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# UK Renal Registry 16th Annual Report: Chapter 11 Blood Pressure Profile of Prevalent Patients receiving Renal Replacement Therapy in 2012: 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

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## Summary

- Data completeness was better for haemodialysis (HD) patients (75% for pre-HD measurements) than for peritoneal dialysis (PD) patients (51%) or transplant recipients (41%).
- In 2012, median pre- and post-HD systolic blood pressures (SBPs) were 140 mmHg and 128 mmHg

respectively. The median SBP of patients on PD was 137 mmHg. Transplant recipients had a median SBP of 134 mmHg.

- In 2012, median diastolic blood pressures (DBPs) were 71 mmHg (pre-HD), 67 mmHg (post-HD), 78 mmHg (PD) and 79 mmHg (transplant).
- In England, Wales and Northern Ireland only 26% of PD patients achieved the Renal Association guideline of SBP <130 mmHg **and** DBP <80 mmHg.
- In England, Wales and Northern Ireland only 27% of transplant patients achieved the Renal Association guideline of SBP <130 mmHg **and** DBP <80 mmHg.

## Introduction

The aetiology of hypertension in established renal failure is multifactorial and interpreting blood pressure (BP) values in this cohort of patients is challenging. In dialysis patients there is a complex interplay between volume overload with salt (and water) which may be appropriately addressed by dialysis, and vasoconstriction caused by neurohumoral mechanisms which may require additional treatment with antihypertensive drugs. These mechanisms lead to cardiovascular dysfunction and may be important in the observation of the 'U-shaped' mortality curve seen in relation to BP in dialysis patients [1, 2]. Original descriptions at the individual patient level were confounded by unmeasured case-mix, with comorbidity associated with both lower BP and lower survival. Similar patterns have now been reported at centre level [3]. It is possible that the association can be overcome by longer or more frequent sessions of dialysis and careful attention to dry-weight [4, 5]. Iatrogenic factors such as erythropoiesis stimulating agents (ESA) [6] in dialysis patients and ciclosporin [7] in transplant patients may also contribute to high BP. Further, BP in dialysis patients varies as much within individuals as it does between individuals [8]. The extent of this variability appears to be as important as the absolute value in predicting cardiovascular mortality in haemodialysis patients [9]. The optimal measure of BP therefore remains the subject of considerable controversy, with ambulatory BP predicting mortality better than pre- or post-dialysis BP [10]. There is some evidence to suggest that pre-dialysis systolic blood pressures (SBPs) >150–160 [11–13] are associated with excess mortality in haemodialysis patients and other data suggesting that very high SBP (>200) pre-dialysis seems to confer an adverse prognosis [14]. Conversely, lowering BP too aggressively may lead to intradialytic hypotension [15], which is an independent predictor of mortality [16, 17]. Data from a number of studies suggest excess mortality associated with pre-dialysis SBP <120 mmHg [14, 18].

The Renal Association guidelines updated in August 2010 and in operation during the period in which the audit data in this chapter were collected [19] stated:

*Guideline 5.2 – CVD: Hypertension in dialysis patients*

***We suggest that pre- and post-dialysis blood pressure (measured after completion of dialysis, including washback) should be recorded and intra-dialytic blood***

***pressure measurements should be made to facilitate good management of the HD session. (2D)***

*Guideline 5.4 – CVD: Hypertension in dialysis patients*

***It would be sensible to avoid sustained BP extremes and, in order to try to provide some guidance we suggest that systolic blood pressure during the inter-dialytic period on HD and for PD patients should not regularly exceed >160 mmHg. (2C)***

*Guideline 5.5 – CVD: Hypotension/Hypertension in dialysis patients*

***We suggest that systolic blood pressure should not routinely be treated with pharmacological agents with antihypertensive properties if SBP is regularly <120 mmHg pre dialysis.***

*Guideline 5.7 – CVD: Hypertension in dialysis patients*

***We suggest that hypertension on dialysis should be managed by ultrafiltration in the first instance. (2D)***

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

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

These guidelines are consistent with international guidelines [20, 21].

This chapter reports UK Renal Registry (UKRR) data completeness for BP for adult renal centres in England, Northern Ireland and Wales and presents centre level average BP attainment for patients on haemodialysis (HD), peritoneal dialysis (PD) and with a functioning kidney transplant at the end of December 2012.

## Methods

All adult patients in England, Wales and Northern Ireland receiving renal replacement therapy (RRT) (HD, PD and transplant recipients) on 31st December 2012 were considered for inclusion in the analyses.

The method of data extraction employed is described in chapter 15 of the 11th UKRR Annual Report [22]. The UKRR extracts quarterly laboratory, clinical and demographic data for all patients receiving RRT in the 62 renal centres in England, Northern Ireland and Wales. Data on some variables from the nine Scottish renal centres are sent annually to the Scottish Renal Registry. However, BP measurements are only collected from the Scottish Registry

for HD patients and therefore PD and transplant patients from Scottish renal centres are excluded from all BP analyses.

Patients who had been on the same modality and at the same renal centre for three months and with a valid BP reading in either the fourth or the third quarter of 2012 were included. This included incident patients starting RRT during 2012 who were still alive on 31st December 2012. Analyses used the last recorded BP from quarter four, however, if this was missing, the last recorded BP from quarter three was used instead. BP data from quarter two were used for patients at renal centres in Scotland because BP data from quarters three and four were unavailable.

Analyses were performed for 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 for that centre.

Patients on HD were analysed both by pre-dialysis and post-dialysis BP. The BP components analysed included systolic blood pressure, diastolic blood pressure (DBP) and pulse pressure (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, the percentage of HD patients with pre-dialysis systolic BP <120 mmHg, between 120–160 mmHg, >160 mmHg; 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.

Chi-squared tests were used in the analyses of the 2012 BP data to test for statistically significant differences between renal centres and between nations. All statistical analyses were performed using SAS version 9.3.

## Results

### *Data completeness*

Data extracts were received from all 62 centres in England, Wales and Northern Ireland. Data completeness is summarised in table 11.1. Overall, completeness was very similar to that previously reported.

### *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 2012, the median pre- and post-HD SBPs were 140 mmHg and 128 mmHg respectively. The median

SBP of patients on PD was 137 mmHg. Transplant recipients had a median SBP of 134 mmHg. Median DBP was 71 mmHg (pre-HD), 67 mmHg (post-HD), 78 mmHg (PD) and 79 mmHg (transplant).

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

As the distribution of BP in each centre approximates a normal distribution (data not shown), the population mean of each BP variable should predict the number of individuals above (or below) a predefined threshold or standard (Rose and Day 1990). As these assumptions were confirmed in the 13th UKRR Annual Report [23] only median BP data by centre are presented below.

### *Centre-specific analyses of BP in haemodialysis patients*

Figures 11.2 and 11.3 illustrate the median and IQR pre-dialysis SBP and DBP in each centre supplying data on >50% of patients. The median HD pre-dialysis SBP and pre-dialysis DBP for the UK were 140 mmHg and 71 mmHg respectively. Figures 11.4 and 11.5 illustrate the equivalent analyses for post-dialysis BP.

There remains marked centre variation. The difference between the centres with the lowest and highest median SBP was >20 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.

### *Adherence to guidelines*

Figures 11.6, 11.7 and 11.8 illustrate the percentages (with 95% confidence intervals (CIs)) of HD patients achieving SBP in the range 120–160 mmHg, <120 mmHg and >160 mmHg respectively. There was marked variation (45–80%) between centres achieving their pre-dialysis SBP readings in the range 120–160 mmHg. The vast majority of centres had greater than 50% of their patients falling in the range 120–160 mmHg. Thirty-five of the centres had greater than 20% of their patients with a pre-dialysis SBP <120 mmHg and there were also 35 centres who had greater than 20% of their patients with a pre-dialysis SBP >160 mmHg.

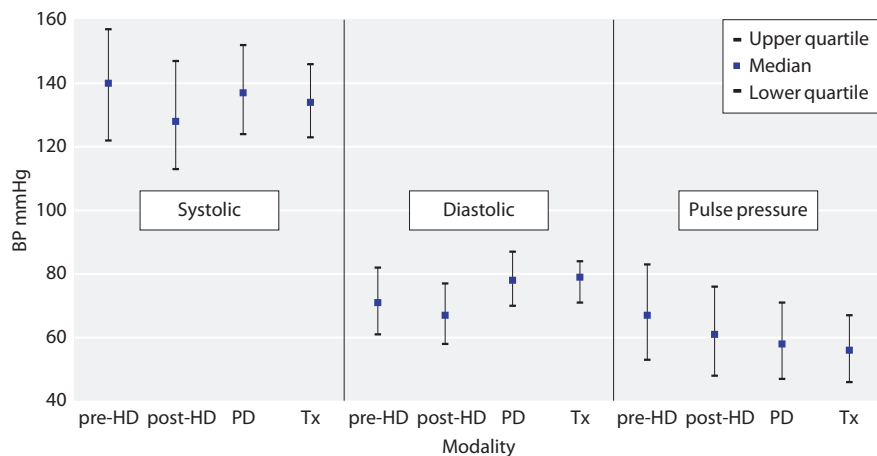
### *Centre-specific analyses of BP in peritoneal dialysis patients*

Figures 11.9 and 11.10 illustrate the median and IQR SBP and DBP in each centre supplying data on >50% of eligible patients. Figure 11.11 gives the percentage of

**Table 11.1.** Percentage of patients by renal centre for whom BP readings were received by the UKRR, by modality

Centre	% completed data				Centre	% completed data			
	Pre-HD	Post-HD	PD	Transplant		Pre-HD	Post-HD	PD	Transplant
<b>England</b>					Prestn	20	0	0	0
B Heart	98	98	2	3	Redng	95	100	0	0
B QEH	94	93	84	93	Salford	97	97	0	0
Basldn	98	93	96	2	Sheff	99	96	99	97
Bradfd	3	2	96	69	Shrew	99	99	0	1
Brightn	54	68	0	0	Stevng	94	91	63	23
Bristol	99	99	91	72	Sthend	99	99	0	61
Camb	100	100	97	97	Stoke	95	95	1	0
Carlis	100	100	5	0	Sund	99	99	0	0
Carsh	92	92	1	0	Truro	83	82	68	19
Chelms	100	98	96	94	Wirral	94	93	14	n/a
Colchr	99	99	n/a	n/a	Wolve	99	99	98	95
Covnt	100	100	95	81	York	100	98	96	53
Derby	99	95	99	83	<b>N Ireland</b>				
Donc	100	95	91	100	Antrim	98	92	100	65
Dorset	100	96	58	81	Belfast	94	87	16	45
Dudley	95	93	47	16	Newry	99	98	71	86
Exeter	100	99	94	92	Ulster	99	94	100	90
Glouc	100	100	90	89	West NI	98	92	100	93
Hull	97	97	89	25	<b>Scotland</b>				
Ipswi	100	100	0	0	Abrdn	99	99	n/a	n/a
Kent	98	98	98	85	Airdrie	94	94	n/a	n/a
L Barts	0	0	0	0	D & Gall	96	96	n/a	n/a
L Guys	0	0	0	0	Dundee	99	96	n/a	n/a
L Kings	0	0	0	0	Dunfn	96	95	n/a	n/a
L Rfree	93	91	99	77	Edinb	94	93	n/a	n/a
L St.G	59	60	0	0	Glasgw	95	88	n/a	n/a
L West	0	0	0	0	Inverns	96	95	n/a	n/a
Leeds	100	97	99	96	Klmarnk	99	99	n/a	n/a
Leic	97	96	81	48	<b>Wales</b>				
Liv Ain	98	98	12	n/a	Bangor	98	98	100	n/a
Liv RI	97	95	2	2	Cardff	4	29	51	98
M RI	0	0	0	0	Clwyd	100	92	0	0
Middlbr	97	96	88	46	Swanse	100	100	96	100
Newc	100	100	0	0	Wrexm	100	99	25	0
Norwch	95	90	4	41	<b>England</b>	73	71	50	37
Nottm	100	100	97	87	<b>N Ireland</b>	97	91	64	60
Oxford	96	95	43	16	<b>Scotland</b>	96	93	n/a	n/a
Plymth	59	10	65	85	<b>Wales</b>	57	67	61	84
Ports	100	100	85	19	<b>UK</b>	75	74	51*	41*

\*UK % completeness for PD and transplant excludes Scotland



**Fig. 11.1.** Summary of BP achievements

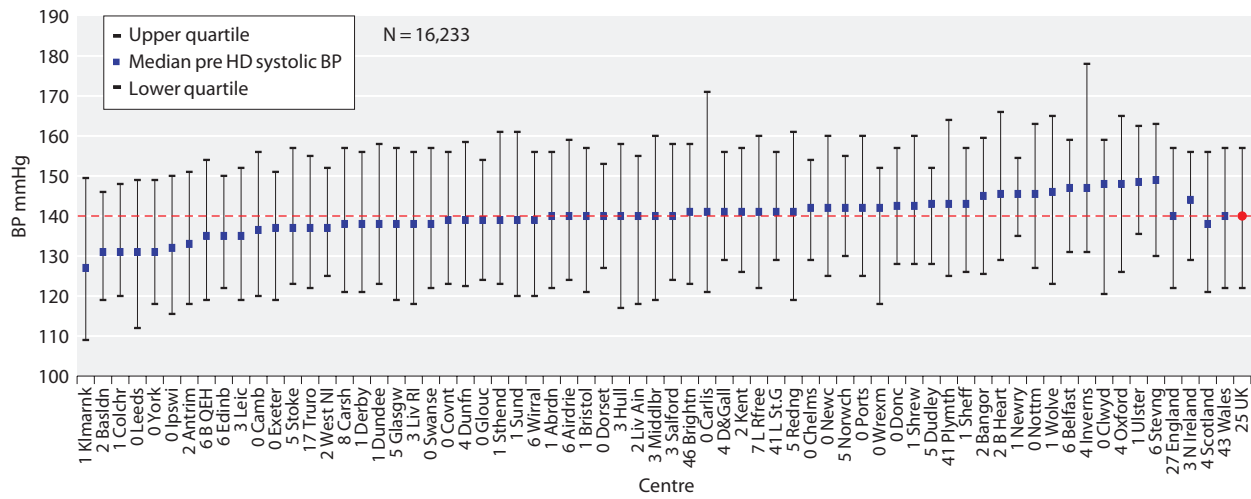


Fig. 11.2. Median systolic BP: pre-HD

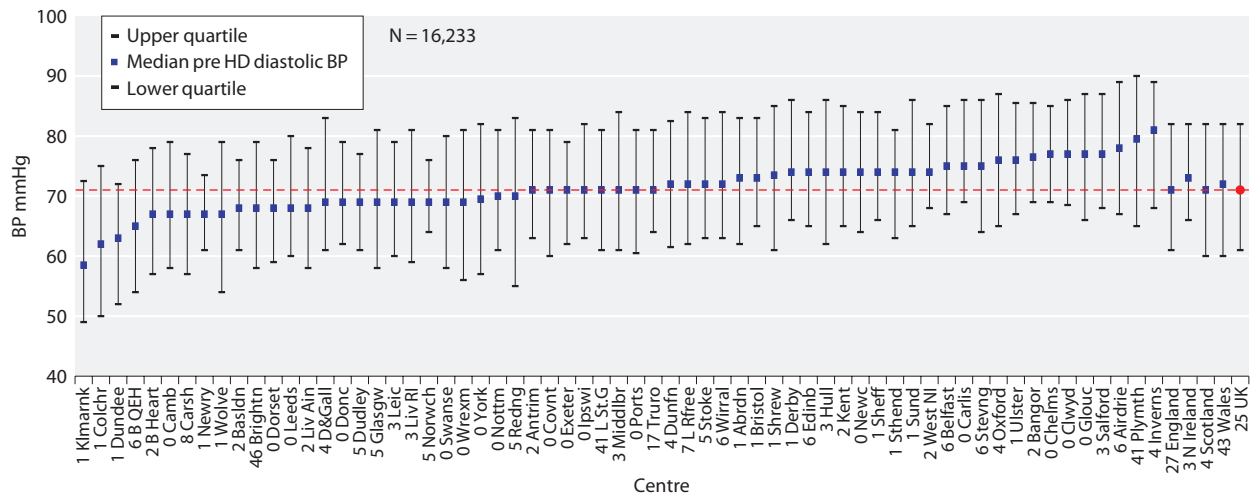


Fig. 11.3. Median diastolic BP: pre-HD

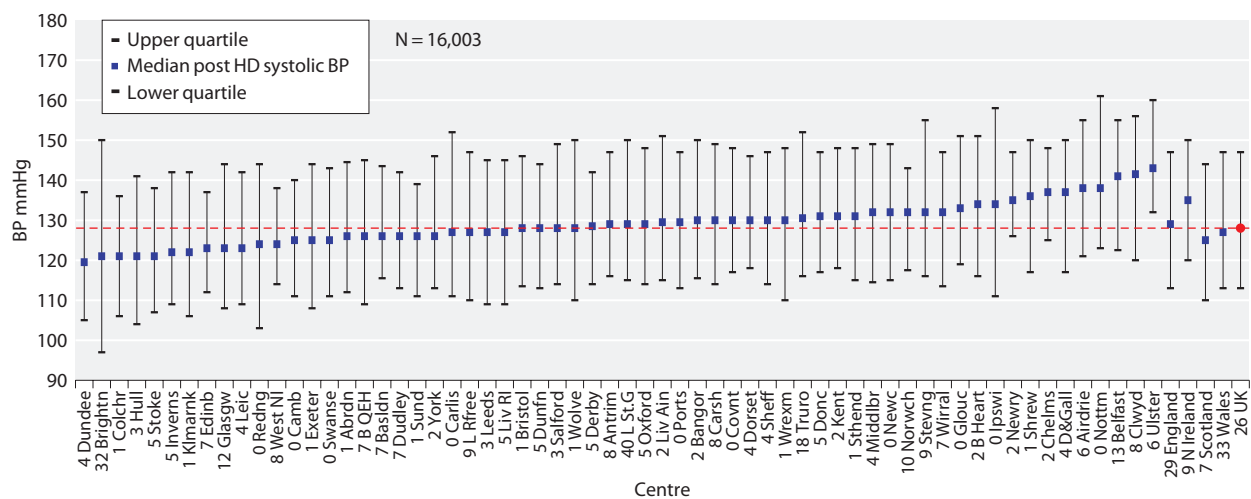


Fig. 11.4. Median systolic BP: post-HD

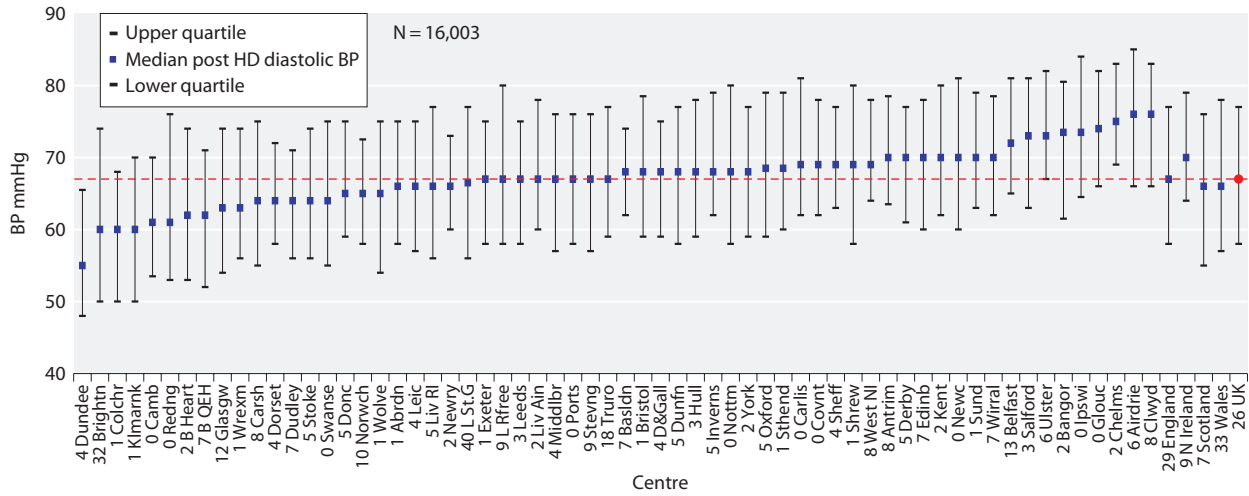


Fig. 11.5. Median diastolic BP: post-HD

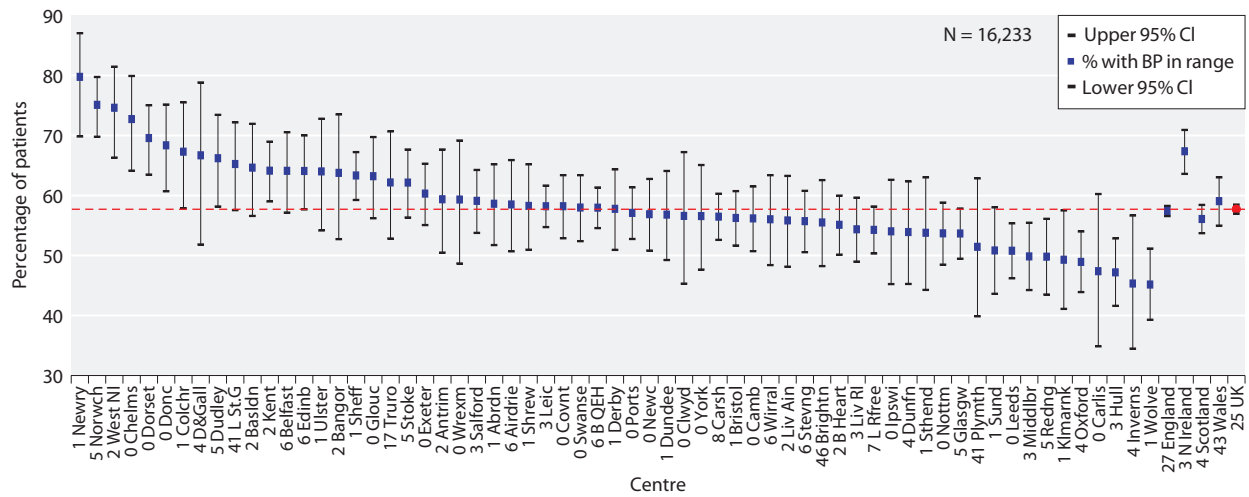


Fig 11.6. Percentage of patients achieving pre-dialysis SBP readings in the range 120–160 mmHg

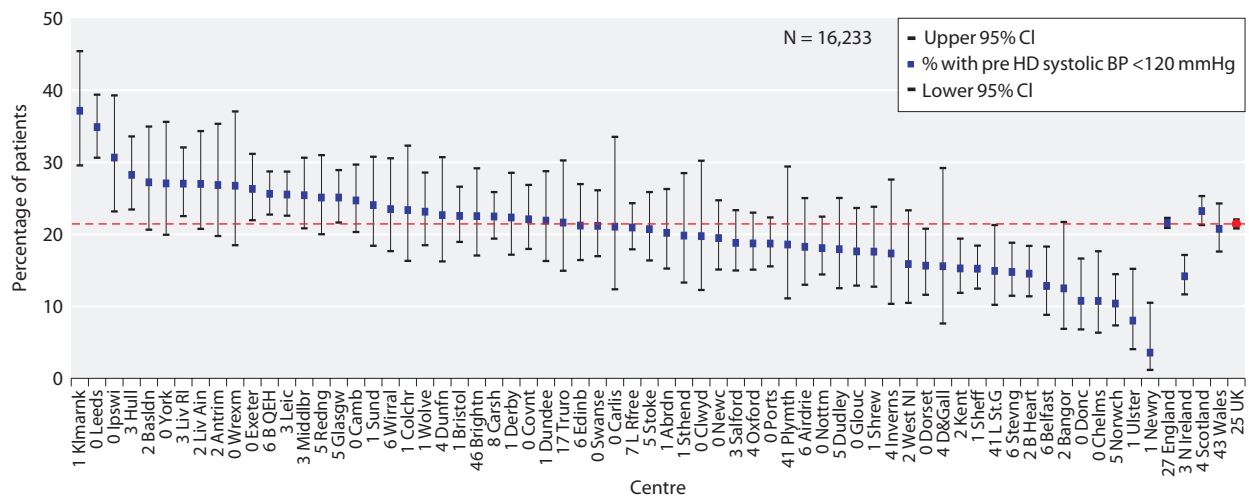
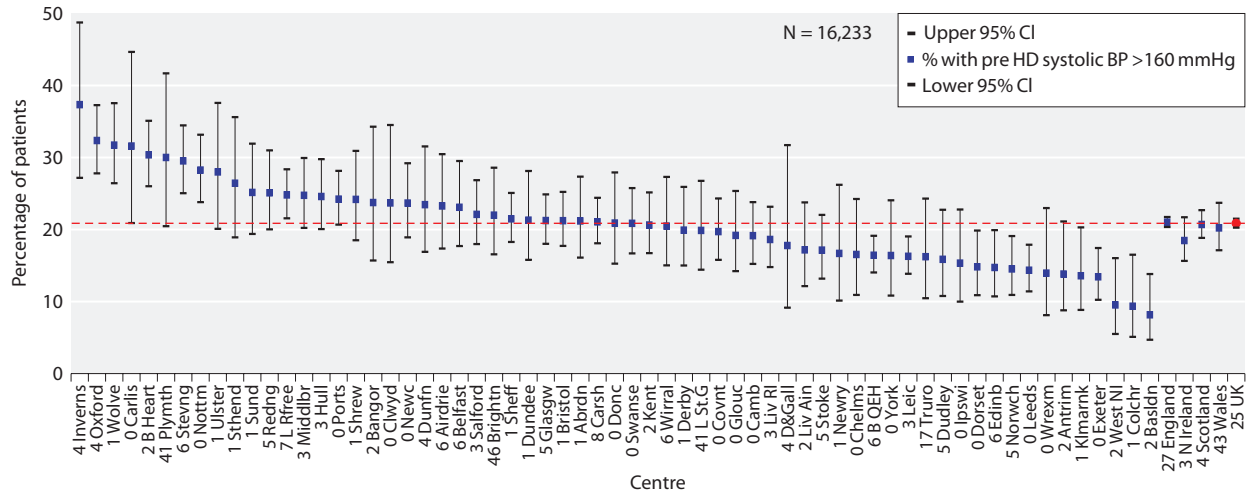
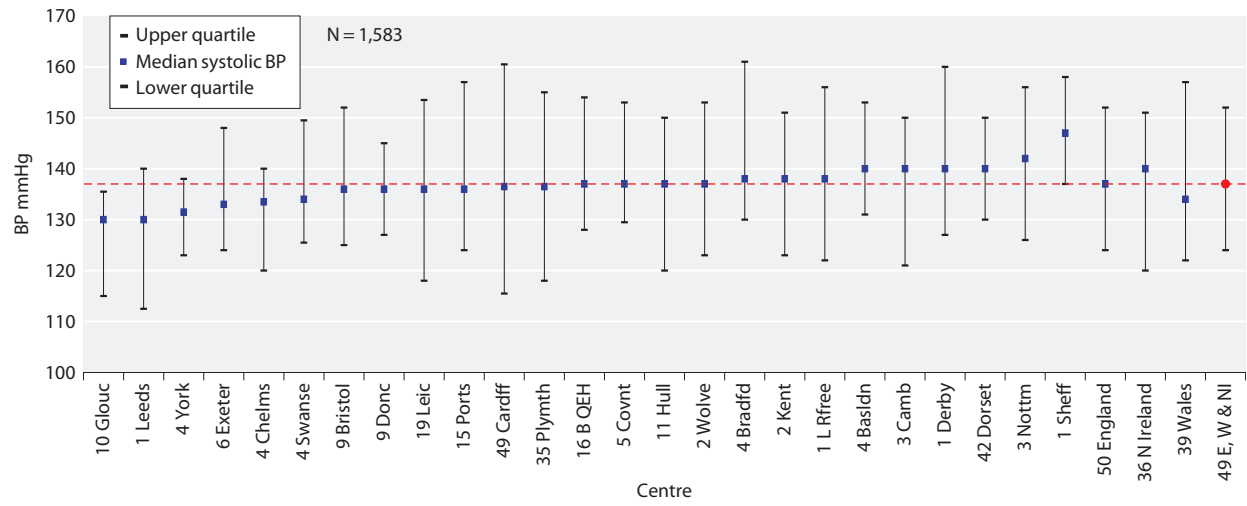


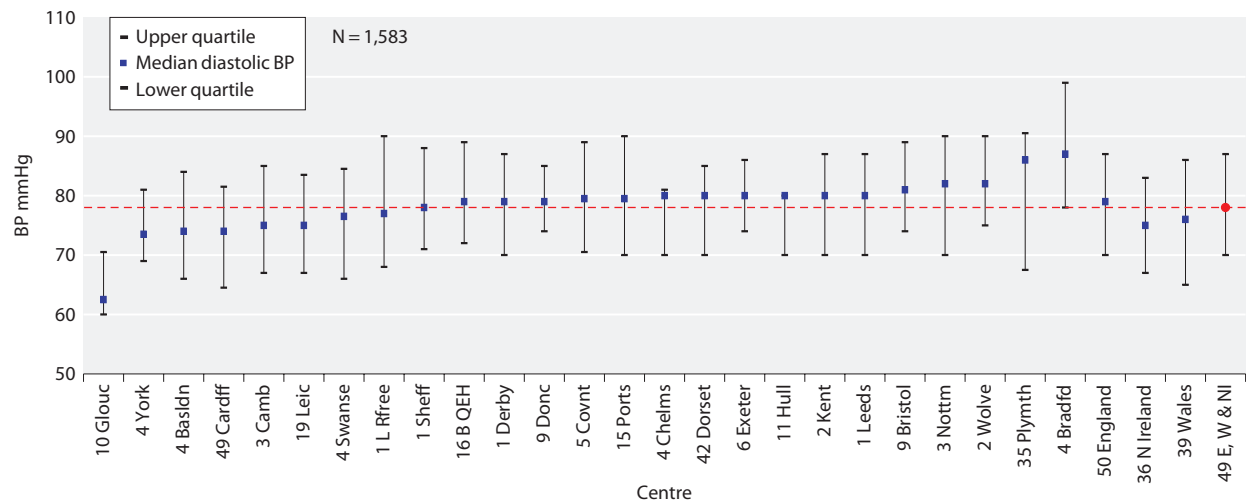
Fig 11.7. Percentage of patients with pre-dialysis SBP <120 mmHg



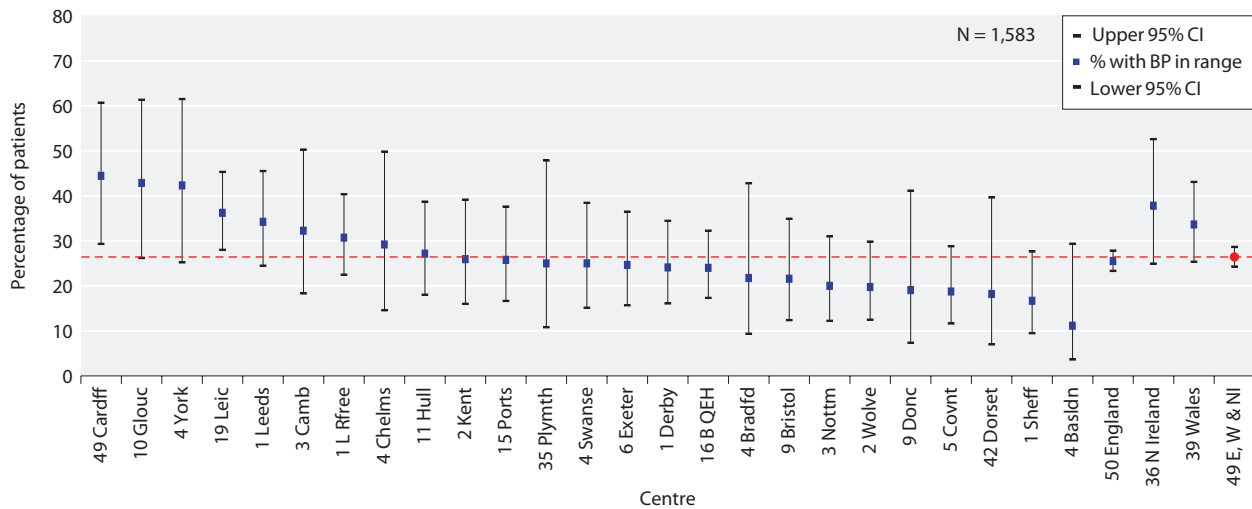
**Fig 11.8.** Percentage of patients with pre-dialysis SBP >160 mmHg



**Fig. 11.9.** Median systolic BP: PD



**Fig. 11.10.** Median diastolic BP: PD



**Fig. 11.11.** Percentage of patients with BP <130 mmHg systolic and <80 mmHg diastolic: PD

patients meeting the audit standard of BP <130/80 mmHg.

The possibility of information bias in these analyses cannot be excluded since BP data are extracted from the routine clinical record.

*Centre-specific analysis of BP in transplant patients*

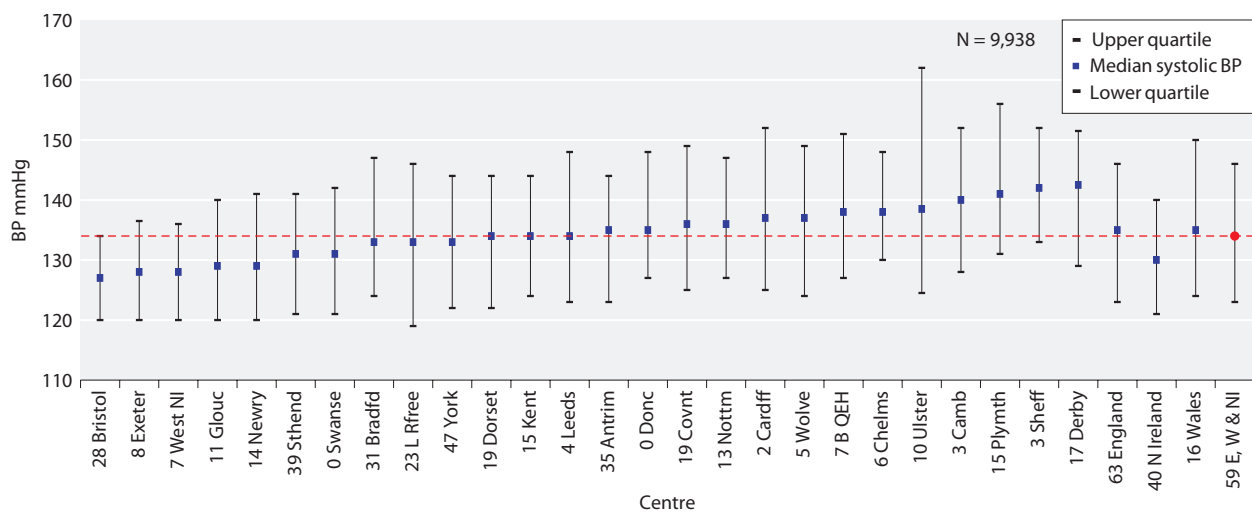
Figures 11.12 and 11.13 illustrate the median and IQR SBP and DBP in each centre supplying data on >50% of eligible patients and figure 11.14 illustrates the percentage of patients meeting the audit standard of BP <130/80 mmHg.

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

**Discussion**

Blood pressure control amongst HD patients in the UK remained poor in 2012. Nearly half of centres had greater than 20% of their patients with pre-dialysis systolic BP <120 mmHg. There were also nearly half who had greater than 20% of their patients with pre-dialysis systolic BP >160 mmHg. There continues to be marked variation between centres in attainment of nationally agreed BP standards for those on PD and those with functioning kidney transplants.

High BP is common in HD patients and contributes to the observed excess of cardiovascular morbidity and mortality in these patients [24]. However, there is still



**Fig. 11.12.** Median systolic BP: transplant



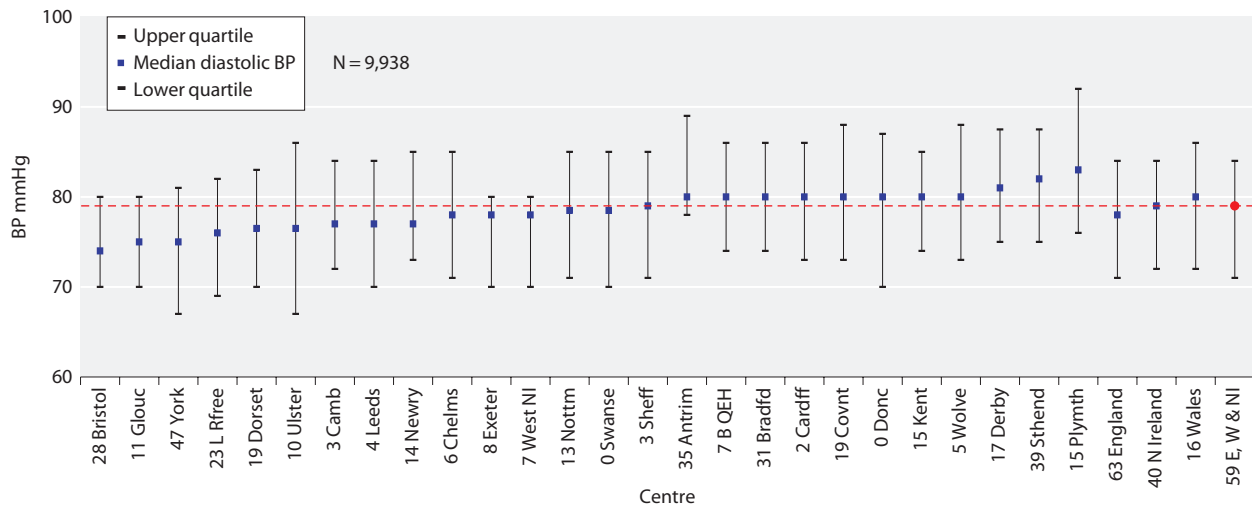


Fig. 11.13. Median diastolic BP: transplant

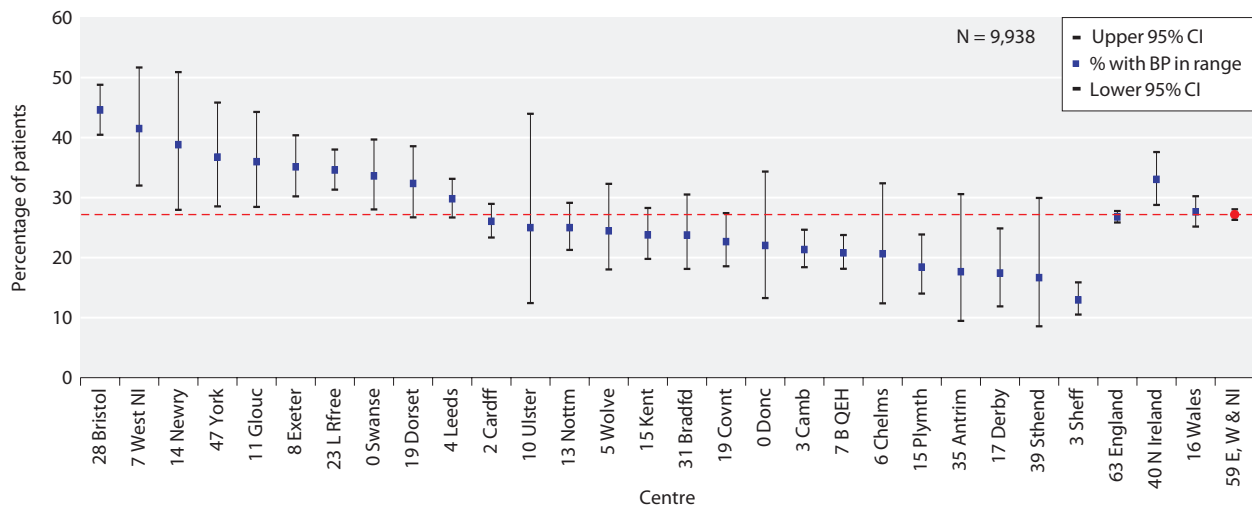


Fig. 11.14. Percentage of patients with BP <130 mmHg systolic and <80 mmHg diastolic: transplant

no clarity about how and when to measure BP, or about BP targets in the haemodialysis population.

Reliance upon immediate pre-dialysis and/or post-dialysis BP measurements alone to detect hypertension in patients undergoing haemodialysis may be misleading [25]. Pre-dialysis BP may substantially overestimate mean ambulatory inter-dialytic BP [26]. For pre-dialysis SBP the overestimate may range from 6–18 mmHg depending on the timing of the measurement and for DBP from 3–9 mmHg. In contrast, post-dialysis measurements underestimate mean systolic BP by approximately 4–14 mmHg for SBP and 1 mmHg for DBP. There are suggestions that post-dialysis BP may be more reflective of mean inter-dialytic BP [25, 26].

The utility of UKRR data could be enhanced by collection of data on intra-dialytic weight gain, the use of BP lowering drugs and the frequency of intra-dialytic hypotension. Future registry analyses should include systolic BP as an independent risk factor in models for predictors of death and variation in survival on dialysis.

Conflicts of interest: none

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