The Janus-faced aspect of ‘dry weight’

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Abstract

Background. The goal of haemodialysis treatment in end-stage renal disease (ESRD) patients is to correct the complications of the uraemic condition. Among the main complications are fluid overload and subsequent hypertension that are corrected by achievement of ‘dry weight’. We report in this study the evolution of post-dialysis body-weight and blood pressure in patients who began their HD treatment in our unit.

Methods. We studied the monthly evolution of post-dialysis body-weight (expressed as a percentage of predialysis body-weight at the first HD treatment) and predialysis mean arterial pressure (MAP) over 24 months in 61 patients (21 females; mean age 59.8 years; 20% diabetic), treated with cellulosic membranes for 8 h, 3 times a week.

Results. The post-dialysis body-weight decreased between the onset of HD and month 2 (M2) (-4.40 ± 0.52%). Then it went up, reaching -1.56 ± 0.96% at M6, +0.3 ± 1.27% at M12, +1.27 ± 1.38% at M18 and +1.64 ± 1.33% at M24. The post-dialysis body-weight increased by 6% between M2 and M24. The mean arterial pressure (MAP) decreased from 111.3 ± 2.5 mmHg at M0 to 94.4 ± 1.7 mmHg at M6, and then remained stable after M6. Between M2 and M6 the post-dialysis body-weight increased, whereas the predialysis MAP continued to decline. The incidence of hypotension episodes was maximal during the first 4 months of HD treatment.

Conclusions. After the second month of dialysis treatment, the simultaneous increase of post-dialysis body-weight and decrease of predialysis MAP are related to the effects of two processes, i.e. increased weight as the result of anabolism induced by the HD treatment on the one hand and normalization of blood pressure by fluid removal on the other. Continuous clinical assessment of the patient is necessary to provide adequate prescription of post-dialysis body-weight. During the first months of HD treatment, the nephrologist, like Janus, is a double-faced gatekeeper: he must be willing to decrease post-dialysis weight to achieve ‘dry weight’ and to normalize blood pressure, but he must also be prepared to increase it to compensate for anabolism and to avoid episodes of hypotension.

Key words: dry weight; post-dialysis body-weight; blood pressure; haemodialysis; cellulosic membrane

Introduction

Extracellular fluid overload is a common condition in end-stage renal disease (ESRD) patients. It is one of the main factors of hypertension in this setting [1]. Haemodialysis (HD) treatment is supposed to correct the fluid overload by achievement of dry-weight, a sort of ‘Holy Grail’ in the HD practice. Dry weight has been previously defined [2]. In our experience, it is the post-dialysis body-weight that allows the predialysis blood pressure to remain normal (i.e. ≤130/80 mmHg or mean arterial pressure (MAP) ≤96 mmHg), despite the interdialytic weight gain and without the need of antihypertensive drugs. Also, at dry weight, the patient has no clinical signs or symptoms of fluid overload or hypovolaemia.

Moreover, improvement of nutritional status by the onset of the HD treatment has been an early observation [3]. Then, in the first months of the HD treatment, the evolution of the body-weight is the net result of two opposing processes, i.e. control of the extracellular fluid volume to reverse hypertension on the one hand and increase in ‘dry mass’ as a result of anabolism induced by HD treatment on the other.

In this study we report the changes in post-dialysis body-weight and the blood pressure during the 24 months following onset of the HD treatment in patients treated with HD sessions of long duration.

Subjects and methods

Patients

Between June 1990 and June 1994, 115 patients were started on HD treatment in our unit. Fifty two patients were excluded from the study for the following reasons: transfer after an early (<6 months) graft failure, n = 5, or from a
peritoneal dialysis programme, \( n = 4 \); malignant disease, \( n = 6 \); hospitalization >4 months in a row, \( n = 1 \); follow-up less than 2 years (kidney transplantation, \( n = 8 \); transfer to another unit, \( n = 8 \); transfer to self or home HD programme, \( n = 12 \); death, \( n = 8 \)). Sixty-one patients remained available for the study.

Post-dialysis body-weight evolution

After each HD treatment, according to interdialytic symptoms, physical examination, pre- and postdialysis blood pressure data and peridialytic side-effects such as cramps and hypotension reported on the dialysis flowsheet, the nephrologist determines the body-weight to be achieved at the end of next HD treatment. Usually, in the first weeks of the HD treatment, the prescribed post-dialysis weight is gradually decreased by steps of 200–500 g per session up to normalization of blood pressure, and according to peridialytic and interdialytic tolerance. During the same period the antihypertensive medications are progressively tapered down and stopped. The body-weight balance (difference between prescribed and achieved post-dialysis body-weight) is automatically displayed on the dialysis flowsheet and taken into account for the ultrafiltration volume at each HD session. All these data are computerized (Alis-LAP, Metz, France), allowing for an easy extraction of data for analysis.

The post-dialysis body-weight was compared over the 24-month period to the pre-dialysis body weight at the first HD treatment. This variation of the post-dialysis body-weight was calculated according to the following formula:

\[
\frac{\text{monthly average of post-dialysis body-weight}}{\text{predialysis body-weight at the first HD treatment}} \times 100
\]

Post-dialysis body-weight data have been calculated for the months 2, 6, 12, 18, and 24, referred to as M2, M6, M12, M18 and M24.

Blood-pressure evolution

Mean arterial pressure (MAP: (systolic – diastolic blood pressure)/3 + diastolic blood pressure; mmHg) was expressed as the monthly average of predialysis MAP at M2, 6, 12, 18 and M24. The M0 value was the predialysis MAP at the first HD treatment.

Haemodialysis side-effects

Side-effects such as muscular cramps and hypotension episodes are collected from the flowsheets by the nephrologist and computerized at the end of each haemodialysis session. Hypotension is defined by a symptomatic drop of blood pressure, requiring from the staff saline infusion or a stop of the ultrafiltration programme.

Statistical analyses

Data are expressed as mean ± SEM. The post-dialysis body-weight variations and pre-dialysis MAP data were studied with the General Linear Model ANOVA method for repeated-measure design during two periods: M0 to M6 and M6 to M24. A \( P \) value <0.05 was considered as significant. Statistical analyses were performed on the Sogo® software (BMDP Statistical Software, Inc., Los Angeles, CA).

Results

The patients characteristics are reported in Table 1. The 61 studied patients were aged 59.8 years and 15/61 (24.6%) were over 70 at the beginning of the HD treatment. The average pre-dialysis body weight at the first HD treatment was 65.3 kg (range 43.3–108.7). The cause of ESRD were nephrosclerosis (23%), diabetes (20%), chronic glomerulonephritis (18%), unknown (18%), uropathy (10%), polycystic kidney disease (6.5%), and miscellaneous (4.5%).

Dialysis parameters are summarized in Table 2. All the patients began dialysis treatment on a basis of 3 x 8 h/week. Eight patients included in the study were changed to 3 x 5 h/week after 10.1 + 2.9 months. All patients were treated with a reused cellulosic membrane (cuprophan 91.4%, or hemophan 8.6%). The dialysate buffer was acetate (35 mmol/l) in 79% and bicarbonate (35 mmol/l) in 21% of the patients. The mean sodium content of dialysate was stable throughout the dialysis session and was 137 mmol/l in acetate dialysate and 140 mmol/l in bicarbonate dialysate. The dietary sodium counselling was 4 g/day. The average of the monthly determined Daugirdas index (second generation) and normalized proteic catabolic rate were respectively 1.92 ± 0.06 and 1.18 ± 0.03 g/kg/day for the 24-month period. The average predialysis serum bicarbonate over the 24-month period was 19.7 ± 3.7 mmol/l (Table 1).

A marked decrease of the post-dialysis body weight occurred during the first 2 months of the treatment, at M2 reaching –4.37% of the predialysis body weight at the first HD treatment (Figure 1). Then the post-
Fig. 1. Evolution over 24 months of the monthly average of post-dialysis body weight and mean arterial pressure (MAP). The post-dialysis body-weight variation is expressed as the deviation (in %) from the pre-dialysis body-weight at the first HD treatment.

dialysis body-weight increased up to $+1.64 \pm 1.33\%$ at M24. Between M2 and M24, the increase of the body-weight reached 6%. The post-dialysis body-weight variations were significantly different throughout the two periods (M0–M6, $P = 0.00000$; M6–M24, $P = 0.00086$).

The evolution of the blood pressure is reported in Figure 1. The initial MAP was $111.8 \pm 19.9$ mmHg. At that stage, 85% of the patients were prescribed anti-hypertensive drugs. At M6, the predialysis MAP was $94.0 \pm 10.6$ mmHg and only four patients needed anti-hypertensive drugs. Between the onset of HD treatment and M6, the predialysis MAP decreased significantly ($P < 0.00001$). Then it stabilized, and predialysis MAP data were not different between M6 and M24 according to GLM ANOVA. The average interdialytic weight gain was stable over the 24-month period ($2.03 \pm 0.9$ kg at M2, $2.19 \pm 0.99$ at M6, $2.06 \pm 1.07$ at M12, $2.11 \pm 0.94$ at M18 and $2.03 \pm 0.97$ at M24), but was lower during M1 ($1.44 \pm 0.66$ kg).

The evolution of the weight balance is reported in Figure 2. The difference between prescribed and achieved post-dialysis body-weight was maximum in the first months of treatment, corresponding to the periodical adjustment of post-dialysis body-weight until blood pressure is normalized. The difference of pre- and post-dialysis MAP did not vary significantly over the studied period and averaged $14.2 \pm 1.2$ mmHg. Whereas the cramp incidence did not vary along the study period (Figure 3), the incidence of hypotension episodes was maximum during the first 4 months of treatment, reaching 20.3% of incidence (Figure 3), and then stabilized under 10% after 1 year of treatment. The proportion of patients presenting with symptomatic hypotension episodes in more than 10% of HD sessions was 39.6% at M1, 36.2% at M6, 29.8% at M12 and 23% at M24. In these patients, the distribution of diabetic patients was stable over the whole period.

Discussion

These data document the peculiar evolution of post-dialysis body-weight after the onset of the HD treatment. Initially, body-weight decreased by the efforts made to achieve dry weight. The magnitude of the decrease was $-4.4\%$ at M2, which represents an average loss of 2.9 kg in 2 months. The evolution of the pre-dialysis MAP during this initial period parallels the removal of fluid. Fluid withdrawal is rendered easy by the slow ultrafiltration rate provided by the long dialysis method. This is the key point in the effort to achieve ‘dry weight’. Lengthening the HD session time reduces the incidence of hypotensive episodes [5]. However, in the first months of treatment, a higher incidence of hypotension episodes were recorded in our patients, reflecting the effort to achieve ‘dry weight’. It may be the price to pay in some patients if one is determined to reach the dry weight and to normalize blood pressure. It is also possible that the use of acetate as buffer may favour hypotensive events in some patients during this phase.
Between M2 and M6, pre-dialysis MAP continued to decrease until M6 when it stabilized. In contrast, the post-dialysis body-weight increased. This period corresponds to a phase of overlap of two opposing influences: HD treatment increases ‘dry weight’ by inducing anabolism [4,6] while blood pressure is normalized as a result of fluid removal. During this period, the nephrologist is, like Janus, a double-faced gatekeeper of post-dialysis body-weight. One face is the effort to reach the dry weight by decreasing the post-dialysis body-weight until normalization of the blood pressure has been achieved (MAP = 96 mmHg). The risk is excessive fluid withdrawal that will lead to episodes of hypotension during HD sessions and symptoms of hypovolaemia between HD sessions. The other face is the need to adjust post-dialysis body-weight upwards because body-weight tends to increase as a result of anabolism at a time when blood pressure is not yet normalized. This dilemma exposes the patient to insufficient fluid removal and persisting hypertension. During this transient period, close clinical monitoring of the patient is needed to adjust post-dialysis body-weight. It is paradoxical that one has to increase post-dialysis body-weight while blood pressure (the key index of optimal dry weight) is still supernormal. This paradox may be explained by the consideration that a certain lag time is necessary between the moment when ‘dry weight’ has been achieved and the moment when blood pressure normalizes [7]. Longitudinal measurements of body fluids with impedance technique, and ambulatory monitoring of blood pressure could be useful tools during this period.

Another feature of the present study is the observation of the sustained increase of post-dialysis body-weight during 18 months, while predialysis MAP did not change. In the 61 patients, post-dialysis body-weight from M2 to M24 increased by 6%, on average by 3.9 kg. The magnitude of the sustained anabolic response to HD treatment is remarkable in view of the fact that patients hospitalized for surgery or infectious diseases were not excluded from the study. It is also of note that this concerned patients treated with cellulosic membranes. In contrast, Parker et al. [6] found an increase of body-weight only in patients treated with biocompatible membranes. The large ‘dose’ of dialysis delivered may explain why HD treatment induced a remarkable positive effect on post-dialysis body-weight. Chauveau et al. [8] recently found a significant linear and positive relationship between Kt/V urea assessed by urea monitoring, and daily protein intake assessed by a 7-day food record.

In conclusion, in our experience, ‘dry weight’ must be viewed as a dynamic concept during the initial months of HD treatment. Further studies using more sophisticated methods to assess nutritional and fluid status are necessary to more clearly understand the mechanism underlying the changes in ‘dry weight’.

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References

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