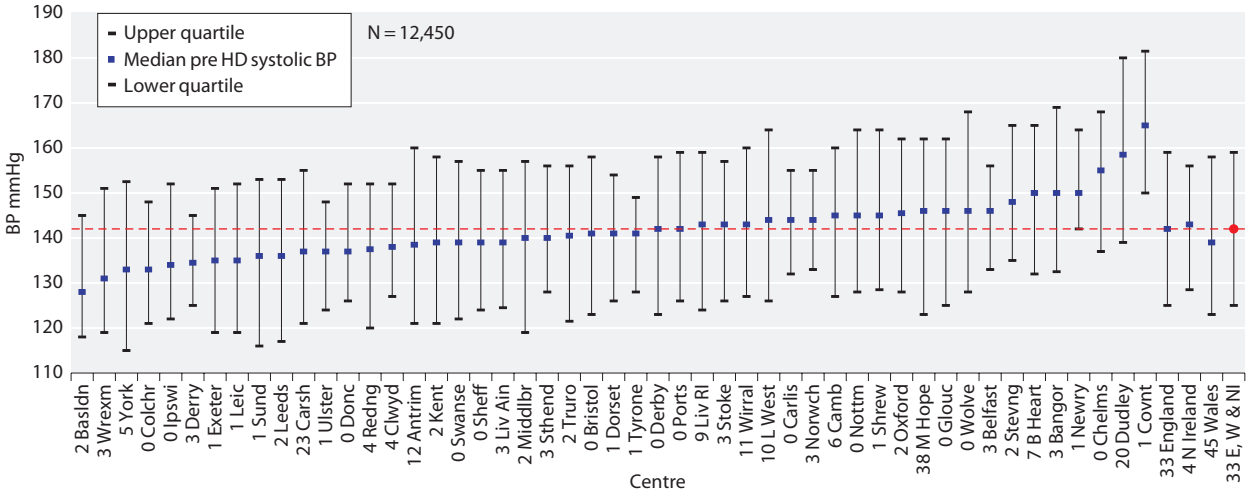

Fig. 11.8. Median systolic BP: pre-HD

These analyses show that it is redundant to show both mean (or median) BP and the proportion of patients whose BP was below a given value.

Centre-specific analyses of BP in haemodialysis patients

Figures 11.8 and 11.9 illustrate the median and IQR pre-dialysis SBP and DBP in each centre supplying data on >50% of patients. Figures 11.10 and 11.11 illustrate the equivalent analyses for post-dialysis BP. Figures for the proportion of patients with pre-dialysis BP <140/90 and for post-dialysis BP <130/80 are not included in this chapter since these audit measures were dropped from the Renal Association standards several years ago and it is clear from the Rose-Day plots in the preceding section, that they add little useful information.

There remained marked centre variation: the difference between the centres with the lowest and highest median SBP was >30 mmHg. Comparison with previous UKRR Reports showed that in general, the same centres can be found at roughly the same place in the distribution from year to year, suggesting differences in centre practice.

Centre-specific analyses of BP in peritoneal dialysis patients

Figures 11.12 and 11.13 illustrate the median and IQR SBP and DBP in each centre supplying data on >50% of eligible patients. Figure 11.14 gives the proportion of patients meeting the audit standard of BP <130/80 mmHg.

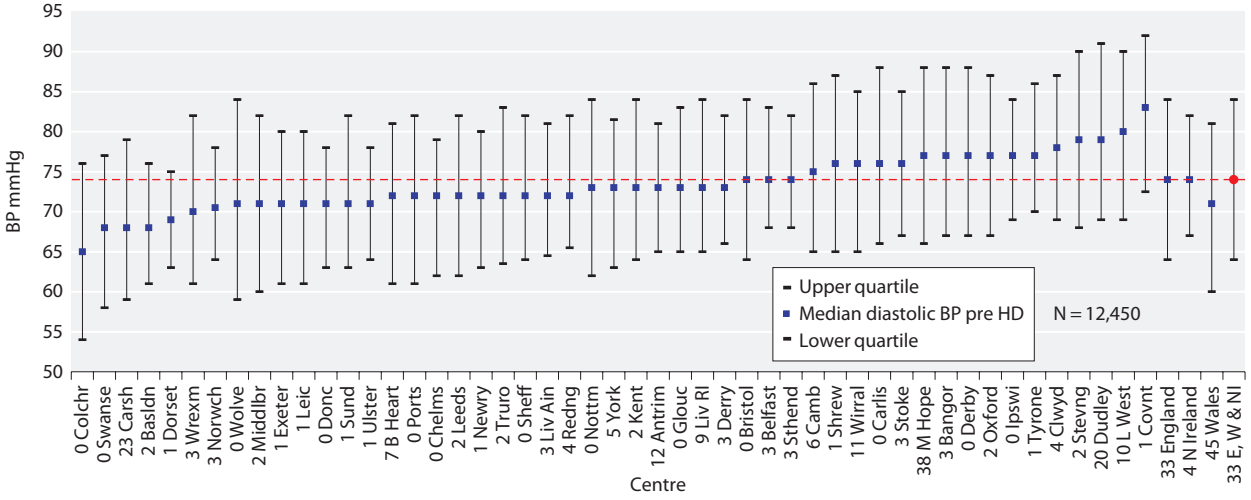

Fig. 11.9. Median diastolic BP: pre-HD

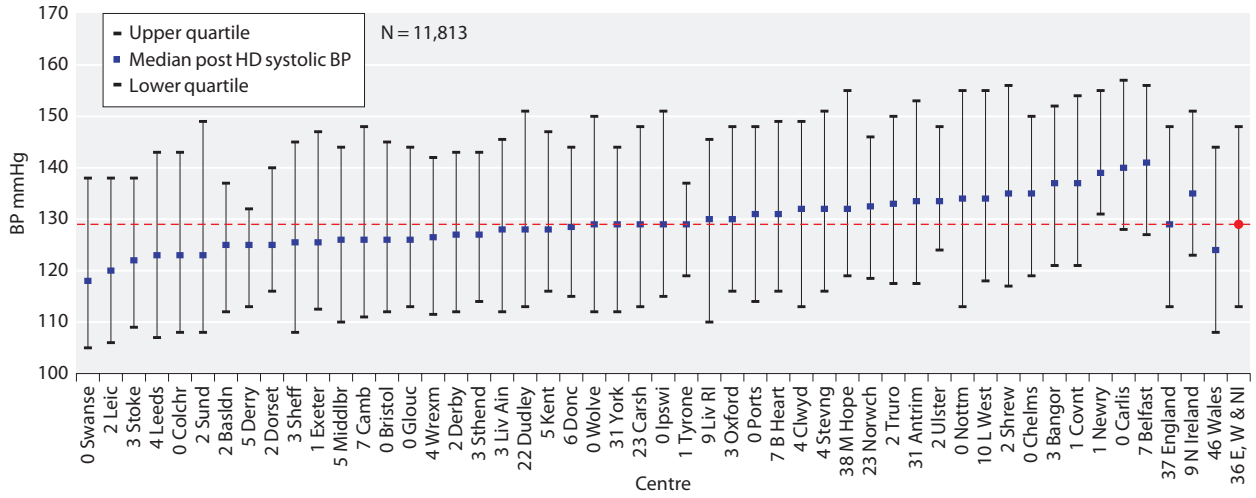

Fig. 11.10. Median systolic BP: post-HD

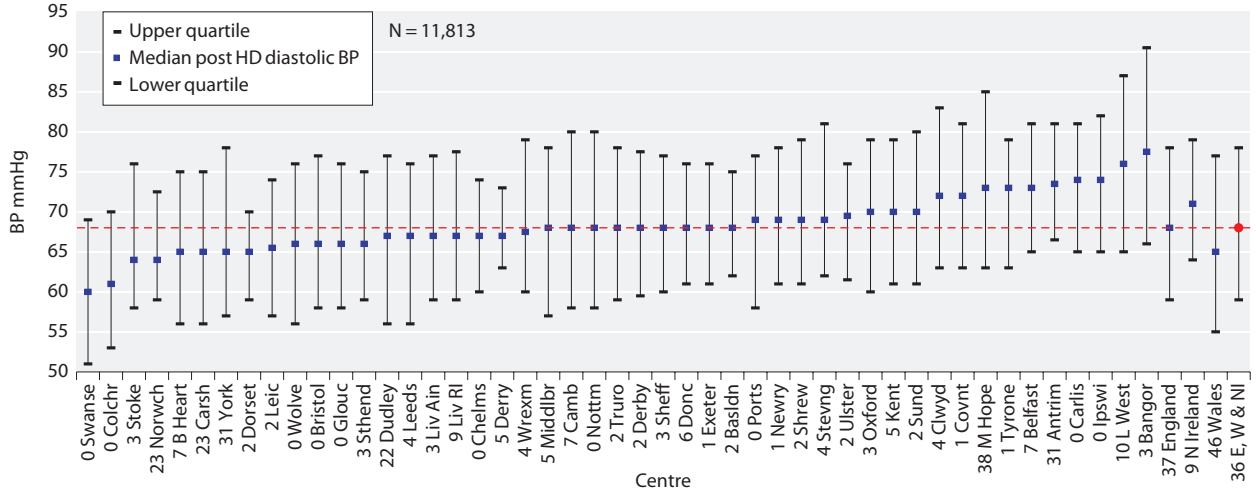

Fig. 11.11. Median diastolic BP: post-HD

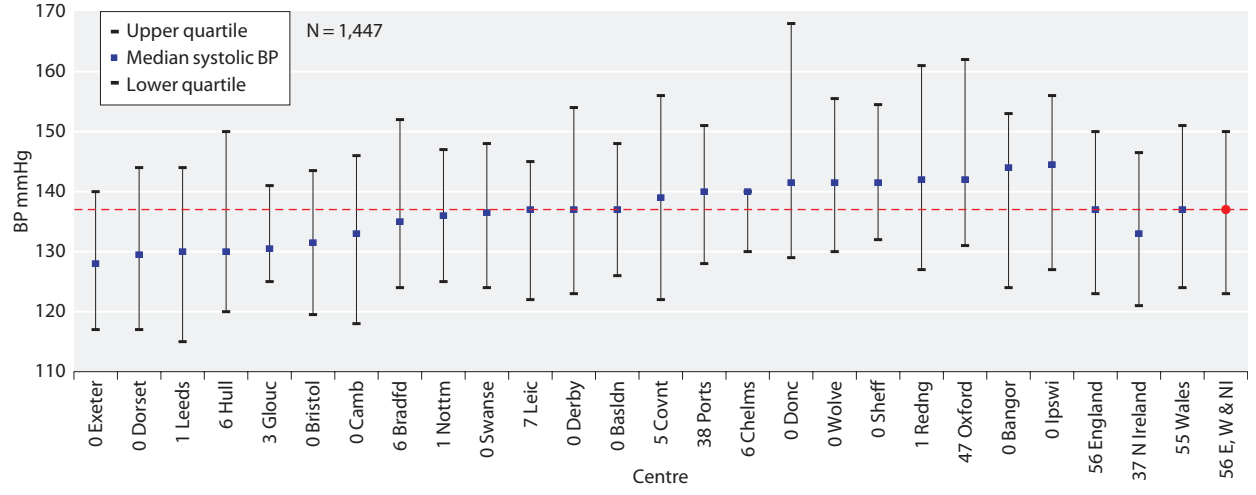

Fig. 11.12. Median systolic BP: PD

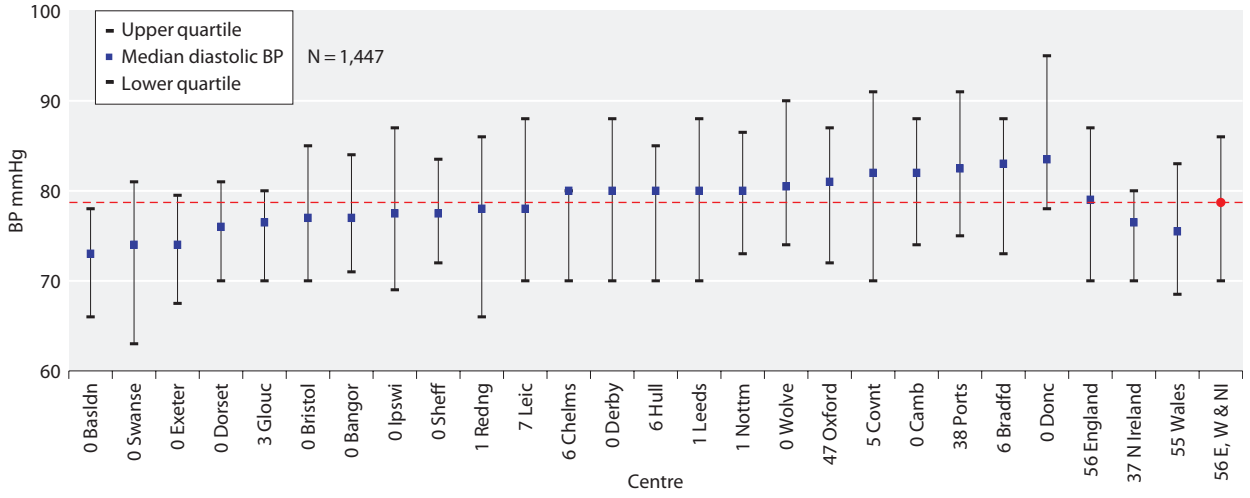

Fig. 11.13. Median diastolic BP: PD

The possibility of information bias in these analyses cannot be excluded, since BP data are extracted from the routine clinical record. For instance, BP might only be recorded during acute illness or unscheduled clinic visits. However, it is unlikely that >80% completeness of data returns would be achieved if this were the case.

Centre-specific analysis of BP in transplant patients

Figures 11.15 and 11.16 illustrate the median and IQR SBP and DBP in each centre supplying data on >50% of eligible patients and figure 11.17 illustrates the proportion of patients meeting the audit standard of BP <130/80 mmHg.

As with PD, the possibility of information bias in these analyses cannot be excluded.

Discussion

Blood pressure control in UK patients on RRT remained poor. Amongst patients on HD, this can be explained partly by the uncertainties highlighted in the Introduction. However, amongst patients on PD and those with functioning kidney transplants, there was evidence of an important gap between accepted best

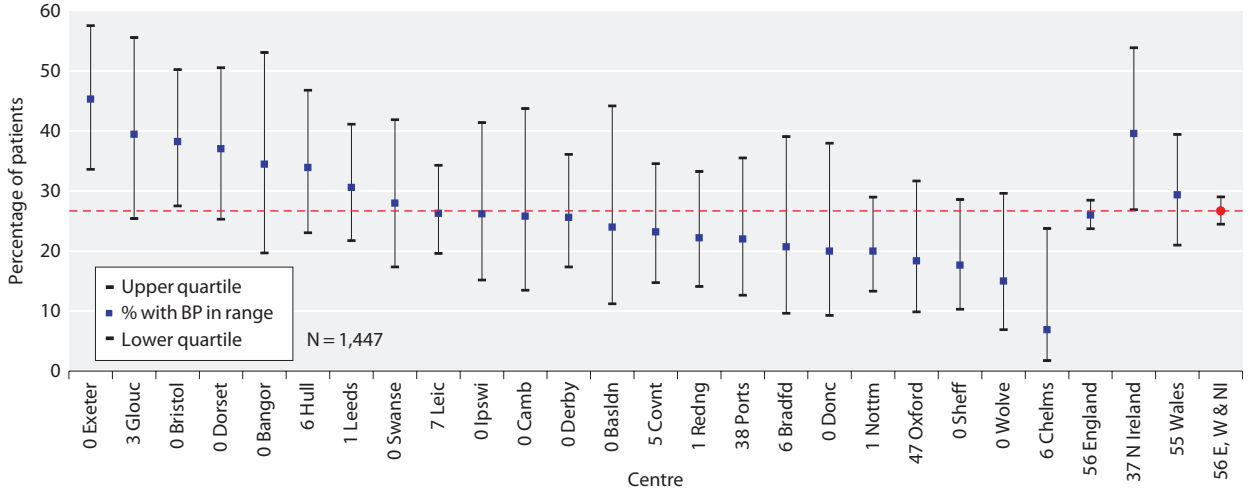

Fig. 11.14. Percentage of patients with BP <130 mmHg systolic and <80 mmHg diastolic: PD

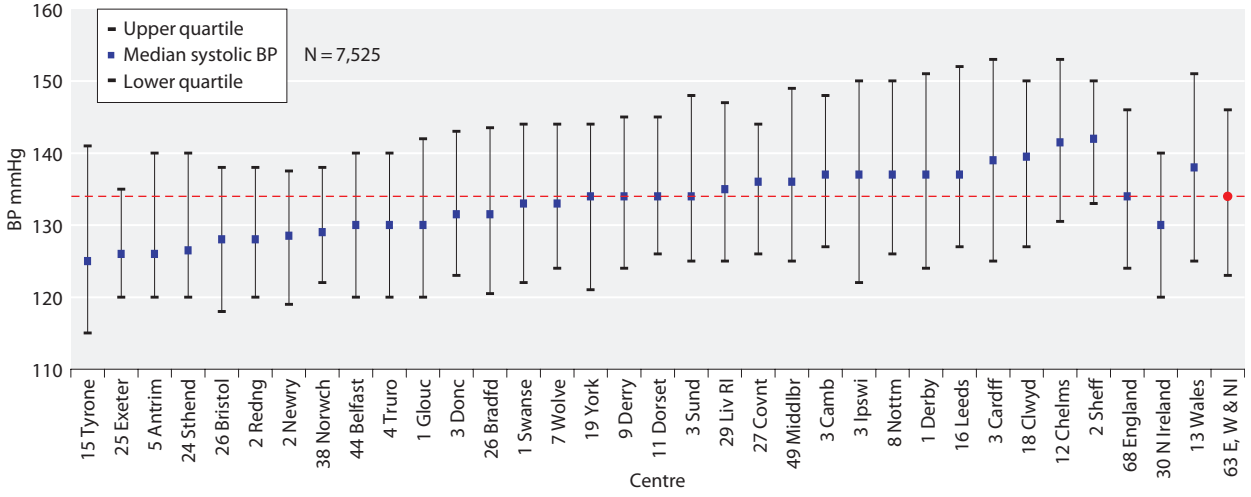

Fig. 11.15. Median systolic BP: Transplant

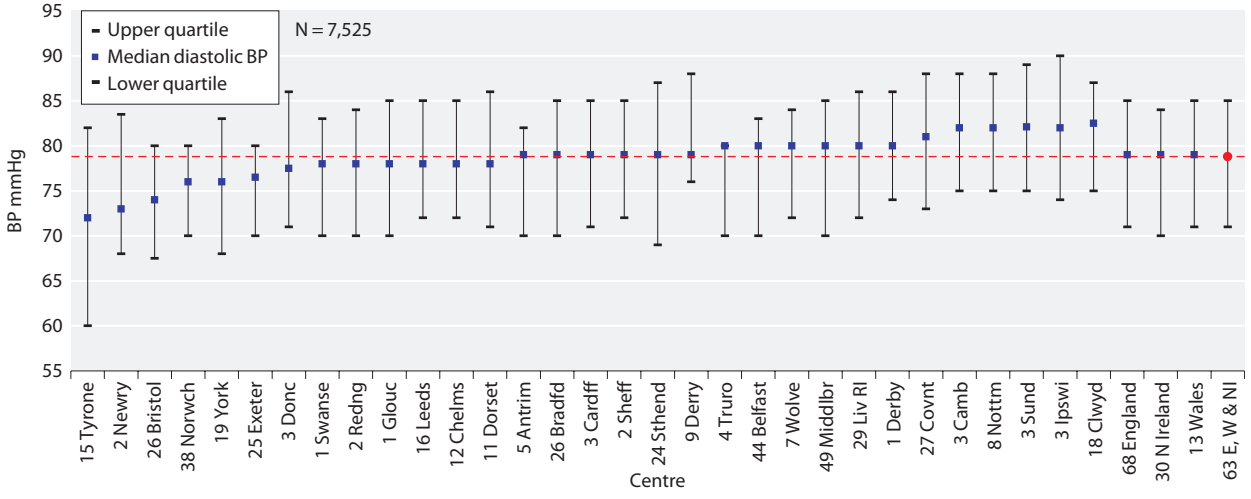

Fig. 11.16. Median diastolic BP: Transplant

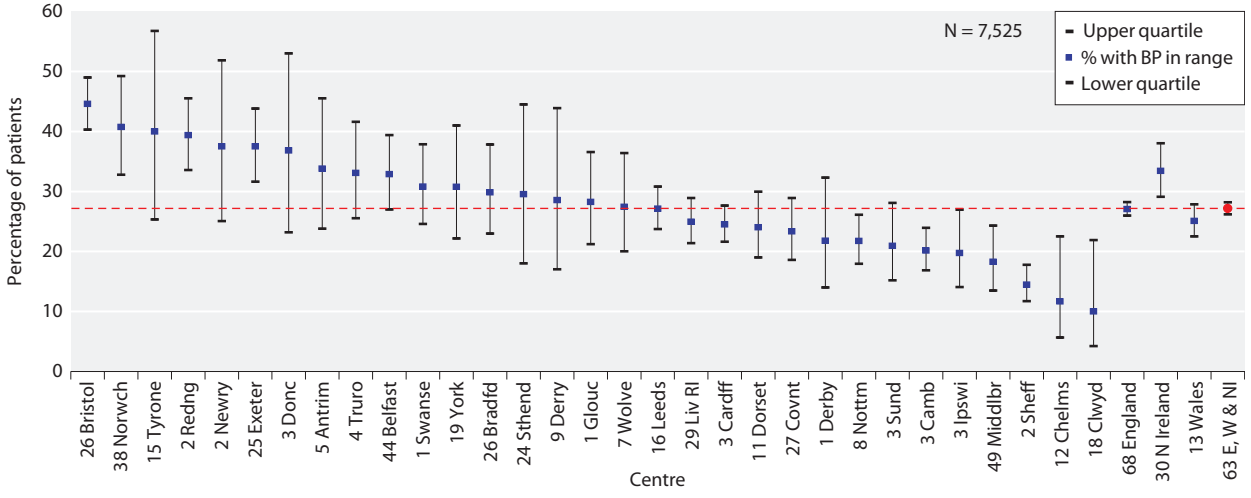

Fig. 11.17. Percentage of patients with BP <130 mmHg systolic and <80 mmHg diastolic: Transplant

practice and current achievement. The reasons for this gap remain to be understood.

Conflicts of interest: none

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