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## Dry-weight reduction in hypertensive hemodialysis patients (DRIP): A randomized controlled trial

Rajiv Agarwal, MD<sup>1,2</sup>, Pooneh Alborzi, MD<sup>1</sup>, Sangeetha Satyan, MD<sup>1</sup>, and Robert P. Light, BS<sup>1</sup>

<sup>1</sup>Division of Nephrology, Indianapolis, IN

<sup>2</sup>Richard L. Roudebush VA Medical Center, Indianapolis, IN

### Abstract

Volume excess is thought to be important in the pathogenesis of hypertension among hemodialysis patients. To determine whether additional volume reduction will result in improvement in blood pressure (BP) among hypertensive patients on hemodialysis and to evaluate the time-course of this response we randomized long-term hypertensive hemodialysis patients to ultrafiltration or control groups. In the additional ultrafiltration group (n=100) we probed the dry-weight without increasing time or duration of dialysis while the control group (n=50) only had physician visits. The primary outcome was change in systolic interdialytic ambulatory BP. Post-dialysis weight was reduced by 0.9 kg at 4 weeks and resulted in -6.9 mm Hg (95% CI -12.4, -1.3 mm Hg, p=0.016) change in systolic BP and -3.1 mm Hg (95% CI -6.2, -0.02 mm Hg, p=0.048) change in diastolic BP. At 8 weeks, dry-weight was reduced 1 kg, systolic BP changed -6.6 mm Hg (95% CI -12.2, -1.0 mm Hg, p=0.021) and diastolic BP -3.3 mm Hg (95% CI -6.4, -0.2 mm Hg, p=0.037) from baseline. The Mantel-Hanzel combined odds-ratio for systolic BP reduction of at least 10 mm Hg was 2.24 (95% CI 1.32, 3.81, p=0.003). There was no deterioration seen in any domain of the kidney disease quality of life health survey despite an increase in intradialytic signs and symptoms of hypotension. The reduction of dry-weight is a simple, efficacious and well tolerated maneuver to improve BP control in hypertensive hemodialysis patients. Long-term control of BP will depend on continued assessment and maintenance of dry-weight.

### Keywords

hemodialysis; hypertension; ultrafiltration; ambulatory blood pressure; volume overload

### Introduction

Chronic kidney disease (CKD) is common in the general population and is associated with increased cardiovascular risk<sup>1</sup>. Cardiovascular mortality is exceedingly high especially in patients with more advanced CKD. Hypertension is a cardiovascular risk factor common in patients with CKD<sup>2</sup>. Despite drug treatment, hypertension is difficult to control especially in patients who have end-stage renal disease (ESRD)<sup>3</sup>. Unlike office blood pressure measurement which forms the basis of most hypertension management, blood pressures obtained in dialysis centers poorly represent the usual level of blood pressure in hemodialysis patients which makes the management of hypertension particularly challenging<sup>4</sup>.

Address for correspondence: Rajiv Agarwal MD Professor of Medicine, VAMC, 111N 1481 West 10<sup>th</sup> St, Indianapolis IN 46202 Phone 317-988-2241 Fax 317-988-2171 Email: E-mail: ragarwal@iupui.edu.

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Among factors causing hypertension in patients on hemodialysis<sup>5, 6</sup> excess volume is thought to be most important<sup>7-12</sup>. Yet few data exist to confirm the role of excess volume in causing hypertension in these patients. Observational studies show that volume reduction is associated with improvement in blood pressure in 70-90% of the patients<sup>13-17</sup>, that this reduction could be delayed for many months<sup>18</sup>, and that hypertension control without medication is the best single marker of survival in hemodialysis patients<sup>19</sup>. These studies were performed by measuring blood pressure in the dialysis unit which may not represent the true level of blood pressure in hemodialysis patients<sup>20</sup>. Whether similar results would be obtained in patients who are now older and have a greater prevalence of vascular disease and diabetes mellitus is also unknown.

Accordingly, we hypothesized that additional volume reduction will result in rapid improvement in blood pressure among hypertensive patients on hemodialysis. To test this hypothesis we designed this 8 week, prospective, randomized trial to assess the efficacy, safety and tolerability of ultrafiltration therapy in controlling systolic hypertension assessed by interdialytic ambulatory blood pressure monitoring in a prevalent hemodialysis cohort.

## Methods

We recruited patients 18 years of age or older on long-term hemodialysis for at least 3 months, who were hypertensive based on a mean interdialytic ambulatory BP of 135/85 mm Hg or more. Patients found to have well-controlled hypertension had antihypertensive medications withdrawn until they become hypertensive. Patients with stroke, myocardial infarction or limb ischemia in the previous 6 months, ambulatory blood pressure of >170/100 mm Hg, who missed more than one dialysis in the prior month, had chronic atrial fibrillation or morbid obesity (body mass index >40 kg/m<sup>2</sup>) were excluded. Baseline measurements included history and examination, signs and symptoms of hemodynamic instability, ambulatory blood pressure monitoring and the assessment of health related quality of life via Kidney Disease Quality of Life questionnaire.

After a six hemodialysis run-in phase, during which baseline data were collected, patients were randomized in 1:2 proportion into control group vs. ultrafiltration trial group for 8 weeks. During this 24 dialysis treatment phase, patients were seen at each dialysis visit and had evaluation of dry-weight and symptoms and signs related to hypovolemia by study personnel.

The assessment of dry-weight remains a clinical judgment<sup>21, 22</sup>, which is what we used to determine the dry-weight in each patient using the following protocol. In the ultrafiltration group an initial additional weight loss of 0.1kg/10 kg body-weight was prescribed per dialysis without increasing the time or frequency of dialysis. This additional weight loss was combined with the ultrafiltration volume required to remove interdialytic weight gain to achieve the desired reduction in dry weight. If ultrafiltration was not tolerated based on symptoms and signs such as muscle cramps, need for excessive saline or symptomatic hypotension, the additional prescribed weight loss was reduced by 50%. If ultrafiltration was still not tolerated, the additional weight loss was further reduced by 50% till even 0.2 kg incremental weight loss per dialysis was not tolerated. At this point, the patient was said to be at his or her dry weight. Thus, by this protocol, each patient had to experience symptoms of volume depletion to be at dry-weight. During the conduct of the trial if the predialysis BP became 180 mmHg systolic or 110 mmHg diastolic or more over two consecutive treatments, the patient had interdialytic ambulatory BP monitoring and excluded from further participation if the mean interdialytic BP was found to be 175/105 mmHg or more. No changes in antihypertensive medication were permitted during the trial.

Ambulatory blood pressure monitoring was performed after the mid-week hemodialysis session for 44 hours. Blood pressures were recorded every 20 minutes during the day (6 AM to 10 PM) and every 30 minutes during the night (10 PM to 6 AM) using a Spacelab 90207 ABP monitor (SpaceLabs Medical Inc, Redmond, WA, USA) in the non-access arm. Recordings began immediately after hemodialysis and terminated immediately before the subsequent dialysis. Accuracy of ambulatory blood pressure recordings was confirmed against auscultated blood pressure at baseline. Hourly means were calculated. These means were then averaged over the entire course of recording to provide systolic and diastolic interdialytic ambulatory blood pressures.

Pre and post-dialysis weights were recorded at each visit. The mean of the last 3 treatments in the baseline period, the 3 treatments in week 4 and the three treatments at week 8 were taken to represent the pre and post-dialysis weights.

The Kidney Disease Quality of Life-Short Form (KDQOL-SF) questionnaire was self-administered prior to randomization and at 8 weeks. The KDQOL-SF includes questions targeted at particular health-related concerns for individuals undergoing dialysis<sup>23</sup>. Scores on each KDQOL-SF dimension range from 0 through 100, with higher scores reflecting better health-related quality of life.

Randomization to treatment or control groups was carried out in permuted blocks with 2:1 ultrafiltration:control ratio. Opaque sealed envelopes were used for treatment allocation by study personnel after assuring that the inclusion-exclusion criteria were met.

The study protocol was approved by the Institutional Review Boards (IRB) and the VA Research and Development Committee and all patients provided written informed consent. The trial was registered at ClinicalTrials.gov (NCT00067665).

### Statistical Analysis

The primary end-point was the reduction in systolic ambulatory blood pressure between groups at 8 weeks using an intent to treat analysis. A mixed model accounting for repeated measurements was fitted for ambulatory systolic blood pressure at baseline, 4 weeks and 8 weeks. The interaction effect of time and intervention was tested and 95% confidence intervals calculated using maximal likelihood estimates. A similar analysis was performed for evaluating changes over time between randomized groups in post dialysis weights and the various domains of KDQOL-SF questionnaire. We assessed the change in post-dialysis weight with lowering of systolic blood pressure in the ultrafiltration group at 4 and 8 weeks by least squares linear regression.

To assess the frequency of hypovolemia-related signs and symptoms during dialysis treatments we calculated the proportion of treatments complicated by a-priori endpoints such as cramps and dizziness. We first calculated the baseline frequency of these symptoms during a two-week run in and then calculated the proportions of treatments complicated by these events within patients. Data were analyzed using a mixed model noted above. An exploratory subgroup analysis was performed to detect any interaction effect of demographic and clinical characteristics on treatment effect.

We expected the systolic blood pressure to increase by 2.5 mm Hg in the group of patients who did not receive ultrafiltration challenge. In the intervention group, we expected the blood pressure to reduce by a mean of 5 mm Hg. When the sample sizes in the two groups were 45 (control) and 73 (intervention), respectively (a total sample size of 118), we calculated 80% power to detect the difference between group means of 7.5 mm Hg. We expected 1 out of 4 patients to drop from the trial in the intervention group due to discomfort of ultrafiltration and

inconvenience of ambulatory blood pressure monitoring. We expected a 10% drop out rate in the control group. Thus 50 patients in the control group and 100 in the intervention group were required to have 80% power to demonstrate 7.5 mm Hg difference between the two groups.

The nominal level of significance was set at two sided  $p$  of  $<0.05$  and all statistical analyses were performed with Stata version 10.1 (StataCorp LP, College Station, TX).

## Results

Between March 2004 and April 2008 we screened 444 patients in 4 dialysis units affiliated with Indiana University School of Medicine (Figure 1). Of these 494 patients, 346 patients met eligibility criteria and 250 consented. One hundred patients failed to randomize: 44 due to lack of hypertension, 4 due to extreme hypertension, 31 withdrawing consent, and 21 due to other reasons. Among 100 patients randomized to the ultrafiltration group, 91 completed the study. Of the 9 patients who did not complete the study, 5 withdrew consent, 3 were hospitalized, and 1 had ambulatory blood pressure above safety cut-off after randomization. Among 50 patients allocated to the control group, 43 completed the study. Of the 7 patients who did not complete the trial, 1 withdrew consent, 1 underwent kidney transplantation, 4 were removed for ambulatory BP above safety cut-off and 1 experiencing accelerated hypertension and pulmonary edema. A total of 87 (87%) participants in the ultrafiltration group and 45 (90%) in the control group provided paired ambulatory blood pressures at baseline and at 4 weeks and 88 (88%) participants in the ultrafiltration group and 43 (86%) in the control group provided paired ambulatory blood pressures at baseline and at 8 weeks.

All patients were hemodialyzed three times weekly for an average of 235 (SD 21) minutes, at a blood flow rate of 400 (34) mL/min and dialysate flow rate of 765 (77) mL/min. The two treatment groups were well balanced with respect to the baseline characteristics of the patients (Table 1).

Baseline post-dialysis weight in the control group was 82.0 kg and in the UF group 1.1 kg lower (95% CI -7.6, + 5.3 kg,  $p=0.73$ ). In the ultrafiltration group, the change from baseline post-dialysis weight was -0.9 kg (95% CI -1.2 to -0.6,  $p<0.001$ ) at 4 weeks and -1.0 kg at 8 weeks (95% CI -1.3 to -0.7,  $p<0.001$ ). In the control group, the change from baseline in post-dialysis weight was 0.0 at 4 weeks (95% CI -0.4, +0.4,  $p=0.99$ ) and 0.0 kg at 8 weeks (95% CI -0.4, 0.5,  $p=0.90$ ). Accounting for the baseline difference in post-dialysis weight and decline in the control group, ultrafiltration resulted in -0.9 kg change (95% CI -1.4, -0.4 kg,  $p=0.001$ ) at 4 weeks and -1.0 kg change at 8 weeks (95% CI -1.6, -0.5 kg,  $p<0.001$ ). Interdialytic weight gain averaged 2.9 kg in the ultrafiltration group and 2.8 kg in the control group at baseline and did not change significantly within or between groups over time.

Baseline ambulatory systolic blood pressures were  $146.4 \pm 10.6/83.4 \pm 10.9$  mm Hg in the control group and  $145.8 \pm 10.2/82.9 \pm 10.0$  mm Hg in the ultrafiltration group and were similar between groups at baseline (Figure 2A). In the ultrafiltration group, the change from baseline in systolic ambulatory blood pressure was -10.7 mm Hg at 4 weeks and -13.5 mm Hg at 8 weeks. In the control group, the change from baseline in systolic ambulatory blood pressure was -3.8 at 4 weeks and -6.9 mm Hg at 8 weeks. The ultrafiltration-attributable change in systolic blood pressure was -6.9 mm Hg (95% CI -1.3, -12.4 mm Hg,  $p=0.016$ ) at 4 weeks and -6.6 mm Hg (95% CI -1.0, -12.2 mm Hg,  $p=0.021$ ) at 8 weeks.

Each kg reduction in post-dialysis weight in the ultrafiltration group resulted in 2.2 mmHg (95% CI -0.02, 4.5,  $p=0.052$ ) reduction in systolic blood pressure at 4 wks and 2.3 mm Hg (95% CI 0.8, 3.8,  $p=0.003$ ) reduction at 8 wks (Figure 3). No relationship was seen between weight change in the control group from baseline to 4 wks or baseline and 8 wks and decline in systolic blood pressure on these respective occasions.

At 4 weeks, 14/45 (31%) patients in the control group and 46/87 (53%) patients in the ultrafiltration group and at 8 weeks 16/43 (37%) patients in the control group and 48/88 (55%) in the ultrafiltration group had 10 mm Hg or more drop in systolic blood pressure. The Mantel-Hanzel combined odds-ratio for systolic blood pressure response was 2.24 (95% CI 1.32, 3.81,  $p=0.003$ ). In the ultrafiltration group, the change from baseline in diastolic ambulatory BP was -6.1 mm Hg at 4 weeks and -7.3 mm Hg at 8 weeks (Figure 2B). In the control group, the change from baseline in diastolic ambulatory blood pressure was -3.0 at 4 weeks and -3.9 mm Hg at 8 weeks. The ultrafiltration-attributable change in diastolic blood pressure was -3.1 mm Hg (95% CI -6.2, -0.02 mm Hg,  $p=0.048$ ) at 4 weeks and -3.3 mm Hg (95% CI -6.4, -0.2 mm Hg,  $p=0.037$ ) at 8 weeks.

At 4 weeks, 6/45 (13%) patients in the control group and 24/87 (28%) patients in the UF group and at 8 weeks 7/43 (16%) patients in the control group and 33/88 (38%) in the UF group had 5 mm Hg or more drop in diastolic blood pressure. The Mantel-Hanzel combined odds-ratio for diastolic BP response was 2.78 (95% CI 1.43, 5.44,  $p=0.002$ ).

The end point of reducing weight in the intervention group was the appearance of symptoms that in the opinion of the investigator suggested that the goal was reached. The proportion of patients experiencing these symptoms is shown in **Table S1** (please see <http://hyper.ahajournals.org>). Cramps, dizziness, intradialytic hypotension, need for saline or reduction in ultrafiltration rates were more commonly seen among patients allocated to the ultrafiltration group as expected. Dialysis treatments complicated by headache or nausea were similar between groups.

Despite more symptoms, the various domains of the Kidney Disease Quality of Life (KDQOL) including energy, symptoms related to kidney disease and physical functioning were unchanged in our study from baseline to 8 weeks (**Table S2**, please see <http://hyper.ahajournals.org>).

Reduction in systolic blood pressure were similar regardless of age, gender, diabetes mellitus antihypertensive drug use, ACE inhibitor or angiotensin receptor blocker use, beta-blocker use or pedal edema. Blacks had a more consistent antihypertensive response to ultrafiltration compared to non-blacks (Figure 4).

Adverse effects related to participation in the trial were as expected. One patient in the ultrafiltration group and 4 in the control group had to be withdrawn due to ambulatory blood pressure that exceeded the limits of safety specified in our study. One patient in the control group developed accelerated hypertension had pulmonary edema and needed emergent ultrafiltration dialysis after 4 weeks of participation. One patient in the ultrafiltration group became hypotensive, seized but did not require hospitalization. Another developed chest pain, was given sublingual nitroglycerine and developed hypotension which resolved with intravenous saline administration. A third became very dizzy and required saline administration in the emergency room. In the ultrafiltration group 3 patients had one episode each of clotted angioaccess, 2 patients had 2 episodes each of clotting each and one patient had 3 episodes of clotting which is in contrast to 2 patients having one episode each of clotting in the control group.

## Discussion

This trial yielded several key findings that will be useful in the management of long-term hemodialysis patients with hypertension. First, reduction in dry-weight as defined by clinical signs and symptoms results in reduction in ambulatory blood pressure. This improvement can be achieved without increasing the time or frequency of dialysis treatments. Although many observational studies suggest that this may be so, randomized trials are lacking to support the

claim that dry-weight reduction is an effective strategy to control hypertension<sup>13-17</sup>. More than half the patients in the intervention group had reduction in systolic blood pressure by at least 10 mm Hg suggesting that dry-weight reduction results in improved systolic blood pressure equivalent to or greater than a single antihypertensive drug. Since most patients in our study were already taking antihypertensive drugs, it is quite likely that dry-weight reduction resulted in enhancement of the effect of other antihypertensive drugs. However, blood pressure reduction in those on no antihypertensive agents was similar.

Second, the reduction in systolic blood pressure is nearly twice as much as diastolic blood pressure which results in attenuation of pulse pressure. Pulse pressure is strongly and independently linked to all-cause mortality among hemodialysis patients<sup>24</sup>. Whether reducing dry-weight will result in improvement in hard outcomes will depend on ongoing attention to dry-weight and blood pressure control and these benefits remain to be demonstrated.

Third, reduction in blood pressure is evident within 4 weeks of the beginning of intervention and at 8 weeks no additional reduction in ambulatory blood pressure attributable to reduction in dry-weight is evident. The “lag phenomenon” refers to a fall in blood pressure that occurs weeks to months after reducing dry-weight. Renal hemodynamic changes with thiazides occur within a week<sup>25</sup> and systemic hemodynamic changes are demonstrable within three days of diuretic administration<sup>26</sup>. In a trial of diuretics in hypertensive patients lasting 10-12 weeks, placebo-corrected fall in BP of 10/5 mm Hg is seen within 4 weeks, which is not statistically different from 12/7 mm Hg fall in blood pressure seen at 10-12 weeks<sup>27</sup>. Thus, our results are similar to those seen with the effect of thiazide diuretics on blood pressure in patients with essential hypertension and we found no support for the lag-phenomenon among prevalent hypertensive hemodialysis patients<sup>18</sup>.

Fourth, only ~2 mm Hg reduction in systolic BP was achieved per kg weight loss with ultrafiltration. Since the observed systolic blood pressure reduction was ~3 times as much, this indicates that post-dialysis weight is a poor proxy of expanded extracellular fluid volume among hemodialysis patients. Fifth, the lack of deterioration in the various components of kidney disease-related quality of life despite experiencing more symptoms related to hypovolemia during dialysis suggests that the therapy was well accepted.

Achieving strict dry-weight control in the prevalent dialysis population as a whole presents a challenge as well as an opportunity. Dietary and dialysate sodium restriction limit interdialytic weight gain and may facilitate the attainment of an appropriate dry-weight<sup>15, 28</sup> and some studies suggest that frequent dialysis may evoke better blood pressure control even when patients are not at dry-weight<sup>29, 30</sup>. We did not alter the dialysate or dietary sodium or the dialysis time or frequency. In our study, dialysis patients were evaluated at each dialysis treatment to evaluate safety and efficacy of further reduction in dry-weight. This strategy optimizes the determination of the effect of dry-weight reduction on blood pressure. Probing for dry-weight led to the predictable increase in muscle cramps, dizziness and hypotensive episodes<sup>21</sup>. And even with careful supervision, we witnessed at least 3 serious adverse events that were likely related to intervention—hypotension and seizures, dizziness requiring saline administration after dialysis, and chest pain followed by hypotension. It is also possible that lower blood pressures achieved as a result of challenging dry weight may increase the risk of access thrombosis.

Blacks had a more consistent response in our study compared to non-blacks. Edema on the other hand was not predictive of a greater antihypertensive response to ultrafiltration. Although these results may suggest more volume-dependent hypertension among blacks<sup>31</sup>, and overt signs of volume excess such as edema not necessary for blood pressure lowering<sup>32</sup>, the results of subgroup analysis especially with limited number of participants should be interpreted with

caution<sup>33</sup>. The variation in blood pressure responses were probably caused in large part by variable tolerance to the prescribed regimen of dry-weight reduction, inadequate trial design or small sample size. The change in blood pressure in the control group was likely a result of participation in the study and numerous physician visits which may have a placebo effect. The intervention periods in our trial was only 8 weeks but the reduction in blood pressure occurred within 4 weeks and persisted for an additional 4 weeks. It is likely that achievement of dry-weight would result in long-term control of hypertension. Whether achievement of better blood pressure control via improvement in dry-weight will result in lower cardiovascular mortality and other “hard” outcomes among dialysis patients remains to be seen and should now be tested in randomized controlled trials.

## Perspective

Our data provide support for the hypothesis that extracellular volume expansion, even in the absence of clinical signs of volume overload may mediate hypertension<sup>34</sup>. Thus, challenging dry-weight in long-term hemodialysis patients as first line therapy appears a reasonable strategy for controlling hypertension. However, given the risks of hypotension-related serious adverse effects, implementation of this strategy requires close clinical supervision. Although we did not find any evidence for the lag-phenomenon, such an effect may exist in incident hemodialysis patients. Better markers of volume status are needed in hemodialysis patients.

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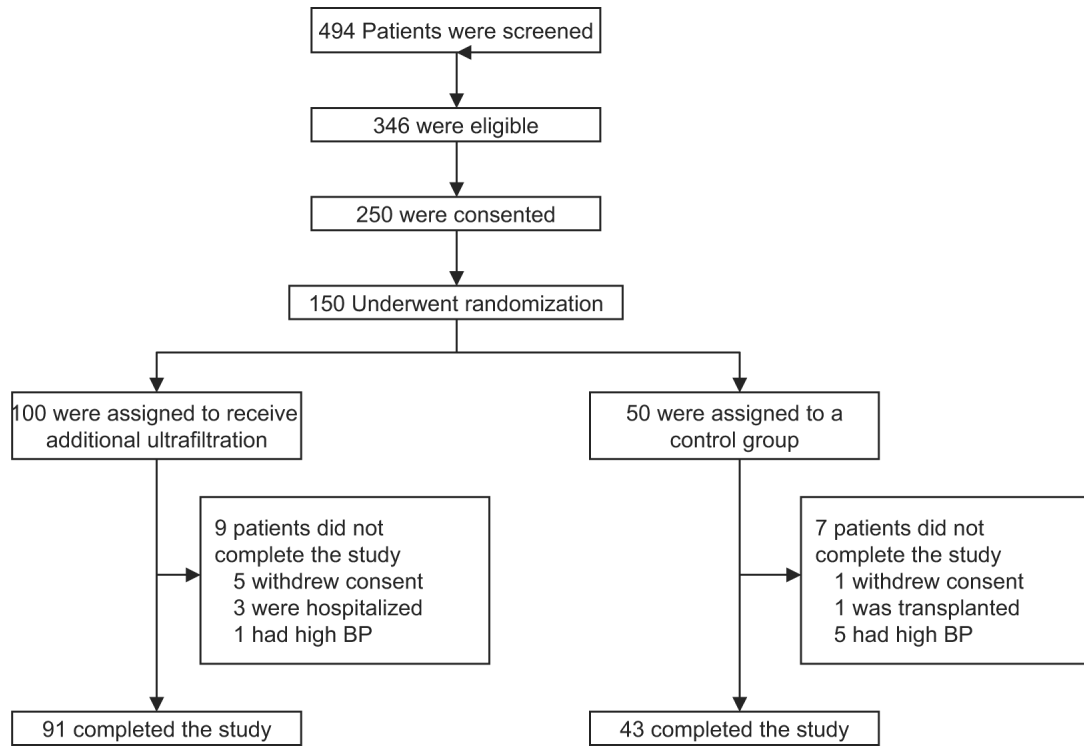
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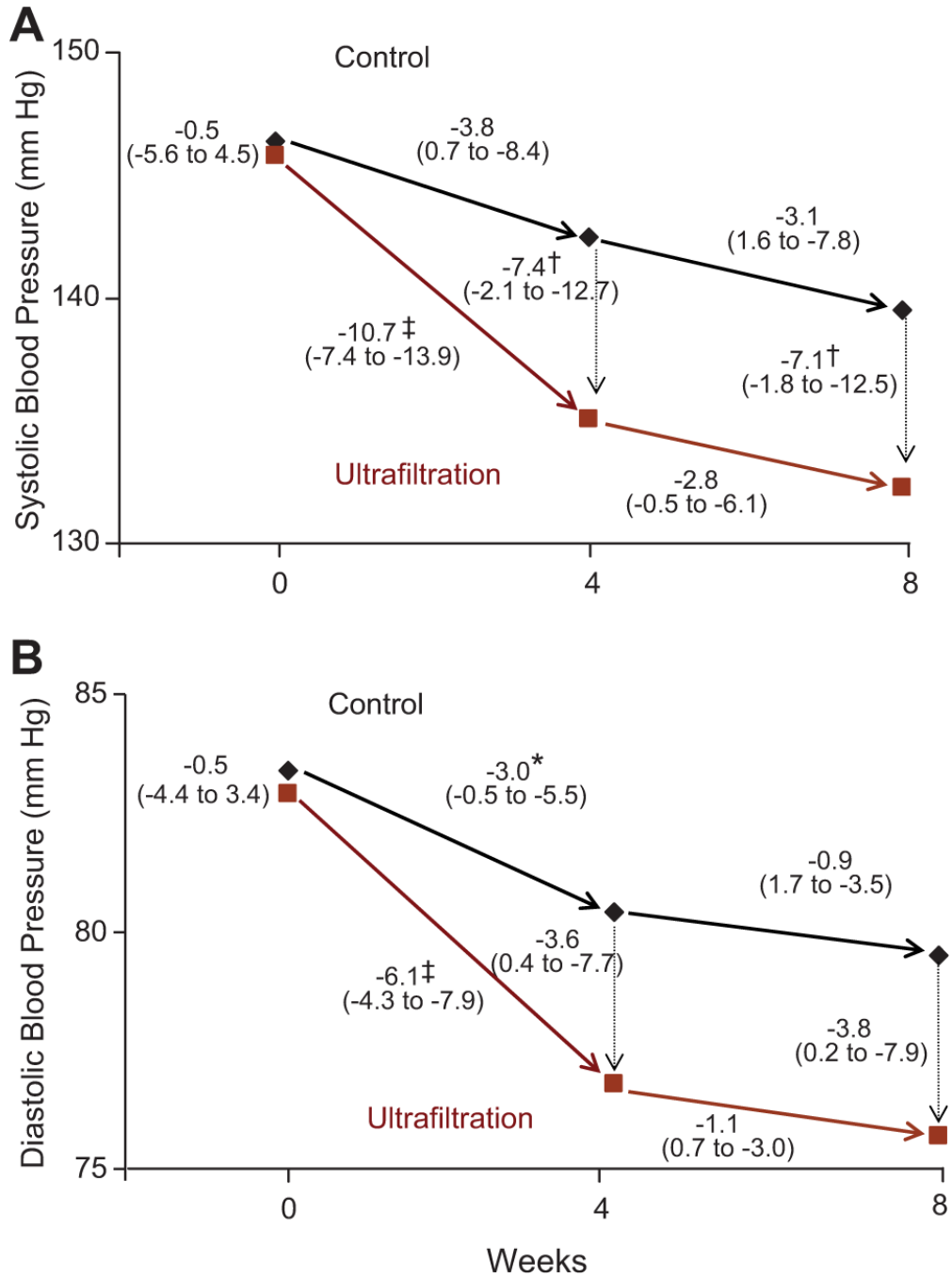
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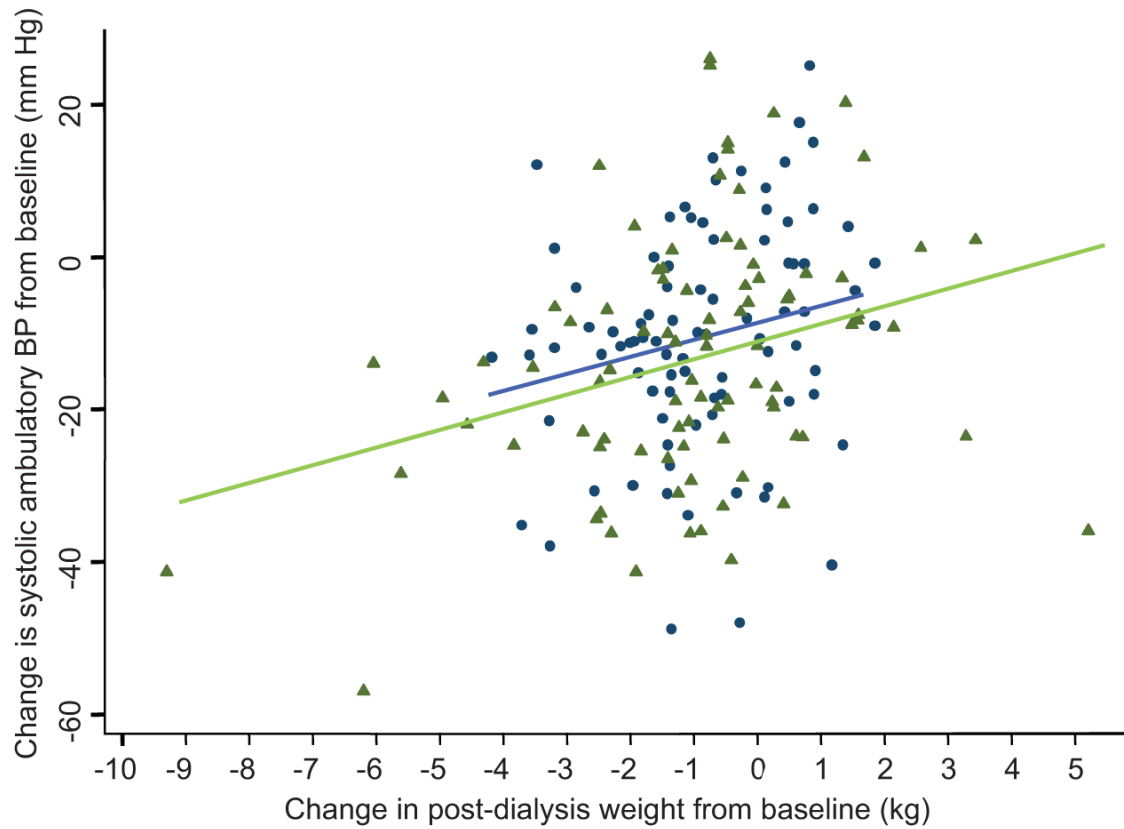


**Figure 1.**  
Enrollment and Trial flow.

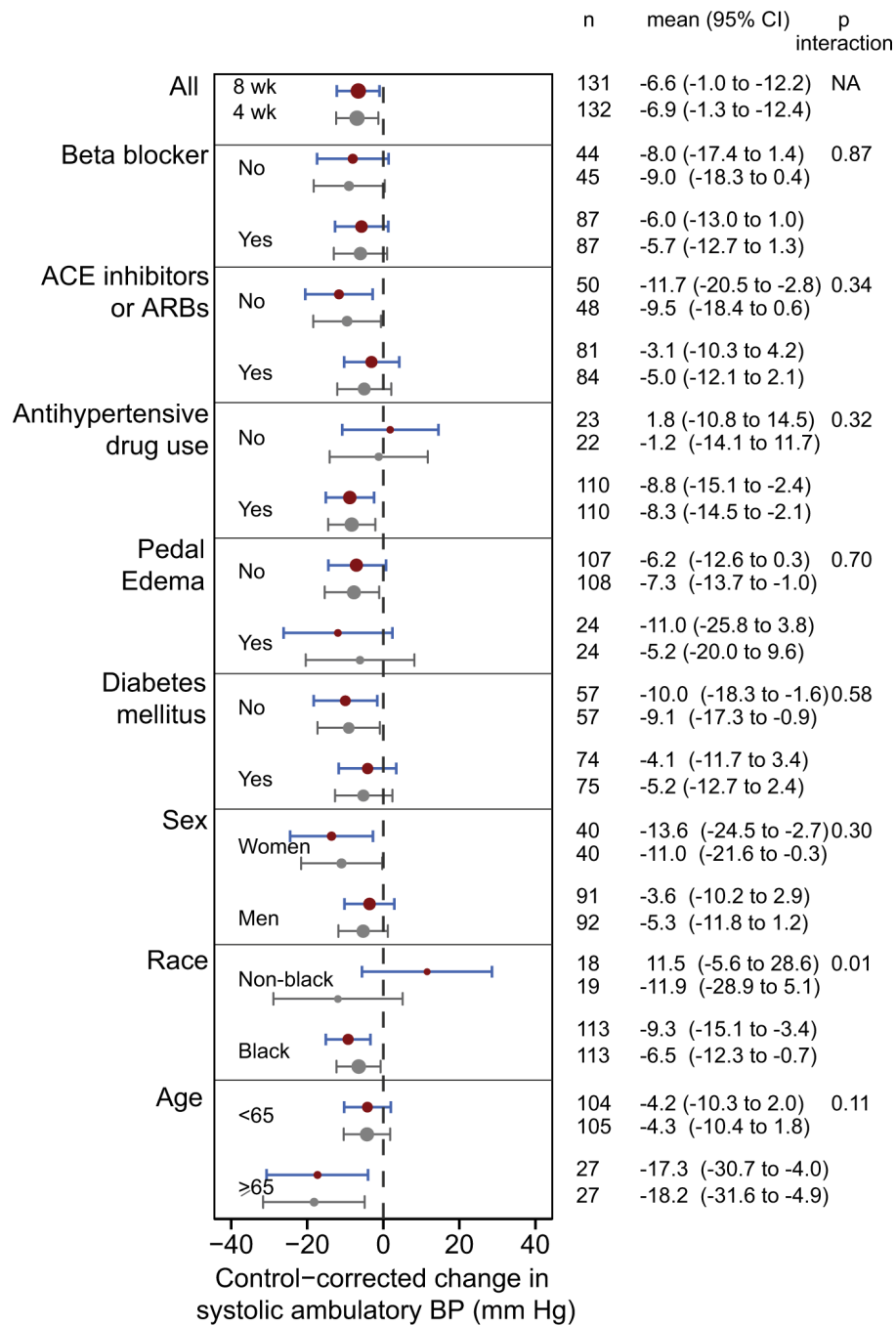


**Figure 2.** The effect of dry-weight reduction on interdialytic ambulatory systolic (Panel A) and diastolic blood pressure (Panel B) in hypertensive hemodialysis patients. The mean systolic and diastolic blood pressures are shown for the baseline control and ultrafiltration groups. The mean changes in blood pressure are shown for weeks 4 and 8 following randomization (solid arrows), and the mean differences in blood pressures (dotted arrows) between the two groups at each 4 week interval. The numbers next to the dotted lines connecting the data points are the mean changes in blood pressure between groups at 4 and 8 weeks following randomization. The 95% confidence intervals are given in parentheses. Asterisks (p<0.05), daggers (p<0.01) and double daggers (p<0.001) indicate significant

differences between groups or within groups. The ultrafiltration-attributable change in systolic BP was -6.9 mm Hg (95% CI -12.4, -1.3 mm Hg,  $p=0.016$ ) at 4 weeks and -6.6 mm Hg (95% CI -12.2, -1.0 mm Hg,  $p=0.021$ ) at 8 weeks. The ultrafiltration-attributable change in diastolic BP was -3.1 mm Hg (95% CI -6.2, -0.02 mm Hg,  $p=0.048$ ) at 4 weeks and -3.3 mm Hg (95% CI -6.4, -0.2 mm Hg,  $p=0.037$ ) at 8 weeks.



**Figure 3.** Relationship of change in systolic ambulatory blood pressure with ultrafiltration compared to the change in post-dialysis weight. Changes depict the reduction in systolic blood pressure at 4 weeks (circles) and 8 weeks (triangles) from baseline plotted against changes in post-dialysis weight at 4 weeks and at 8 weeks. Regression lines reflect the linear relationships at 4 weeks (blue line) and at 8 weeks (green line)



**Figure 4.** Reduction in systolic ambulatory blood pressure with ultrafiltration compared to the control group. Changes depict the reduction in systolic blood pressure at 4 weeks (grey circles) and 8 weeks (brown circles) and their 95% confidence intervals. Only the interaction between ultrafiltration and race was significant (p=0.01). The size of the circles is proportional to the number of patients.

**Table 1**

Clinical characteristics of the study population

Clinical Characteristic	Ultrafiltration (n=100)	Control (n=50)
Age (years)	54.1 ± 12.9	54.7 ± 11.5
Men	66 (66%)	38 (76%)
Race		
White	12 (12%)	3 (6%)
Black	85 (85%)	46 (92%)
Other	3 (3%)	1 (2%)
Pre-dialysis BP	159.6 ± 16.3/86.2 ± 10.4	159.1 ± 15.1 /87.5 ± 12.0
Post-dialysis BP	143.3 ± 17.5/77.8 ± 10.3	142.7 ± 19.4/78.3 ± 12.8
Pre-dialysis weight (kg)	84.2 ± 20.2	84.8 ± 19.8
Post-dialysis weight (kg)	81.3 ± 19.6	82.0 ± 19.2
Body Mass Index (kg/m <sup>2</sup> )	27.3 ± 5.9	27.3 ± 6.5
Years of dialysis	3.8 ± 4.7	4.5 ± 5.7
Etiology of end-stage renal disease		
Diabetes Mellitus	40 (40%)	19 (38%)
Hypertension	47 (47%)	24 (48%)
Glomerulonephritis	4 (4%)	2 (4%)
Obstruction	0 (0%)	0 (0%)
Polycystic Kidney Disease	3 (3%)	0 (0%)
Other	6 (6%)	5 (10%)
Current Smoker	32 (32%)	19 (38%)
History of		
Congestive Heart Failure	18 (18%)	4 (8%)
Myocardial Infarction	14 (14%)	6 (12%)
Stroke	10 (10%)	5 (10%)
Urea reduction ratio	74.1 ± 7.0	73.4 ± 6.2
Albumin (g/dl)	3.7 ± 0.5	3.7 ± 0.4
Hemoglobin (g/dl)	12.2 ± 1.1	12.0 ± 1.3
Presence of Edema*	19 (20%)	8 (16%)
Number receiving antihypertensive drugs	87 (87%)	38 (76%)
Number of antihypertensives in users	2.7 ± 1.4	2.6 ± 1.3
Nature of antihypertensive agent		
Dihydropyridine calcium channel blockers	48 (48%)	20 (40%)
Non-dihydropyridine calcium-channel blockers	4 (4%)	2 (4%)
Beta-blockers	71 (71%)	32 (64%)
Alpha-blockers	8 (8%)	4 (8%)
Centrally acting agents	26 (26%)	10 (20%)
Vasodilators	17 (17%)	9 (18%)
ACE Inhibitors	52 (52%)	25 (50%)
Angiotension Receptor Blockers	19 (19%)	4 (8%)

± indicates standard deviation. Parentheses have percent of patients.

\* Missing in 3 patients in the ultrafiltration group.