Renal Replacement Therapy

RESEARCH Open Access

Falls in systolic blood pressure during dialysis which require no nursing intervention are associated with increased patient intra-dialytic symptom self-reporting and prolonged post-dialysis recovery times

Suree Yoowannakul[1], Surachet Vongsanim[2], Kamonwan Tangvoraphonkchai[3], Ahmed Mohamed[4] and Andrew Davenport[4*]

Abstract

Background: Haemodialysis (HD) patients may suffer symptoms during dialysis and take time to recover post HD. We wished to determine whether patients with symptomatic intra-dialytic hypotension (IDH), requiring nursing interventions, or an asymptomatic fall in systolic blood pressure (SBP) reported more symptoms during dialysis.

Methods: Six hundred three HD patients completed self-reported intra-dialytic symptom questionnaires and recovery using a visual analogue scale, which were compared with their dialysis session records.

Results: Twenty-nine (4.8%) of patients suffered symptomatic IDH, and 187 (31.0%) had a fall in SBP of > 20 mmHg. Symptomatic patients had greater total symptom scores (30 (23–44) vs 23 (10–38), $p < 0.05$, versus asymptomatic patients, with increased low blood pressure, dizziness, cramps, palpitations and feeling cold reported (all $p < 0.05$). Patients with a SBP fall of > 20 mmHg had greater total scores compared with those with a SBP increase of > 10 mmHg (26 (13–38) vs 17 (7–34), $p < 0.05$), with more dizziness, cramps, backache, shortness of breath and headache reported (all $p < 0.05$). Although ultrafiltration rates were similar, HD weight loss was greater for patients with a SBP fall of > 20 mmHg (2.5 ± 1.1 vs 2.0 ± 1.3%, $p < 0.05$). Patients with highest symptoms scores (highest vs lowest quartile) had longer recovery times (40.3 vs 7.6% > 4 h), $p < 0.001$.
Multivariable analysis showed that patients reporting more intradialytic symptoms had higher psychological distress thermometer scores (odds ratio (OR) 1.34 (95% confidence limits 1.26–1.44)), systolic blood pressure < 100 mmHg (OR 2.53 (1.04–6.1)), whereas symptom scores were lower for male gender (OR 0.34 (0.22–0.51)), and with increasing age (OR 0.99 (0.97–0.99)).

Conclusion: Patients with both symptomatic and asymptomatic IDH, self-reported more symptoms during dialysis, and those patients reporting more symptoms had longer recovery times. We found that younger, female patients, those with greater psychological distress, and lower systolic blood pressure self-reported more intra-dialytic symptoms. More attention is required to prevent falls in intra-dialytic blood pressure to improve the patient experience of HD and shorten post-dialysis recovery times.

Keywords: Haemodialysis, Distress thermometer, Hand-grip strength, Cramps, Headaches

* Correspondence: a.davenport@ucl.ac.uk; andrewdavenport@nhs.net
[4]UCL Department of Nephrology, Royal Free Hospital, Rowland Hill Street, NW3 2PF, London, UK
Full list of author information is available at the end of the article

Introduction

In addition to the impact of chronic kidney disease on lifestyle and patient well-being, haemodialysis treatments themselves may additionally cause symptoms [1–5]. Previous studies have reported a reduction of intra-dialytic symptoms by altering the standard dialysis schedule, with several studies reporting that more frequent and lower efficiency dialysis reduce intra-dialytic symptoms, although other studies have failed to confirm these findings [6–8]. On the other hand, there has been no substantive evidence to support that dialyzer selection, dialysis modality or choice of dialysate composition significantly impact on reducing patient self-reported intra-dialytic symptoms [1].

During dialysis, there are relatively rapid fluid and electrolyte shifts and changes in plasma osmolality which may result in hypotension, which is the commonest complication of outpatient haemodialysis [9]. Although only a minority of patients suffer with symptomatic intra-dialytic hypotension, there is growing concern about asymptomatic intra-dialytic hypotension [10], which may lead to longer term adverse health consequences. As such, we wished to determine whether changes in blood pressure during a haemodiafiltration session increased the frequency of patient self-reported intra-dialytic symptoms and increased postdialysis recovery times.

Patients and methods

In keeping with UK National Health Service (NHS) guidelines to obtain patient feedback on treatment, we asked all patients attending for outpatient dialysis treatment under the care of the Royal Free Hospital, London, to self-report the frequency of dialysis associated symptoms, including fatigue, feeling cold, cramps, dizziness, headache, nausea, abdominal pain, back ache, pruritus, short of breath and palpitations and time to recovery using a previously reported visual analogue scale [4, 11], when they attended for a routine out-patient mid-week dialysis session in four outlying satellite dialysis centres under the care of a university hospital in sequence in May, June and November 2017, respectively. Psychological distress was determined using the distress thermometer score, a visual scoring system initially introduced in the management of patients with cancer [12]. Hospital computerised medical records were reviewed to obtain their Stoke-Davies comorbidity grades, a comorbidity score developed in the UK and used by the UK national renal registry [13], and frailty using the Canadian geriatric frailty score, which assess functional ability, in terms of activities of daily living [14].

Pre-midweek blood samples were taken on the day of the questionnaire for standard biochemical measurement of urea, creatinine, albumin, C reactive protein (CRP) and N terminal pro-brain natriuretic peptide (NT-proBNP) (Roche Integra, Roche Diagnostics, Lewes, UK) [15] and haemoglobin along with the corresponding post-dialysis urea.

The dialysis prescription and dialysis session details were reviewed retrospectively from hospital computerised records. Patients dialysed using either a Fresenius 4000H, or 5008 dialysis machines (Fresenius MC, Bad Homburg, Germany) or BBraun DialogueR$^+$ (BBraun, Melsungen, Germany) with a polysulphone dialyzer (Fresenius MC, Bad Homburg, Germany) [16] and anticoagulated with a bolus of tinzaparin low molecular weight heparin (Leo Laboratories, Princes Risborough, UK) [17]. All dialysates used a common concentration of bicarbonate 32 mmol/L, acetate 3.0 mmol/L, magnesium 0.5 mmol/L and glucose 5.5 mmol/L. Median dialysate sodium concentration was 136 (136–138) mmol/L and temperature 35°C (35–35.5). Conductivity modules were regularly calibrated and checked [18]. We used constant ultrafiltration profiles, and ultrafiltration rates (UFR) were calculated as the difference in pre- and post-dialysis weights divided by sessional time and adjusted for patient weight. When comparing UFR, we excluded sessions where the UFR had been altered in response to patient symptoms. We calculated the serum to dialysate sodium gradient by subtracting dialysate sodium from pre-dialysis serum sodium. All patients were treated with haemodiafiltration median convective volume exchange 19.1 (16.0–23.0) L.

Blood pressure was measured in the sitting position immediately prior to the start of the dialysis treatment using integrated automatic oscillometric devices. There have been various definitions of intra-dialytic hypotension ranging from the European Dialysis and Transplant clinical guidelines of a fall in systolic blood pressure of > 20 mmHg and patient symptoms [19], to others simply based on changes in blood pressure [20, 21]. Our computerised dialysis records code symptomatic hypotension; as 0 no symptomatic hypotension; 1 a reduction in ultrafiltration rate; 2 administration of intravenous fluids. We divided patients into those who had symptomatic hypotension (score 1 or 2), and also into three groups based on whether their post-dialysis systolic blood pressure, or intra-dialytic systolic blood pressure had fallen by > 20 mmHg (group 1), fell by less than 20 mmHg or increased by less than 10 mmHg (group 2), or increased by > 10 mmHg (post-dialysis hypertension) (group 3) [20]. In addition, we also used nadir cutoff systolic blood pressures of 90 and 100 mmHg or lower [21].

Ethics

This audit of clinical service complied with the UK National Health Service (NHS) guidelines for clinical audit and service development, and met with approval from the Health Research Authority (HRA). In keeping with UK guidelines, all patient data was anonymised prior to analysis (https://www.hra.nhs.uk).

Statistical analysis

Data is presented as mean ± standard deviation, median (interquartile range) or as percentage. Standard statistical tests were used to analyse data; D'Agostino and Pearson normality test, *t* test, Wilcoxon rank sum tests, ANOVA, Kruskal Wallis, or chi square test) with appropriate corrections made for multiple testing, by Tukey or Gannet-Howell post-hoc testing. Spearman correlation analysis was used for univariate analysis. To develop a multi-variable model for dialysis symptoms, we took all variables associated with the total symptom score $p < 0.1$, and variables thought to be clinically relevant (weight loss, ultrafiltration rate, dialyzer surface area, dialysate to serum sodium gradient, dialysate temperature, months of dialysis treatment, serum albumin, haemoglobin, glucose and N terminal brain natriuretic peptide). A step backward logistic regression model with above and below the median total symptom score as the dependent variable was generated, removing variables which were not significant, or 95% confidence limits crossed the line of unity, unless they added to the model strength. Statistical analysis used Prism 8.2 (Graph Pad, San Diego, USA) and Social and Political Sciences Statistical Package (SPSS 24.0, IBM, Armonk, USA). Statistical significance was taken as $p < 0.05$.

Results

A total of 633 patients were scheduled to dialyse on the day of the prospective audit in their dialysis centre, and 603 (95.4%) completed the self-reported questionnaires. Thirty patients were unable to complete the questionnaires; 8 due to their inability to understand English, 5 due to dementia or other cognitive disorders, and 17 declined to participate. The questionnaire was read out to those patients unable to read the questionnaire. Twenty-nine patients suffered symptomatic intra-dialytic hypotension during the dialysis session (4.7%). These patients more frequently reported muscle cramps, dizziness, palpitations and feeling cold (Fig. 1). Patients suffering from symptomatic intra-dialytic hypotension were more likely to be female, of lower body weight, with greater frailty scores and with more comorbidity, and started dialysis with a lower blood pressure and serum albumin (Table 1). There were no differences between groups in terms of previous coronary artery bypass surgery (CABG) (6.8 vs 13.8%), coronary artery stenting (9.6 vs 10.3%), peripheral vascular disease (PVD) (15.2 vs 10.3%), prescription of blood pressure medications(62.2 vs 65.5%); calcium channel blockers (CCB) (24.9 vs 13.8%), angiotensin converting enzyme inhibitors (ACEI) (10.3 vs 10.3%), angiotensin receptor blocker (ARB) (9.1 vs 13.8%) or βblocker prescription (40.4 vs 55.2%) (all $p > 0.05$).

As less than 5% of patients had suffered symptomatic intra-dialytic hypotension, we then divided patients into three groups based on whether their post-dialysis or intra-dialytic systolic blood pressure had fallen by > 20 mmHg (intra-dialytic hypotension), post-dialysis systolic blood pressure fallen by less than 20 mmHg or increased by less than 10 mmHg, or post-dialysis systolic blood pressure increased by > 10 mmHg (intradialytic hypertension) [20]. The demographics and comorbidity of these three groups are set out in Table 2. Compared with those with intra-dialytic hypertension, patients in the intra-dialytic hypotensive group who experienced the greater fall in systolic blood pressure reported more intra-dialytic cramps, headache, dizziness, shortness of breath and backache (Fig. 2. and Table 3), but time to recover post-dialysis was not different (X^2 6.4, $p = 0.6$). There were no differences in specific comorbidities, or drug prescriptions between the three study groups in terms of previous CABG (7.5 vs 7.3 vs 3.5%), coronary artery stenting (8 vs 10 vs 9.6%), PVD (17.5 vs 11.6 vs 14.8%), prescription of blood pressure medications (60.4 vs 57.4 vs 67.8%); CCBs, (19.3 vs 23.9 vs 31.3%), ACEIs (10.2 vs 8.3 vs 13%), ARBs (10.7 vs 8 vs 9.6%) or βblocker prescription (40.6 vs 38.2 vs 44.3%) (all $p > 0.05$).

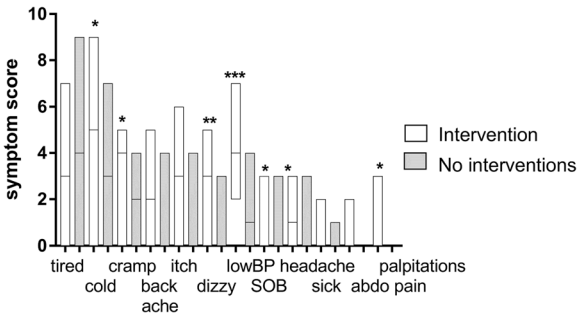

Fig. 1 Dialysis symptom frequency scores using a visual analogue scale of 0 to 10. Patients divided into those who suffered symptomatic intra-dialytic hypotension requiring nursing intervention and those who had dialysis sessions without any intervention.Results expressed as median, interquartile and 95% limits. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$ vs those with no interventions

Patients who had an asymptomatic 20 mmHg fall in systolic blood pressure or greater were heavier and had both greater absolute weight loss, and also when adjusted for pre-dialysis weight, and had higher pre-dialysis blood pressures (Table 2). However, there were no differences in comorbidity grading, frailty or self-reported distress thermometer scores, and haematocrit was highest in the group with the greatest fall in blood pressure with dialysis.

Systolic blood pressure fell to 90 mmHg in 12 patients (< 2%) and less than 100 mmHg in 42 patients (7%). In both cases lower nadir blood pressure was more common in female patients (X^2 10, $p = 0.002$; X^2 9.7, $p = 0.02$, respectively), and although individual symptom scores did not differ, total symptom scores were greater

Table 1 Comparison of patient demographics, dialysis session and pre-dialysis blood tests of the 29 dialysis patients who suffered symptomatic hypotension requiring a nursing intervention vs all other patients who had no nursing interventions (574)

	No intervention	Intervention
Male (%)	62.6	24.1**
Age years	64.3 ± 16.3	68.5 ± 13.4
Diabetic (%)	44.6	48.3
White ethnicity (%)	42.9	44.8
Vintage months	33.8 (13.7–67.3)	30.4 (7.8–101)
Frailty	4.0 (3.0–5.0)	5.0 (4.0–6.0)*
Comorbidity grade	1.0 (1.0–1.0)	1.0 (1.0–2.0)*
Distress thermometer	3.0 (0-6.0)	4.0 (2.0–7.0)
Pre-dialysis weight kg	74.5 ± 18.5	65.8 ± 14.6**
Pre-dialysis systolic blood pressure mmHg	145.8 ± 26.0	132.8 ± 29.4**
Dialysis session time hours	3.72 ± 0.52	3.64 ± 0.50
Serum minus dialysate sodium mmol/L	2 (0–4)	1(− 1 to 3)
Dialyzer surface area m2	2.0 ± 0.3	1.9 ± 0.3
% weight loss	2.2 ± 1.4	2.2 ± 1.2
Urea reduction ratio %	72.9 ± 8.9	73.8 ± 14.2
Haematocrit	0.340 ± 0.044	0.349 ± 0.057
Serum albumin g/L	38.5 ± 4.4	36.6 ± 4.3*
C reactive protein mg/L	6.0 (2.9–11.0)	8.0 (5.0–15.0)
Blood glucose mmol/L	6.5 (5.4–8.2)	6.6 (5.4–8.1)
N terminal brain natriuretic peptide ng/L	3565(1545–11,815)	4271 (1825–12,295)

Results displayed as integers, percentage or median and interquartile range, *$p < 0.05$, **$p < 0.01$

for those with a nadir systolic blood pressure of than 90 mmHg or lower (42.5 (21.5–61.5) vs 23 (19–38), $p = 0.03$) and with a nadir of 100 mmHg or less (22 (12–36) vs 13 (5–21) , $p = 0.003$). Time to recover reported was also longer for those patients with a nadir systolic blood pressure of than 90 mmHg or 100 mmHg compared with those with higher systolic blood pressures (Fig. 3).

On univariate analysis, the change in systolic blood pressure, the absolute difference between the pre-dialysis and post-dialysis systolic pressures, so a greater fall in systolic blood pressure was associated with greater self-reported total symptom scores ($r = 0.102$, $p = 0.013$), backache ($r = 0.13$, $p = 0.002$), symptoms of low blood pressure ($r = 0.098$, $p = 0.016$), dizziness ($r = 0.096$, $p = 0.019$), headache ($r = 0.09$, $p = 0.027$), but not tiredness ($r = 0.070$, $p = 0.088$) or cramps ($r = 0.070$, $p = 0.096$). There was no statistically significant correlation between dialysis symptoms scores and psychological distress as assessed by self-reported distress thermometer scores, or dialysate temperature and patients reporting feeling cold during dialysis sessions, both $p > 0.05$.

We calculated the total symptom score for each patient and performed univariate analysis (Table 3). Taking the composite score, then there was a significant association with psychological distress, post-dialysis recovery time, and also the fall in systolic blood pressure and for patients with a systolic blood pressure < 100 mmHg (Table 4). A step-backward logistic regression model showed that a higher distress thermometer score, female gender, younger patients and those with a systolic blood pressure of < 100 mmHg were independently associated with a higher total symptom score (Table 5).

Discussion

Although haemodialysis treatments have been transformed over the last 50 years with many patients now attending for their dialysis treatment in free-standing dialysis centres without medical supervision, dialysis is not without complications. As intra-dialytic hypotension remains the most commonly reported complication of dialysis session [19–21], we wished to determine whether changes in blood pressure led to increased symptom reporting, as previous studies have reported that higher ultra-filtration rates result in longer post-dialysis recovery times [22].

Although only a small minority of patients had symptomatic hypotension requiring nursing interventions, when directly questioned the majority of patients reported some symptoms with their dialysis session. Both patients who had nursing interventions for intra-dialytic hypotension, and also those with an absolute fall in systolic blood pressure of more than 20 mmHg or a fall in systolic blood pressure to 100 mmHg or less, reported more symptoms,. Symptomatic patients were generally

Table 2 Patient demographics of 603 dialysis patients, divided into three groups depending on whether systolic blood pressure (SBP) fell by 20 mmHg or greater (group 1), fell by less than 20 mmHg or increased by less than 10 mmHg (group 2), or increased by more than 10 mmHg (group 3)

Variable	Group 1	Group 2	Group 3
Number of patients	187	301	115
Male (%)	106 (56.7)	182 (60.5)	79 (68.7)
Age years	62.9 ± 14.3	64.6 ± 17.4	66.5 ± 16.6
Diabetic (%)	94 (50.3)	122 (40.5)	53 (46.1)
White ethnicity (%)	81 (43.3)	123 (40.9)	54 (47.0)
Vintage months	34.7(15.7–68.6)	32.9(14–71.3)	27.2(9.2–54.9)
Frailty	4 (3–5)	4 (3–5)	4 (3–5)
Comorbidity grade	2 (1–2)	1 (1–2)	1 (1–2)
Distress thermometer	4.0 (1.0–6.0)	4.0 (1.0–6.0)	3.0 (0–6.0)
Pre-dialysis weight kg	77.1 ± 19.6	72.5 ± 16.4	72.0 ± 18.8*
Pre-dialysis systolic blood pressure mmHg	159.4 ± 20.5	142.1 ± 26.2***	130.6 ± 23.1***
Dialysis session time hours	3.79 ± 0.50	3.60 ± 0.50*	3.72 ± 0.50
% weight loss	2.5 ± 1.1	2.1 ± 1.4*	2.0 ± 1.3*
Ultrafiltration rate ml/kg/h	4.4 ± 0.7	4.5 ± 0.7	4.4 ± 0.7
Serum minus dialysate sodium mmol/L	2.5(0–4)	2(− 1 to 4)	2 (− 1 to 4)
Dialyzer surface area m2	2.0 ± 0.2	1.9 ± 0.3*	1.9 ± 0.3
Urea reduction ratio %	72.9 ± 9.2	72.9 ± 9.6	73.4 ± 7.8
Haematocrit	0.349 ± 0.053	0.338 ± 0.046*	0.335 ± 0.044*
Serum albumin g/L	38.9 ± 4.3	38.2 ± 4.4	38.0 ± 4.8
C reactive protein mg/L	6 (3–11)	5 (2–11)	6 (2–12)
Blood glucose mmol/L	6.2 (5.2–8.0)	4.5 (5.4–8.0)	6.7 (5.8–8.2)
N terminal brain natriuretic peptide ng/L	3599 (1625–12381)	3734 (1580–13958)	3581 (1649–8528)

Results displayed as integers, percentage, or median and interquartile range, *$p < 0.05$, **$p < 0.01$, ***< 0.001 vs group 1

frailer, more likely to be female with lower pre-dialysis weight, which is in keeping with previous studies reporting that women are more likely to be at risk of intradialytic hypotension [23]. There has been a debate as to whether dialysis prescription factors or patient psychological factors are more important in determining patient reports of symptoms associated with dialysis [24, 25]. We found that patients reporting psychological distress, as assessed by self-reported distress thermometer scores [12], reported more symptoms with dialysis

As the number of patients who developed symptomatic hypotension requiring a nursing intervention, or those

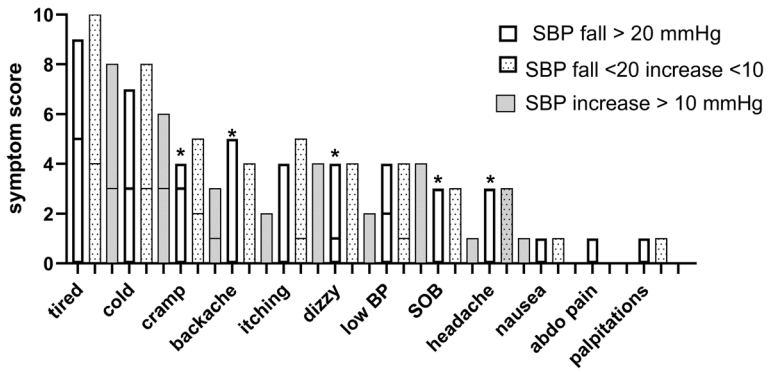

Fig. 2 Dialysis symptom frequency scores using a visual analogue scale of 0 to 10. Patients divided into three groups based on whether their post-dialysis systolic blood pressure (SBP) had fallen by > 20 mmHg, fell by less than 20 mmHg or increased by less than 10 mmHg, or increased by > 10 mmHg. Results expressed as median, interquartile and 95% limits. *$p < 0.05$, vs those with an increase in SBP of > 10 mmHg

Table 3 Percentage of patients reporting no symptoms during dialysis, divided into three groups depending on whether systolic blood pressure (SBP) fell by 20 mmHg or greater (group 1), fell by less than 20 mmHg or increased by less than 10 mmHg (group 2), or increased by more than 10 mmHg (group 3)

Symptom	Group 1	Group 2	Group 3
Tiredness	31.5	31.4	38.2
Feeling cold	42.6	39.4	38.2
Cramps	48.7	50.3	52.8
Pruritus	50.8	54.9	58.5
Low blood pressure	50.8	53.5	67.5
Dizziness	54.3	58.4	60.2
Backache	56.3	60.5	65.9
Headache	67.0	61.6	72.4
Short of breath	72.1	72.1	76.4
Nausea	75.6	72.7	80.5
Abdominal pain	76.5	79.7	80.5

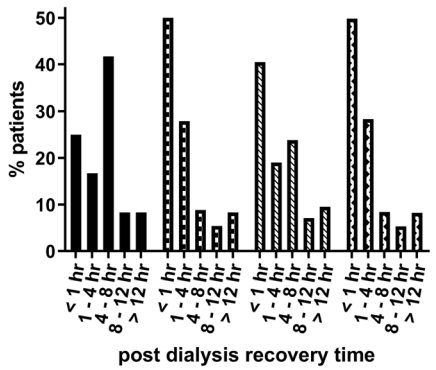

Fig. 3 Percentage of patients reporting time to recover after their haemodialysis session between less than an hour to more than 12 h. Patients divided into four groups based on whether their nadir systolic blood pressure (SBP) had fallen to 90 or 100 mmHg or less. Patients with a SBP of ≤ 90 mmHg reported longer recovery times compared with those with SBP > 90 mmHg (adjusted X^2 15.7, p = 0.004); as did those with SBP of ≤ 100 mmHg compared to those with SBP > 100 mmHg (adjusted X^2 = 12.1, p = 0.017)

with a nadir systolic blood pressure of 90 mmHg or lower was relatively small, we reviewed the symptom scores from those patients with asymptomatic hypotension [18, 19]. These patients had a greater percentage weight loss, which would be in keeping with reports of higher ultrafiltration rates leading to more post-dialysis fatigue [26]. However, the ultrafiltration rates used in our patient cohort were much lower than those previously reported, and as such in our study, there was no statistically significant association [27]. Even so, a reduction in blood pressure during dialysis has been shown to lead to a reduction in the blood supply to vital internal organs. In addition to reports demonstrating reduced perfusion to the heart and brain, recent reports have also highlighted an association with mesenteric ischaemia [28, 29], which may reflect the increase in reports of backache with dialysis, in addition to the increased frequency of self-reported dizziness, headache, cramps and breathlessness comparing patients who had asymptomatic hypotension to those with intra-dialytic hypertension. Those patients with the lowest systolic blood pressures recorded during dialysis reported taking longer to recover post-dialysis.

Table 4 Spearman univariate association with self-reported total dialysis symptom score

Variable	rho	*p* value
Distress thermometer score	0.46	< 0.001
Time to recover post dialysis	0.38	< 0.001
Female gender	0.29	< 0.001
Age years	− 0.13	0.001
Systolic blood pressure < 100 mmHg	0.12	0.003
Urea reduction ratio %	0.10	0.012
Fall in systolic blood pressure mmHg	0.12	0.013
C reactive protein mg/L	0.09	0.029

Only statistically significant variables listed

Our study demonstrates that patients with both symptomatic and asymptomatic intra-dialytic hypotension report more symptoms with dialysis sessions. This would suggest that interventions to alter the dialysis session prescription could potentially reduce patient symptoms. As previous studies reporting on dialysis symptoms have observed an association between symptom reporting and higher ultrafiltration rates [26], required as a consequence of greater inter-dialytic weight gains, then designing interventions ranging from patient education initiatives to reduce inter-dialytic weight gains [30], altering dialysate sodium to achieve greater sodium losses without causing adverse effects [31, 32] could potentially ameliorate patient symptoms, although we could not demonstrate any effect of dialysate sodium or serum to dialysate sodium gradient on symptom reporting. We dialysed patients against cooled dialysates, and interestingly, there was no association between dialysate temperature and patients reporting feeling cold. Previous studies reporting on using lower dialysate temperatures have reported fewer intra-dialytic symptoms [33]. We found no effect of dialysate temperature on symptom reporting.

When we analysed patient total symptom scores, we found that patients with higher dialysis symptom scores also reported longer post-dialysis recovery times. Patients with higher symptom scores had higher distress thermometer scores [34], in keeping with an earlier report from a multi-centre study [24]. Previous studies have reported that younger dialysis patients report greater psychological distress [35], and this may account for our findings of

Table 5 Step backward logistic multivariable model of high self-reported total dialysis symptom score compared to low total dialysis scores

Variable	β	StE β	Wald	OR	95% OR CL	*p*
Distress thermometer score	0.30	0.04	71.9	1.34	1.26–1.44	< 0.001
Male vs female gender	− 1–09	0.21	26.3	0.34	0.22–0.51	< 0.001
Age years	− 0.01	0.01	4.5	0.99	0.97–0.99	0.033
SBP < 100 mmHg	0.94	0.45	4.2	2.53	1.04–6.14	0.040

Only statistically significant variables listed. Standard error β (StE β), odds ratio (OR), 95% odds ratio confidence limits (CL). Nagelkerke $r^2 = 0.32$

greater dialysis symptom scores in younger patients. In addition, there was an association between patent symptom scores with low systolic blood pressure and female gender. Previous studies have reported that female dialysis patients are at greater risk of intra-dialytic hypotension [23]. On multivariable logistic regression, then psychological distress, female gender, younger age and a systolic blood pressure of < 100 mmHg remained independently associated with higher total dialysis symptom scores.

Although only a minority of our patients had nadir systolic blood pressure of 90 and 100 mmHg or lower, again these patients reported greater total symptom scores. Despite these patients having dialysis sessions which required no nursing interventions, they reported more intra-dialytic symptoms, and patients with a fall in systolic blood pressure also reported longer post-dialysis recovery times. It is therefore important to try and reduce hypotensive episodes during dialysis. Our study showed that a major difference between patients who had a fall in systolic blood pressure and those with a more stable blood pressure, or an increase in blood pressure, was greater weight loss, and as these patients had a higher pre-dialysis systolic blood pressure, this would suggest that these patients potentially were more fluid overloaded. As such, greater emphasis on patient education to restrict sodium intake may help to reduce inter-dialytic weight gains [36] and so reduce the amount of fluid required to be removed during the dialysis session [22].

Our study suggests that although most patients do not request nursing help and so appear to tolerate a fall in systolic blood pressure during dialysis, the fall in blood pressure is not asymptomatic as these patients report more intra-dialytic symptoms when directly questioned, and repetitive episodes of what has been thought to be asymptomatic temporary episodes of hypotension may result in permanent organ damage in the longer term, and increased risk of mortality [21, 37]. As such, more attention is required to minimise changes in blood pressure during dialysis sessions, and dialysis staff should also take more note of what are currently considered as asymptomatic changes in blood pressure.

Abbreviations

ACEI: Angiotensin converting enzyme inhibitor; ARB: Angiotensin receptor blocker; CABG: Coronary artery bypass surgery; CCB: Calcium channel blockers; CRP: C reactive protein; HD: Haemodialysis; IDH: Intra-dialytic hypotension; NHS: National Health Service; NT-proBNP: N terminal pro-brain natriuretic peptide; PVD: Peripheral vascular disease; SPSS: Social and Political Sciences Statistical Package; SBP: Systolic blood pressure; UFR: Ultrafiltration rate; UK: United Kingdom

Acknowledgements

Drs Suree Yoowannakul, Kamonwan Tangvoraphonkchai, Surachet Vongsanim, and Ahmed Mohamed were in receipt of International Society of Nephrology and Kindey Research UK training scholarships.

Authors' contributions

AD registered the audit; SY, KT, SV, and AM handed out and collected the questionaires. Data analysis was by AD. All authors contributed to the first draft, and all authors approved the final draft.

Funding

None

Availability of data and materials

Data is deposited with UCL Department of Renal Medicine audits, Royal Free Hospital.

Ethics approval and consent to participate

This retrospective audit complied with the United Kingdom National Health Service guidelines for clinical audit and service development, and met with approval from the Health Research Authority. In keeping with United Kingdom guidelines, all patient data was anonymised prior to analysis (https://www.hra.nhs.uk/).

Consent for publication

Not relevant

Competing interests

The authors declare that they have no competing interest

Author details

[1]Division of Nephrology, Department of Medicine, Bhumibol Adulyadej Hospital, Klong Thanon, Saimai, Bangkok 10220, Thailand. [2]Renal Division, Department of Internal Medicine, Chiang Mai University, Suthep Road, Chiang Mai, Thailand. [3]Faculty of Medicine, Mahasarakham University, Maha Sarakham, Thailand. [4]UCL Department of Nephrology, Royal Free Hospital, Rowland Hill Street, NW3 2PF, London, UK.

Received: 9 August 2019 Accepted: 27 November 2019
Published online: 07 January 2020

References

1. Valderrábano F, Jofre R, López-Gómez JM. Quality of life in end-stage renal disease patients. AmJ KidDis. 2001;38(3):443–64.
2. Chilcot J, Almond MK, Guirguis A, Friedli K, Day C, Davenport A, Wellsted D, Farrington K. Self-reported depression symptoms in haemodialysis patients: bi-factor structures of two common measures and their association with clinical factors. Gen Hosp Psychiatry. 2018;54:31–6.
3. Chilcot J, Guirguis A, Friedli K, Almond M, Davenport A, Day C, Wellsted D, Farrington K. Measuring fatigue using the multidimensional fatigue inventory-20: a questionable factor structure in haemodialysis patients. Nephron. 2017;136(2):121–6.

4. Flythe JE, Dorough A, Narendra JH, Forfang D, Hartwell L, Abdel-Rahman E. Perspectives on symptom experiences and symptom reporting among individuals on haemodialysis. Nephrol Dial Transplant. 2018;33(10):1842–52.
5. Caplin B, Kumar S, Davenport A. Patients' perspective of haemodialysis-associated symptoms. Nephrol Dial Transplant. 2011;26(8):2656–63.
6. Garg AX, Suri RS, Eggers P, Finkelstein FO, Greene T, Kimmel PL, Kliger AS, Larive B, Lindsay RM, Pierratos A, Unruh M, Chertow GM. Frequent Hemodialysis Network Trial Investigators. Patients receiving frequent haemodialysis have better health-related quality of life compared to patients receiving conventional haemodialysis. Kidney Int. 2017;91(3):746–54.
7. Davenport A, Gura V, Ronco C, Beizai M, Ezon C, Rambod E. A wearable haemodialysis device for patients with end-stage renal failure: a pilot study. Lancet. 2007;370(9604):2005–10.
8. Hall YN, Larive B, Painter P, Kaysen GA, Lindsay RM, Nissenson AR, Unruh ML, Rocco MV, Chertow GM. Frequent Haemodialysis Network Trial Group. Effects of six versus three times per week hemodialysis on physical performance, health, and functioning: Frequent Haemodialysis Network (FHN) randomized trials. Clin J Am Soc Nephrol. 2012;7(5):782–94.
9. Davenport A, Cox C, Thuraisingham R. Achieving blood pressure targets during dialysis improves control but increases intradialytic hypotension. Kidney Int. 2008;73(6):759–64.
10. Steinwandel U, Gibson N, Towell-Barnard M, Parsons R, Rippey JJ, Rosman J. Measuring the prevalence of intradialytic hypotension in a satellite dialysis clinic: are we too complacent? J Clin Nurs 2018;27(7-8):e1561-e1570. doi: https://doi.org/10.1111/jocn.14309. Epub 2018 Mar 30. PMID: 29446172
11. Caplin B, Alston H, Davenport A. Does online haemodiafiltration reduce intra-dialytic patient symptoms? Nephron Clin Pract. 2013;124(3-4):184–90.
12. Alston H, Burns A, Davenport A. Loss of appendicular muscle mass in haemodialysis patients is associated with increased self-reported depression, anxiety and lower general health scores. Nephrology (Carlton). 2018;23(6):546–51.
13. Davies SJ, Phillips L, Naish PF, Russell GI. Quantifying comorbidity in peritoneal dialysis patients and its relationship to other predictors of survival. Nephrol Dial Transplant. 2002;17(6):1085–92.
14. Walker SR, Brar R, Eng F, Komenda P, Rigatto C, Prasad B, Bohm CJ, Storsley LJ, Tangri N. Frailty and physical function in chronic kidney disease: the CanFIT study. Can J Kidney Health Dis 2015;2:32. PMID: 26346754
15. Booth J, Pinney J, Davenport A. N-terminal proBNP--marker of cardiac dysfunction, fluid overload, or malnutrition in haemodialysis patients? Clin J Am Soc Nephrol. 2010;5(6):1036–40.
16. Tangvoraphonkchai K, Riddell A, Davenport A. Platelet activation and clotting cascade activation by dialyzers designed for high volume online haemo-diafiltration. Hemodial Int. 2018;22(2):192–200.
17. Davenport A. Low-molecular-weight heparin as an alternative anticoagulant to unfractionated heparin for routine outpatient haemodialysis treatments. Nephrology (Carlton). 2009;14(5):455–61.
18. Sandhu E, Crawford C, Davenport A. Weight gains and increased blood pressure in outpatient haemodialysis patients due to change in acid dialysate concentrate supplier. Int J Artif Organs. 2012;35(9):642–7.
19. Kooman J, Basci A, Pizzarelli F, Canaud B, Haage P, Fouque D, Konner K, Martin-Malo A, Pedrini L, Tattersall J, Tordoir J, Vennegoor M, Wanner C, ter Wee P, Vanholder R. EBPG guideline on haemodynamic instability. Nephrol Dial Transplant. 2007;22(Suppl 2):ii22–44.
20. Assimon MM, Flythe JE. Definitions of intradialytic hypotension. Semin Dial. 2017;30(6):464–72.
21. Flythe JE, Xue H, Lynch KE, Curhan GC, Brunelli SM. Association of mortality risk with various definitions of intradialytic hypotension. J Am Soc Nephrol. 2015;26(3):724–34.
22. Hussein WF, Arramreddy R, Sun SJ, Reiterman M, Schiller B. Higher ultrafiltration rate is associated with longer recovery time in patients undergoing conventional haemodialysis. Am J Nephrol. 2017;46:3–10.
23. Sands JJ, Usvyat LA, Sullivan T, Segal JH, Zabetakis P, Kotanko P, Maddux FW, Diaz-Buxo JA. Intradialytic hypotension: frequency, sources of variation and correlation with clinical outcome. Hemodial Int. 2014;18(2):415–22.
24. Davenport A, Guirguis A, Almond M, Day C, Chilcot J, Da Silva GM, Fineberg N, Friedl K, Spencer B, Wellsted D, Farrington K. Postdialysis recovery time is extended in patients with greater self-reported depression screening questionnaire scores. Hemodial Int. 2018;22(3):369–76.
25. Sklar A, Newman N, Scott R, Semenyuk L, Schultz J, Fiacco V. Identification of factors responsible for post-dialysis fatigue. Am J Kid Dis. 1999;34(3):464–70.
26. Bossola M, Di Stasio E, Monteburini T, Parodi E, Ippoliti F, Cenerelli S, Santarelli S, Nebiolo PE, Sirolli V, Bonomini M, Antocicco M, Zuccalà G, Laudisio A. Recovery Time after Hemodialysis Is Inversely Associated with the Ultrafiltration Rate. Blood Purif. 2019;47(1-3):45–51.
27. Assimon MM, Wenger JB, Wang L, Flythe JE. Ultrafiltration Rate and Mortality in Maintenance Haemodialysis Patients. Am J Kidney Dis. 2016;68(6):911–22.
28. Seong EY, Zheng Y, Winkelmayer WC, Montez-Rath ME, Chang TI. The relationship between intradialytic hypotension and hospitalized mesenteric ischemia: a case-control study. Clin J Am Soc Nephrol. 2018;13(10):1517–25.
29. Inrig JK. Beware intradialytic hypotension: how low is too low? Clin J Am Soc Nephrol. 2018;13(10):1453–4.
30. Gkza A, Davenport A. Estimated dietary sodium intake in haemodialysis patients using food frequency questionnaires. Clin Kidney J. 2017;10(5):715–20.
31. Shah A, Davenport A. Does a reduction in dialysate sodium improve blood pressure control in haemodialysis patients? Nephrology (Carlton). 2012;17(4):358–63.
32. Davenport A. Negative dialysate to sodium gradient does not lead to intracellular volume expansion post haemodialysis. Int J Artif Organs. 2010;33(10):700–5.
33. Marcén R, Quereda C, Orofino L, Lamas S, Teruel JL, Matesanz R, Ortuño J. Hemodialysis with low-temperature dialysate: a long-term experience. Nephron. 1988;49(1):29–32.
34. Hinz A, Mitchell AJ, Dégi CL, Mehnert-Theuerkauf A. Normative values for the distress thermometer (DT) and the emotion thermometers (ET), derived from a German general population sample. Q ual Life Res. 2019;28(1):277–82.
35. Camilleri S, Chong S, Tangvoraphonkchai K, Yoowannakul S, Davenport A. Effect of self-reported distress thermometer score on the maximal handgrip and pinch strength measurements in haemodialysis patients. Nutr Clin Pract. 2017;32(5):682–6.
36. Wileman V, Chilcot J, Armitage CJ, Farrington K, Wellsted DM, Norton S, Davenport A, Franklin G, Da Silva GM, Horne R, Almond M. Evidence of improved fluid management in patients receiving haemodialysis following a self-affirmation theory-based intervention: a randomised controlled trial. Psychol Health. 2016;31(1):100–14.
37. Griva K, Thompson D, Jayasena D, Davenport A, Harrison M, Newman SP. Cognitive functioning pre- to post-kidney transplantation--a prospective study. Nephrol Dial Transplant. 2006;21(11):3275–82.

Publisher's Note