Relative Plasma Volume Monitoring and Blood Pressure Control
An Overlooked Opportunity to Achieve Dry Weight in the Hemodialysis Patient

Matthew R. Weir

Establishing dry weight in hemodialysis patients is an inexact science. Monitoring changes in blood pressure with volume removal is crude but can be effective in establishing dry weight. Unfortunately, probing for dry weight (eg, reduction of volume on dialysis sufficient to reduce blood pressure to $<140/90$ mm Hg) can lead to intradialytic hypotension, and this is more common in patients with large intradialytic weight gain.

Often clinicians use medication-directed blood pressure control strategies in the hemodialysis patient. This paradoxically may interfere with the opportunity to achieve dry weight, because if the patient is on increased amounts of antihypertensive medication, more sizeable reductions in blood pressure with ultrafiltration may occur during dialysis. This would limit the opportunity for volume removal. As a consequence, the patient would then be chronically volume overloaded. If antihypertensive medication escalation results from inadequate achievement of goal blood pressure during dialysis, a vicious cycle would ensue. The net result is more risk of adverse events from medications and increased ventricular volume and pressure. Recurrent ventricular volume overload may be one of the most important factors leading to heart failure and increased risk of arrhythmia. Thus, a more rational approach to controlling blood pressure could be a simple, reliable, safe, measure of relative plasma volume. To measure relative plasma volume, a device is attached to the hemodialysis blood tubing that can continuously measure hematocrit by optical absorbance. The percentage of increase in hematocrit during volume removal on hemodialysis estimates the percentage of decrease in blood volume accurately.

Sinha et al have made an important contribution to our clinical understanding about how to scientifically probe dry weight. They demonstrated that the change from baseline in relative plasma volume slope depended on quartiles of weight loss. Those patients with flat relative plasma volume slopes at baseline experienced the greatest decline in blood pressure on probing dry weight. Not surprisingly, the most profound effect on blood pressure reduction was seen when the initial relative plasma volume slope was flat and then steepened subsequently.

The investigators were clever in how they designed their trial in that they had both a control and an ultrafiltration group. The ultrafiltration group underwent an additional weight loss of $0.1$ kg/$10.0$ kg of body weight per dialysis without increasing time or frequency of dialysis. This additional weight loss was combined with the ultrafiltration volume required to remove interdialytic weight gain. If the patients developed symptoms such as muscle cramps, the ultrafiltration was reduced. Thus, on the basis of the protocol, each patient had to experience symptoms of volume depletion to be at dry weight, and there were no changes in antihypertensive medication permitted during the trial. This approach, although appropriate for a clinical trial, may not be a comfortable experience for patients receiving chronic dialysis, particularly if they are older or have larger interdialytic weight gains.

Realistically, sequential ultrafiltration in dialysis patients may be a more appropriate strategy, because patients will often experience more symptoms when dry weight is probed during dialysis as opposed to only with ultrafiltration. The disadvantage of this approach is that it may extend the necessary time of the treatment to provide sufficient time for clearance, yet also adequate removal of volume. However, the advantage is that the patients may not become symptomatic. Thus, using relative plasma volume slopes may provide the clinician a more scientific opportunity to evaluate the requirement for ultrafiltration with dialysis or possibly to minimize symptomatology of hypotension. In this way, patients could be effectively weaned from many of the antihypertensive medications that are used for traditional medication-directed blood pressure control. The flat slope of the relative plasma volume clearly identifies volume-responsive hypertension in dialysis patients.

Another important part of this particular clinical trial is its size ($\approx 150$ dialysis patients) and the use of 44-hour interdialytic ambulatory blood pressure monitoring. This latter approach provides the most important clinically relevant perspective on blood pressure measurement in dialysis patients, because it correlates with cardiac enlargement.

The investigators clearly note that there are some limitations to their observations, including relative plasma volume monitoring only at the beginning and the end of the trial. Routine monitoring with each treatment, particularly when there may be changes in dry weight because of illness, may provide more precision in identifying dry weight. Moreover,
the investigators did not use isolated ultrafiltration as a strategy to achieve a steeper slope of relative plasma volume in individuals who experienced symptoms.

Until periodic monitoring of relative plasma volume becomes a more established form of monitoring patients on dialysis, the management of dry weight continues to be a vexing problem. Perhaps the use of isolated ultrafiltration, in the meantime, may assist clinicians in volume removal in a way that is associated with fewer symptoms and may provide more opportunity for achieving appropriate dry weight and better control of blood pressure in the absence of antihypertensive medications.

Ultimately, the main goal of treatment of blood pressure is to prevent cardiac events. Perhaps the most important strategy in the dialysis patient is to achieve an appropriate dry weight, minimize volume overload, and use blood pressure–lowering medications only in the setting of “hypertension” when dry weight is truly probed and demonstrated. It is possible that if more patients achieved dry weight, then less antihypertensive medication would be required, as is observed in patients on longer-session nocturnal hemodialysis. I suspect that long-term volume/pressure overload of the left ventricle because of inadequate achievement of dry weight maybe one of the most important cardiovascular concerns in the hemodialysis patient.

Acknowledgments
I thank Tia A. Paul, University of Maryland School of Medicine (Baltimore, Md), for editing the article.

Disclosures
None.

References
Relative Plasma Volume Monitoring and Blood Pressure Control: An Overlooked Opportunity to Achieve Dry Weight in the Hemodialysis Patient
Matthew R. Weir

Hypertension. 2010;55:226-227; originally published online December 28, 2009;
doi: 10.1161/HYPERTENSIONAHA.109.146084

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://hyper.ahajournals.org/content/55/2/226

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Hypertension can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Hypertension is online at:
http://hyper.ahajournals.org//subscriptions/