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 predialysis 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 UKR relaxes 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.

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

<table>
<thead>
<tr>
<th>Centre</th>
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<th>Post-HD</th>
<th>PD</th>
<th>Transplant</th>
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*UK % completeness for PD and transplant excludes Scotland

Fig. 11.1. Summary of BP achievements
Chapter 11

Blood pressure in UK RRT patients

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
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...
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

References

5 The FHN Trial Group. In-Center Hemodialysis Six Times per Week versus Three Times per Week. New England Journal of Medicine. 2010; 363:2287–2300