Clinical assessment of dry weight

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Abstract. Unsatisfactory control of blood pressure (BP) leading to an increased rate of cardiovascular events is the main cause of mortality in haemodialysis. BP control has deteriorated since haemodialysis session times have been reduced. Inadequate BP control most often is due to a failure to achieve and maintain dry weight. Dry weight and normotension have been gradually omitted in the goals of dialysis, satisfactory dialysis being reduced to an 'adequate' urea Kt/V. Ideal dry body weight needs a reappraisal. What is dry weight? How should it be clinically assessed, established and maintained in patients? The problems encountered in estimating dry weight can be solved at the bedside in most cases. The additional laboratory, echography and impedancemetry methods are research tools that hopefully can be made simpler and lower in cost so they can be used everyday at the bedside. In the mean time, with the exception of ambulatory blood pressure measurement, one must rely on careful and repeated clinical observation to determine and maintain dry weight.

Keywords: blood pressure; dry weight; haemodialysis; hypertension

Introduction

Cardiovascular complications result in serious morbidity and mortality in patients on maintenance haemodialysis. Hypertension is a major cause of these complications [1]. Fortunately many of these complications can be prevented by controlling hypertension [2,3].

In our view, the only way to gain control of blood pressure of dialysis patients is to slowly remove excess extracellular volume (ECV) by means of ultrafiltration over a period of 2–3 months until they reach dry weight. At dry weight the vast majority of dialysis patients will be normotensive off anti-hypertensive medications [3].

What is dry weight?

In a dialysis patient, dry weight is that body weight at the end of dialysis at which the patient can remain normotensive until the next dialysis despite the retention of salt water (saline). Dry weight varies over time as lean body mass and body fat change. At dry weight, the ECV is at or near normal but not less than normal [4,5].

The intermittent nature of haemodialysis results in an increase in ECV as reflected in a body weight increase between sessions. There is a dry point achieved at the end of each session and a wet point just before the next one. The blood pressure (BP) should remain in the normal range during the whole interdialytic period. If the patient remains hypertensive after a dialysis or becomes hypertensive before the next dialysis, he is, by definition, above his dry weight.

The concept of dry weight and its relationship to treating hypertension has its roots in history. Throughout the world, the incidence of hypertension is proportional to the sodium intake [6]. In cultures with a very low sodium intake, hypertension is virtually absent [7]. In our culture, despite a huge sodium intake, only about 20% of the adult population is hypertensive because normal kidneys can handle the load. On the other hand, among the population with chronic kidney failure, nearly 100% become hypertensive due to chronic sodium overload [4,8,9]. It is pertinent that those patients with chronic renal failure who remain normotensive have, as the result of their disease, a renal sodium leak [10]. In the history of chronic dialysis, the very first patient was saved from death from malignant hypertension by means of vigorous ultrafiltration [11]. This experience led to the development of the concept of dry weight in the dialysis population [4,11]. The term 'dry weight' was used for the first time in the literature in 1967 [12].

Determining the dry weight of a patient

The difficulty of this task should not be underestimated. It is comparable to initiating insulin therapy in a brittle diabetic.

At the beginning, the patient is usually hypertensive
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Despite being on antihypertensive medication, invariably his ECV is expanded but usually not enough to show oedema. This expansion will be proven by the fact that with vigorous ultrafiltration over several weeks, the patient will be able to tolerate the loss of several kilos without becoming saline depleted. However, the patient will not give up his excess of saline without a struggle, as his vascular system slowly readjusts its tone in response to stopping antihypertensive medication and removing the excess saline. This process is the reverse of the sequence first described by Guyton [13]. It is this struggle that can try the patience of the medical staff, and cause severe episodes of muscle cramps in the patient. The process is called 'probing for dry weight'.

Probing for dry weight

This difficult process is best explained in terms of a case example: a 54 year old female who has been on dialysis for 3 weeks and is adjusting well. She observes a strict low salt diet and her interdialytic weight gain does not exceed 1.5 kg. Her major problem is that despite a loss in post-dialysis weight from 69.3 to 67.2 kg, her BP remains elevated at 160/100 mmHg. The dose of enalapril has already been reduced from 5 to 2.5 mg/day. Toward the end of her ninth dialysis, she develops muscle cramps and hypotension. Ultrafiltration is terminated and her post-dialysis weight is 67.7 kg. During the next few dialyses, despite some episodes of hypotension, her post-dialysis weight drops to 66.2 kg. Her BP between dialysis is now 155/105 mmHg, but enalapril is totally discontinued after 5 weeks of dialysis treatment. During the next several dialyses her post-dialysis weight gradually drops to around 65 kg, and cramps and hypotension during each dialysis become less significant. The interdialytic BP is now down to the 140/80 mmHg range. She is near her dry weight. During the next six dialyses, she manages to drop an additional 0.5 kg to 64.5 kg, and no more hypotensive episodes are observed. Her interdialytic BP is now in the 115/80 mmHg range, and her dry weight is 64.5 kg. The whole process takes about 12 weeks.

Clinical guidelines

During the probe for dry weight, the length of dialysis sessions must be at least 5–6 h and may have to be even longer in treatment-resistant cases (see below). If shorter sessions are attempted, severe episodes of hypotension will prevent successful removal of excess ECV [14].

The all-important ongoing clinical evaluation of the patient during the probe for dry weight includes the following.

1. Case history, to look for conditions leading to ECV overload (excessive Na\(^+\) intake) or depletion (usually excessive Na\(^+\) losses) and for their symptoms (dyspnoea, headache, postural dizziness, cramps).

2. Clinical signs: BP with postural changes and weight with its interdialytic changes are the two key points. Neck vein filling in supine position, and presence or absence of oedema are also of great value.

3. X-ray (cardiac size) and lab. data (haematocrit, total protein, albumin) are a useful complement.

At the initiation of haemodialysis, carefully controlled vigorous ultrafiltration and strict low salt diet are used to remove the excess saline, while anti-hypertensive medications are gently tapered down. This transition phase usually requires several weeks. Hypotension and cramping will often occur when nearing hypovolaemia. At this point the patient must be informed that orthostatic dizziness may occur in the few hours following the session. He must be instructed to prevent these uncomfortable events by avoiding abrupt postural changes.

In planning the ultrafiltration for each dialysis session, review of the logs of previous sessions is essential. This information used in conjunction with the predialysis weight defines the ultrafiltration rate to be used for that session.

Early in the probe for dry weight it is absolutely essential that all anti-hypertensive medications be tapered down and stopped. If the patient remains on anti-hypertensive medication, the natural readjustment in vascular tone cannot take place. If these medications are not discontinued, it will be impossible to ultrafilter the patient down to dry weight [15,16].

Maintaining dry weight

Compared to the difficult task of determining dry weight, maintaining dry weight is relatively easy. One simply tries to establish a pattern for removing fluid by ultrafiltration during each dialysis, so that the patient's weight post-dialysis is within 0.2 kg of the nominal dry weight. Of course the shorter the dialysis time, the more difficult this task. Looking back at the patient's log showing the course of previous dialysis is of great value in planning the next dialysis.

The non-compliant patient

Some patients simply cannot follow even a moderately restricted salt diet. As a result they gain as much as 4–5 kg between dialyses. This weight gain makes removal during a single dialysis much more difficult. If the patient cannot tolerate an increased rate of ultrafiltration, then the only answer is to increase the length of each dialysis sufficiently to remove the customary accumulation for that particular patient.

Occasionally, a patient will binge out on salty food and come in several kg more than the dry weight. Here it is advisable to take two or three dialyses to bring that patient back down to dry weight.

Changes in dry weight over time

The absolute value for dry weight may change over time. As shown in Figure 1, the greatest change usually occurs in the first months after starting dialysis, when
the typical patient gains fat and lean body mass as his health and appetite improve after starting dialysis. During this period, the value for dry weight gradually will increase as much as several kg, but his BP will remain normal.

The value for dry weight may decrease abruptly if the patient loses fat and muscle mass as a result of an intercurrent illness. This type of acute change is easily recognized. However it is important to keep in mind that dry weight may vary in a more undetectable way. A discrete lack of appetite for a few weeks reduces the lean body mass by several kg. If this goes undetected and the target dry weight remains unchanged, the loss of lean tissue is masked by an equal excess of ECV, which in turn translates into an ‘unexplained’ increasing BP.

In all cases the need for dry weight reassessment is recognized, using the three information sources previously mentioned. The dry weight is then readjusted by steps of 200 g or so. When the new guessed dry weight is achieved, BP is allowed 2-3 weeks to reequilibrate. If the BP fails to normalize, a new weight readjustment is set.

The treatment-resistant patient

Patients with diabetes mellitus or severe atherosclerosis have a poor vascular compliance, which explains their large fluctuations between hypotension and hypertension. A pragmatic global assessment considering all signs and symptoms will usually suffice to clarify the ECV situation of the patient. In difficult situations the trial and error process used during the transition phase has great value. In managing these difficult cases, we have found that ambulatory blood pressure monitoring is a valuable tool [17]; it gives the best estimate of the ‘true’ interdialytic BP which is the touchstone of dry weight evaluation.

There remain a small number of cases that have such advanced atherosclerosis or long-standing hypertension that they remain resistant to treatment by the dry weight method. In this case we reintroduce after several months very low doses of antihypertensive medication, usually an ACE inhibitor. In our experience, on long slow dialysis they number less than 5%.

Comment

The absence of immediate correlation between interdialytic weight gain and BP changes has been put forward as an argument against the volume-sensitive nature of BP in haemodialysis patients [18,19]. This delayed (some weeks) relationship between ECV and BP change is widely acknowledged in physiology [13], in physiopathology of hypertension [20], as well as in dialysis [3,4,8-12,14,21,22].

Some authors claim that clinical assessment of dry weight is difficult, inaccurate, insensitive, and unreliable. Hence, many surrogates are suggested. Echographic measurement of inferior vena cava is a good indication of intravascular volume [23], but its estimation immediately at the end of dialysis is grossly 50% lower than 4 h after the session [24]. Blood volume estimation by densitometry deserves the same observation: it predicts hypotensive episodes, rather than assesses dry weight. ANP and cGMP indicate ECV overload but lack sensitivity [23]. Multifrequency bioimpedance requires validation on haemodialysis. Hopefully, continued research using these tools will result in new diagnostic tests simple enough to be used in the day to day management of the dialysis patient. Aside from them, ambulatory BP monitoring is, as mentioned earlier, the most useful recent technical achievement to improve dry weight evaluation.

In the mean time, careful and continued clinical observation must constitute the only way to achieve and maintain dry weight. That it can be successful is demonstrated by the results achieved in Tassin in the past 25 years [3].

References

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