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Original Research Article

Prevalence of Hypertension in Maintenance Hemodialysis Patients in Twice Weekly versus Thrice Weekly Schedule in a Tertiary Health Care Centre in North-Eastern Region

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Abstract

Background: Various studies have shown that fluid overload is the main cause of hypertension in chronic kidney disease patients on dialysis. Frequently the dialysis frequency is either kept at either twice or thrice per week. Thrice per week modality might have better control of fluid overload and less frequency of hypertension, the study has been designed to find out the same.

Materials and Method: Pre-dialytic blood pressure has been recorded one hour before starting and Post-dialytic blood pressure has been recorded two hours after finishing Hemodialysis. All blood pressure recordings have been taken for all patients for five hemodialysis sessions and the average reading has been taken. The maximum number of Antihypertensive drugs required in each group has been recorded.

Results: The frequency of controlled Pre-dialysis blood pressure is more in thrice per week modality than twice per week modality (9% vs 7%). The frequency of controlled Post-dialysis blood pressure is more in thrice per week modality than twice per week modality (16% vs 13%). The requirement of anti-hypertensive medication is less in thrice per week modality than twice per week modality (2.13 vs 2.46)

Conclusion: Thrice per week modality of dialysis is more efficient in controlling both Pre-dialysis and Post-dialysis blood pressure and requirement of anti-hypertensive drugs is also less in thrice per week modality, though much larger randomized control studies are required to impose the statistical significance.

Keywords: Hypertension, Dialysis frequency, Pre-dialysis BP, Post-dialysis BP.

Introduction

Studies show that almost 10% of adult population is having some form of renal dysfunction and significant proportion will land up in dialysis. [1] Hypertension is an important and prevalent cardiovascular risk factor, with over 80% of HD patients carrying a diagnosis of hypertension.1 Volume overload is a key modifiable contributor to hypertension and cardiovascular disease in HD patients. This connection has been appreciated since the inception of dialysis when Belding Scribner demonstrated that BP could be controlled with strict ultrafiltration. [2] Despite the early appreciation of the importance of volume control, several forces -- including advances in dialysis technologies (e.g. volumetric ultrafiltration, bicarbonate buffer, biocompatible membranes), emphasis on center-based (vs. home) dialysis treatments, and reimbursement rules favoring operational efficiency – led the nephrology community to emphasize metrics of small molecule clearance rather than volume control for years. However, in recent time, there has been renewed interest in volume management. [3] However, despite the growing recognition of the importance of volume control, volume overload and hypertension remain major clinical challenges that have substantial implications for both clinical outcomes and patient experiences of care. Majority of the dialysis patients are on hemodialysis (HD) and it is assumed that those are on thrice per week schedule would have better control of fluid overload and hypertension as compared to those are on twice per week schedule, this study has been designed to interpret so.

Diagnosis of hypertension

The diagnosis of hypertension in patients receiving HD is based predominantly on dialysis clinic BP measurements, despite robust epidemiological evidence supporting the superiority of ambulatory BP monitoring (ABPM) and home BP measurements, [4–6] Pre- and post-HD BP measurements, even when taken with standardized protocols, do not correlate well with ABPM measurements and generally over-estimate BP. [6–8] Compared with in-clinic measured BP, ABPM has a stronger association with left ventricular hypertrophy [9] and all-cause and cardiovascular mortality.10–[13] Reimbursement restrictions and patient intolerance, however, limit widespread use of ABPM, and many experts favor home BP measurements for the diagnosis and management of hypertension in HD patients. Compared with peri-dialytic BP measurements, home BP measurements correlate better with ABPM, [14] display higher short term reproducibility [15] and have stronger associations with morbidity and mortality. [9,10,13] However, adherence to home BP has been cited as a barrier in HD patients. [16,17] The management of hypertension in dialysis patients is further complicated by the lack of a universally accepted definition of hypertension. Guideline recommendations include: a pre-dialysis BP of >140/90 or post-dialysis BP of >130/80; [18] goal home or ABPM measured systolic BPs of 120–160 mmHg, [19] and, recently, home BPs consistently ≥135/85 mmHg or ABPM-measured values averaging ≥130/80 mmHg. [6] Only randomized controlled trials can establish the optimal threshold for hypertension diagnosis, and to date, the only such study is the pilot Blood-Pressure-in-Dialysis Study. [16]

Epidemiology of hypertension: Hypertension, by any definition, is common among individuals receiving HD. According to the U.S. Renal Data System, hypertension is the second leading cause of end-stage kidney disease (ESKD), responsible for nearly 30% of incident cases. [1] Moreover, more than 80% of individuals have a comorbid diagnosis of hypertension at the time of HD initiation. [1]

Confirmatory biopsies are uncommon, particularly when disease is attributed to hypertension; and emerging risk factors, such as the APOL1 high-risk genotype, are under recognized. While there is likely some inaccuracy in administratively reported hypertension rates, studies of measured BP support a high prevalence of hypertension in HD patients. [10,12,15]

Given the high prevalence of hypertension, it is not surprising that rates of antihypertensive medication use among HD patients are also high. In an administrative claims data study, the mean number of antihypertensive medication classes prescribed to dialysis patients two years after dialysis initiation was 2.2. [20] Over 85% of HD patients take at least 1 antihypertensive agent. [21] In a study of over 12,000 incident HD patients, 59% of patients were prescribed beta-blockers, 45% were prescribed renin angiotensin system agents, 49% were prescribed calcium channel blockers and<25% were prescribed diuretics 6 months into HD therapy. [21] Despite the high prevalence of antihypertensive agent use, average ABPMs remain poorly controlled: in one study, only 38% of patients had an average ABPM <135/85 mmHg. [22]

Pathophysiology of hypertension in dialysis patients: Such poor BP control despite pharmacologic therapy highlights the unique pathophysiology of hypertension among individuals receiving HD. Experience in Tassin, France and Izmir, Turkey suggest that the majority of hypertension can be controlled with careful management of volume status. In these two regions, fewer than 5% of HD patients have mean systolic BP >140 mmHg, [23,24] and antihypertensive medication use is rare. Strategies common to both regions include longer dialysis treatment times and dietary salt restriction. Data from Izmir showed that these strategies reduced systolic BP and improved both interdialytic weight gain (IDWG) and cardiothoracic index among HD patients. [24] Randomized trial data from the U.S. support these findings. Agarwal, et al. demonstrated significant lowering of both systolic and diastolic BPs in HD patients who had their dry weight successively probed without increasing time or duration of HD compared to those who did not. [25] It is generally accepted that the total amount of sodium in the body dictates volume status. As kidney function wanes, the natriuretic capacity of the kidney declines, salt sensitivity increases, and BP rises. Classic canine studies [26] demonstrated the relationship between sodium, extracellular volume and BP, showing that a sodium load induces expansion of extracellular volume, venous return, and augmentation of cardiac output and, eventually, increased total peripheral resistance. It is the increased peripheral resistance that leads to persistently elevated BP (i.e. hypertension). In HD patients, sodium excess results from both impaired excretion and increased exogenous load. Exogenous sources include dietary sodium, HD treatment (e.g. dialysate sodium, saline flushes and/or boluses) and medications loaded in saline solutions (e.g. some antibiotics). While the long-standing paradigm of sodium retention driving volume retention remains the mostly widely accepted explanation for the salt—water—hypertension connection, emerging data suggest a role for body sodium reservoirs that act independently of volume. Sodium magnetic resonance imaging (MRI) studies show sodium reservoirs in the skin and muscle that correlate with BP elevation independent of extracellular volume status. [27–29] Inflammation is one hypothesized mechanism for this observation. While sodium and volume are central to hypertension pathophysiology, other factors contribute and, in some cases, augment BP elevation. Key contributors include over-activity of the sympathetic nervous system, inappropriately high angiotensin (AT) II activity, inflammation, comorbid health conditions such as obstructive sleep apnea and thyroid dysfunction and, to a lesser degree in the modern HD era, erythropoietin stimulating agents.The renin-angiotensin-aldosterone system (RAAS) also plays a role in hypertension. Increased renin and AT II cause blood vessel constriction, stimulate aldosterone release and activate the sympathetic nervous system. In addition, AT II stimulates oxidant production and stress that lead to endothelial cell dysfunction and associated vasoconstriction, vascular remodeling and inflammation. [30]

In summary, the pathogenesis of hypertension among HD patients is multifactorial. While sodium and volume excess are the most important contributors, the effects of sodium and volume excess are amplified in the ESKD milieu, an environment of enhanced vascular tone stemming from increased neurogenic activity and decreased endothelial responsiveness to endogenous vasodilators.

Prevalence and clinical consequences of volume overload in HD patients: While hypertension has multiple contributors in HD patients, sodium and volume excess are common and modifiable. Bioimpedance spectroscopy (BIS)-based studies suggest that over 50% of HD patients are chronically volume-overloaded, [31] and more than 35% have IDWGs exceeding 3.5% of body weight. [32] Hypervolemia is often under-appreciated in practice because of the absence of widely used tools that accurately and objectively measure extracellular volume status and the generally poor correlation between volume status and clinical markers such as BP, jugular venous pressure elevation and peripheral edema. [33–36] Both inaccurately prescribed target weight (i.e. estimated dry weight) and failure to achieve target weight can lead to volume overload.

The latter often, but not always, occurs in the setting of high IDWGs and reactive higher ultrafiltration rates. Many studies have shown an association between volume overload and adverse outcomes in the HD population. In the largest study to-date utilizing objective volume status measurement (multi-frequency BIS), Zoccali et al. showed that individuals with baseline volume overload (assessed within 3 months of HD initiation) had a 26% excess risk of mortality compared to individuals who were not volume overloaded. [31] When the association was considered across strata of pre-HD systolic BP, the results were similar. In analyses restricted to individuals surviving the first year of HD therapy, cumulative volume overload, calculated by area under the curve analyses, was also associated with increased mortality with the risks highest at the extremes of pre-HD BP, 160 mmHg. In studies without objective volume status measurement, failure to reach the prescribed target weight at the end of HD (i.e. failed post-HD target weight achievement) associates with adverse outcomes, including higher cardiovascular mortality, higher absolute risk of 30-day emergency department visits and cardiovascular and volume-related hospitalizations. [37]

Beyond these "hard" outcomes, volume overload has substantial implications for patients. Hypervolemia, measured by BIS, associates with fatigue. [38] Higher ultrafiltration rates, often used in the setting of volume overload, associate with prolonged recovery time after HD. [39] Patients also report substantial life impact from debilitating volume-related symptoms such as shortness of breath. BP measurement at this acute breathlessness cannot be done as per ACC/AHA guidelines, [40] leading to falsely high BP recording. Thus, despite an enhanced clinical focus on volume in recent years, volume control remains a major challenge for both patients and providers.

Current strategies to manage volume overload

Dialytic strategies: Studies have shown that different approaches to the HD prescription may have differential effects on volume management and BP in HD patients. More frequent in-center dialysis or nocturnal dialysis are two approaches that have demonstrated better volume management and BP control compared with standard thrice weekly in-center HD. In the Frequent Hemodialysis Network Daily Trial, which randomized 255 participants to six-times a week frequent HD vs. three times a week conventional HD, 2 months of frequent HD lowered the pre-dialysis systolic BP by 7.7 mmHg (95% CI: 11.9 to 3.5). [41,42] The nocturnal trial of the Frequent Hemodialysis Network randomized 87 patients to 12 months of six-times weekly nocturnal HD vs. three-times weekly predominantly home-based HD. The participants randomized to nocturnal home HD had lower pre-dialysis systolic BP by 7.3 mmHg (95% CI: 14.2 to 0.3). [42] Wider adoption of frequent (e.g. such as home HD) and nocturnal dialysis should be encouraged to improve BP and volume management in ESKD patients. Hybrid therapies comprised of peritoneal dialysis (PD) and HD may also be a novel approach to better control volume and BP. One study reported an improvement in cardiac systolic function among 93 patients who underwent hybrid therapy for three years. [43] Standard dialysis therapies can also be modified for better volume and BP control. Correct prescription of dry weight and achievement of this weight with each HD treatment may improve volume control and BP. As reviewed above, studies have associated the failure to achieve the prescribed target weight with higher cardiovascular mortality

[31,44,45] and the adjustment of target weight after hospitalizations (vs. not) with reduced 30-day hospital readmission rates. [45] These studies suggest that failed target weight achievement may be a clinical marker for impending volume-related events. The rate of ultrafiltration used to achieve target weight is also important and has implications for volume overload and hypertension. Observational data have demonstrated that higher ultrafiltration rates (>13 vs. ≤10 mL/h/kg) are associated with higher cardiovascular mortality: adjusted HR (95% CI) 1.71 (1.23–2.38).46 Data suggest that harm begins at ultrafiltration rates as low as 6 mL/h/kg. [47] Overly rapid ultrafiltration induces subclinical end-organ hypoperfusion and hypotension, which can lead to regional myocardial hypoxia as evidenced by "stunning" on transthoracic echocardiography (TTE) among other biological insults. [48–53] Higher UF rates that induce intradialytic hypotension and/or patient symptoms often result in hypervolemia due to UF termination and/or saline bolus administration.

Furthermore, several studies have shown a beneficial effect of lower sodium concentration in the dialysate on controlling Intra Dialytic Weight Gain (IDWG), ultrafiltration rates and hypertension. [54–59] For example, in a cross-over study in which patients received a reduction in of the standard dialysate sodium prescription, investigators found a significant decrease in IDWG (2.91 vs. 2.29 kg), intradialytic thirst scores, intradialytic hypotension and pre-dialysis BP. [58] Data from a non-randomized single center study in New Zealand showed that a clinic-wide decrease in dialysate sodium from 141 to 138 mEq/L was associated with a reduction in systolic BP with the most striking difference among individuals in the highest tertile of pre-HD systolic BP. [60] Similarly, in an international DOPPS analysis of nearly 24,000 patients, pre-HD systolic BPs were higher among patients at clinics using standardized dialysate sodium concentrations >140 mEq/L (vs. lower concentrations). [61] Thus, judicious assessment and targeting of dry weights; appropriate ultrafiltration rates; and utilization of lower dialysate sodium may mitigate complications related to BP and volume overload in the dialysis patient.

Dietary Strategies: Several studies have reported that greater IDWG are associated with adverse outcomes. [62,63] Dietary fluid and sodium restrictions are the most common approaches to managing volume in dialysis patients. For example, in a cross-over, interventional study of 40 HD patients, reduction of meal salt content led to a reduction in IDWG (2.17 to 2.03 kg) and the number of symptomatic intradialytic hypotension episodes (6.1% versus 3.2%). [64] However, adherence to these dietary restrictions remains difficult for most dialysis patients. [65–69] One review of 44 studies of dietary adherence in dialysis patients found that the mean adherence rate to dietary recommendations was just 31.5% and for fluid restrictions, 68.5%. [67] Lower socioeconomic status, younger age, and poorer social support were associated with lower dietary adherence. Other factors such as taste, the centrality of food to social occasions, and clinic dietetic staffing also played roles in adherence. [67] The BalanceWise Study was a clinical trial designed to evaluate the efficacy of behavior counseling combined with technology-based self-monitoring for sodium restriction in 179 HD patients. [70] The participants randomized to the intervention had a significant change in dietary sodium intake at 8 weeks. However, the change was not sustained at 16 weeks, and IDWG did not differ by treatment group at any time point. [70] In a post-hoc analysis of this trial, investigators found that self-efficacy (defined as one's confidence in performing a behavior) was an important determinant of the success of interventions at reducing dietary sodium. [71] Therefore, sodium and fluid restriction interventions that focus on self-efficacy and empowerment may have meaningful impact on outcomes among individuals receiving HD.

Medications: Diuretics can be used to manage volume in dialysis patients; yet use of diuretics remains heterogeneous, regardless of residual kidney function. Over 40% of advanced chronic kidney disease and peritoneal dialysis patients receive diuretics for volume control. [1,21] However, among maintenance HD patients, diuretic use declines sharply after HD initiation. Over 50% of U.S. HD patients stop diuretic therapy at HD initiation, and<25% of patients remain on diuretics 6 months after HD initiation. [72,73] In contrast, the majority of patients in Europe and Japan (regions with lower UF rates and IDWGs), stay on diuretics after HD initiation. [73]

Observational studies show that diuretics may improve volume status, reduce and improve long-term outcomes in dialysis patients. In a recent study of 11,000 patients with incident end-stage kidney disease (ESKD), [74] loop diuretic continuation was associated with lower rates of all-cause hospitalization (adjusted incidence rate ratio 7% lower; 95% confidence interval 11% to 2% lower), but not a lower rate of death (adjusted hazard ratio 8% lower; 95% confidence interval 16% lower to 1% higher). Loop diuretic use also associated with lower incidence of intra-dialytic hypotension and lower IDWG; but no differences inmonthly ultrafiltration rates or BP between the two groups were observed. In another large observational study of 16,000 HD patients across three continents, diuretic use was associated with lower odds of

IDWG and hyperkalemia, higher odds of preserving residual kidney function at one year, and lower cardiac mortality.

There was a trend towards lower all-cause mortality. [73] While these observational data are compelling, clinical trials are needed to confirm the benefits of continued diuretic use in dialysis patients.

Barriers to volume management: While better volume management would likely improve both BP and cardiovascular outcomes in HD patients, many challenges remain. Most importantly, the current clinical approach to volume status assessment is not objective. Physical examination is highly subjective and has low reproducibility; and there are few widely available, non-invasive, objective volume assessment measures. Prior studies have identified several promising tools that may aid in volume assessment. BIS is a portable tool that determines the impedance of electric current flow through body tissues. Shorter pre-dialysis BIS vectors, indicating greater tissue hydration, are associated with higher mortality risk in HD patients. [75]

Moreover, two trials have suggested that increased hydration status assessed by BIS may be used as a proxy to guide ultrafiltration in HD patients. [76,77] Lung ultrasound is another novel non-invasive method that estimates lung water in patients with heart disease and respiratory failure. An observational study showed subclinical pulmonary congestion detected on lung ultrasound to be an independent predictor of cardiovascular events and death in HD patients. [78]

A large multinational study testing the effect of lung ultrasound-measured extravascular lung water on clinical outcomes is ongoing. Natriuretic peptides are elevated in states of volume overload due to increased myocardial stretch and may also serve as early markers of abnormal cardiac physiology. Elevation of brain natriuretic peptide has been shown to associate with higher mortality in dialysis patients, but results across studies are inconsistent. [79–82] Future studies assessing these and other non-invasive, objective measures of volume status would provide useful information to guide diuretic therapy titration, target weight estimation, ultrafiltration goals, and, subsequently, improve volume management in the HD population.

This study has been designed to assess the prevalence of hypertension among the patients of Maintenance hemodialysis twice per week vs thrice per week. Other than physician advice, patient non-compliance to dialysis prescription is an important factor for inadequate dialysis, leading to fluid overload and hypertension.

Materials and Method

Patients those who are on maintenance hemodialysis have been selected from the Dialysis department from January 2025 to June 2025. They have been divided into two groups.

Group – 1: Maintenance hemodialysis twice per week

Group – 2: Maintenance hemodialysis thrice per week

Who are on dialysis for Acute Kidney Injury (AKI) have been excluded.

History of all eligible cases regarding cause of CKD, whether kidney biopsy was done or not, drug compliance, compliance to fluid and salt restriction, have been taken. BP has been recorded following 2017 ACC/AHA guidelines. [40] BP is measured in supine position, using adult cuff size (16×30 cm) by Auscultatory method, using Aneroid sphygmomanometer.

Pre-dialytic BP has been recorded one hour before starting and Post-dialytic BP has been recorded two hours after finishing Hemodialysis. All BP recordings have been taken for all patients for five hemodialysis sessions and the average reading has been taken. The maximum number of Antihypertensive drugs required in each group has been recorded. It has been assumed that all the patients are compliant to their prescribed antihypertensive drugs.As per KDOQI clinical practice guidelines Pre-dialysis BP more than 140/90mm Hg and Post-dialysis BP more than 130/80mm Hg [18] is taken as HTN in CKD patients on Maintenance Hemodialysis (MHD).

The average readings of five sessions for Pre-dialytic and Post-dialytic BP are taken into consideration and all the recordings have been compared in each group.To calculate antihypertensive requirement, the maximum number of antihypertensive drugs prescribed to the patient for BP control, is taken into account.

Results

In 6 months duration 102 patients have been evaluated in Group 1 those are on Maintenance hemodialysis twice per week and 129 patients have been evaluated in Group 2 those are on Maintenance hemodialysis thrice per week.

1. In Group 1 (twice per week) out of 102 patients, 7% (n=7) of the patients are having Controlled and 93% (n=95) are having Un-controlled Pre-dialytic BP.

2. In Group 1 (twice per week) out of 102 patients, 13% (n=13) of the patients are having Controlled and 87% (n=89) are having Un-controlled Post-dialytic BP.

3. In Group 2 (thrice per week) out of 129 patients,9% (n=12) of the patients are having Controlled and 91% (n=117) are having Un-controlled Pre-dialytic BP.

4. In Group 2 (thrice per week) out of 129 patients, 16% (n=21) of the patients are having Controlled and 84% (n=108) are having Un-controlled Post-dialytic BP.

To compare in between Group 1 and Group 2

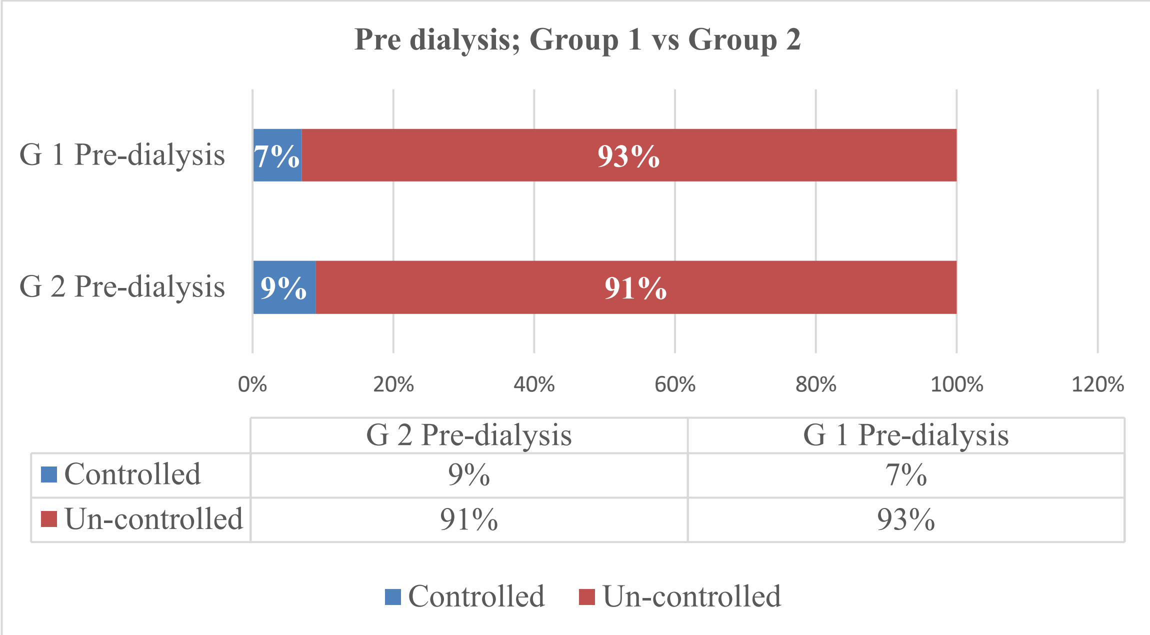

Figure 1: Comparison of Pre-Dialysis BP in Group 1 and Group 2

To compare, in Group 1 (HD 2 per week) 7% (n=7) are having Controlled Pre-dialysis BP and 93% (n=95) are having Un-controlled Pre-dialysis BP where as in Group 2 (HD 3 per week) 9% (n=12) are having Controlled Pre-dialysis BP and 91% (n=117) are having Un-controlled Pre-dialysis BP.

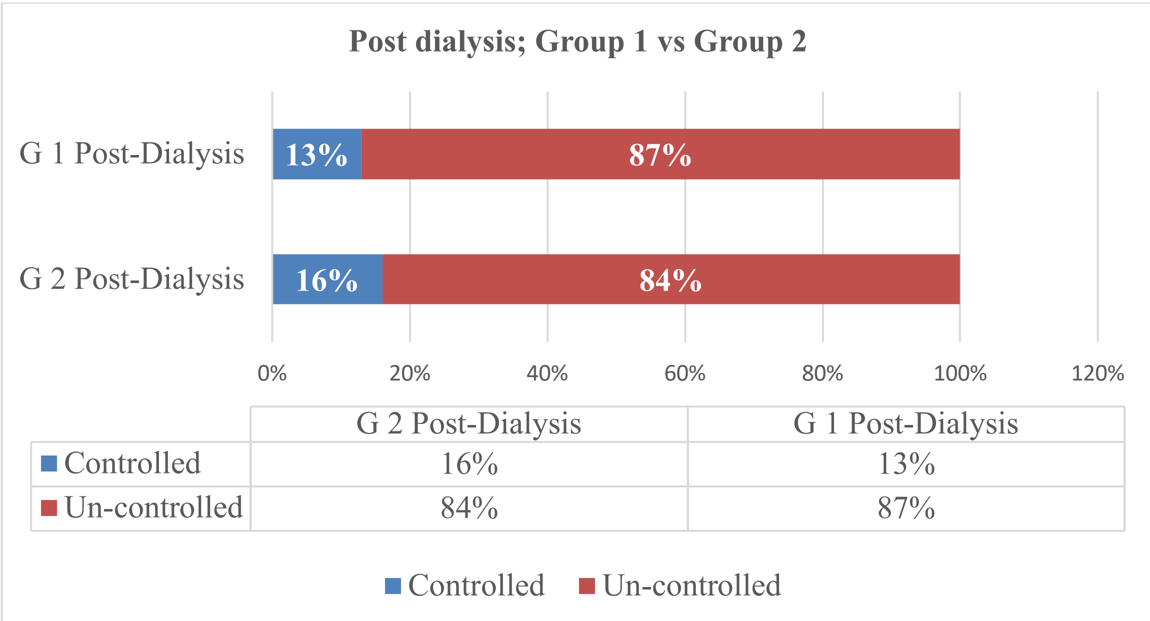

Figure 2: Comparison of Post-Dialysis BP in Group 1 and Group 2

To compare, in Group 1 (HD 2 per week) 13% (n=13) are having Controlled Post-dialysis BP and 87% (n=89) are having Un-controlled Post-dialysis BP where as in Group 2 (HD 3 per week) 16% (n=21) are having Controlled Post-dialysis BP and 84% (n=108) are having Un-controlled Post-dialysis BP.

Requirement of Antihypertensive drug across Group 1 and group 2: The average number of drugs used to control BP in Group 1 (twice per week) is 2.46, where as in Group 2 (thrice per week) is 2.13.

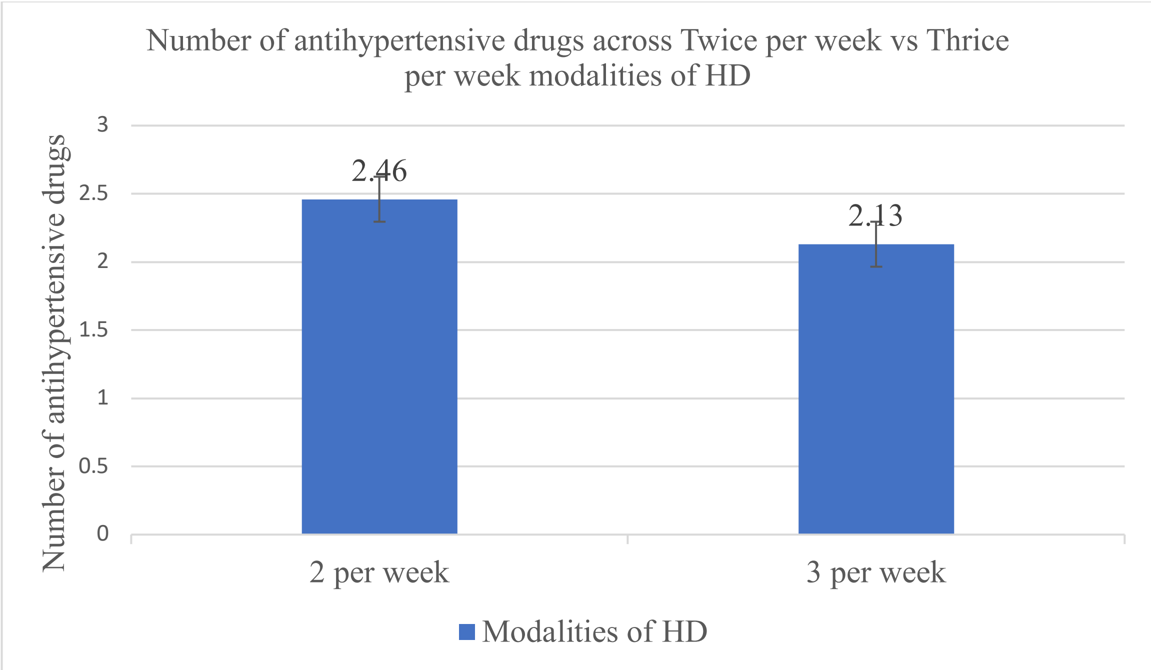

Figure 3: Comparison of Antihypertensive drugs requirement for control of BP in Group 1 and Group 2

Discussion and Conclusion

In Group 1 (HD 2 per week) 7% are having Controlled Pre-dialysis BP and 93% are having Un-controlled Pre-dialysis BP where as in Group 2 (HD 3 per week) 9% are having Controlled Pre-dialysis BP and 91% are having Un-controlled Pre-dialysis BP. So, there frequency of controlled Pre-dialysis BP is more in Group 2, but much larger randomized control studies (RCTs) are required to impose the statistical significance.

In Group 1 (HD 2 per week) 13% are having Controlled Post-dialysis BP and 87% are having Un-controlled Post-dialysis BP where as in Group 2 (HD 3 per week) 16% are having Controlled Post-dialysis BP and 84% are having Un-controlled Post-dialysis BP. So, there frequency of controlled Post-dialysis BP is more in Group 2, but much larger RCTs are required to impose the statistical significance.

The average number of drugs used to control BP in Group 1 (twice per week) is 2.46, where as in Group 2 (thrice per week) is 2.13, which is lower than Group 1, but much larger RCTs are required to impose the statistical significance.

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