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# Interdialytic weight gain as a marker of blood pressure, nutrition, and survival in hemodialysis patients

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**Interdialytic weight gain as a marker of blood pressure, nutrition, and survival in hemodialysis patients.**

*Background.* Excessive interdialytic weight gain (IDWG) is usually related to an overload of sodium and water, and is the most important factor for arterial hypertension in dialysis. On the other hand, food intake also contributes to IDWG, and is the basic factor for nutrition. The objective of this study is to assess the long-term prognostic effect of IDWG and its relationship with the nutritional status and blood pressure in patients in hemodialysis (HD).

*Methods.* We describe the results of a 5-year prospective observation study in which 134 HD patients were included (70 males and 64 females), with ages between 18 and 81. Initially, the average data were collected during 4 weeks, including total IDWG and percentages according to dry weight (IDWG%), nutritional parameters, and blood pressure. Patients were divided into 3 cohorts according to IDWG% (<2.9, 2.9–3.9, and >3.9%, respectively). Student *t* test, ANOVA, linear regression analysis, and Kaplan-Meier survival curves compared with log-rank test were used as statistical tools.

*Results.* The mean IDWG% for the whole studied population was $3.5 \pm 1.1\%$ (1.5–8.0%). It was not related to gender, but had an inverse correlation with age ($P < 0.000$) and serum bicarbonate level ($P = 0.009$). It was directly correlated with predialysis systolic and diastolic blood pressure, nPCR, urea and creatinine levels ($P < 0.01$ for all of them), and the body mass index ($P < 0.000$). Serum levels of albumin ($44.7 \pm 4.0$ g/dL) and prealbumin ($31.9 \pm 7.4$ mg/dL) had a direct correlation with total IDWG ($P < 0.01$). We found no significant relationship between or IDWG% and ferritin and transferrin levels. Five-year actuarial survival was 0.38, 0.52, and 0.63, respectively, in the 3 cohorts for IDWG% ($P < 0.01$).

*Conclusion.* Our results show that a greater IDWG is directly associated with a better nutritional status, although it is also associated with higher predialysis blood pressure. The greater the IDWG%, the better the long-term prognosis of the patients. The beneficial effects of IDWG on the nutritional status and prognosis are greater than the negative aspects that depend on its effects on blood pressure. One must distinguish clearly between some isolated instances of not complying with a diet from those situations where a higher IDWG is merely a reflection of a good nutritional status, and one must be careful so that dietary recommendations will not have a negative influence on nutritional aspects. One must watch and correct the trend towards higher acidosis in patients with a greater IDWG.

**Key words:** interdialytic weight gain, dry weight, survival on hemodialysis, nutrition, arterial hypertension.



Interdialytic weight gain (IDWG) is mainly the result of salt and water intake between two dialysis sessions. Theoretically, the consequences of this variable have a double meaning. On the one hand, the water and saline intake can frequently be done together with caloric and protein foods, which means it would be associated with a better nutritional status [1–4]. But, on the other hand, water and salt intake can give rise to a volume overload, which can be the key for the developing of high blood pressure [5–11] and left ventricle hypertrophy, both of which can increase the cardiovascular risk [12, 13].

The objective of this study was to assess the long-term prognostic effect of IDWG and its relationship with the nutritional status and blood pressure of the patients on hemodialysis (HD).

## METHODS

We prospectively studied the outcome of 134 patients, 70 men and 64 women, with an average age of $60.6 \pm 14.5$ years (18–81 years), and with an average time on dialysis of $43.8 \pm 23.0$ months. All of them received conventional hemodialysis 3 times a week, with a mean duration of $3.7 \pm 0.4$ hours. Sixty-eight percent was dialyzed with high flux membranes. The spKt/V and normalized protein catabolic rate (nPCR) were calculated with the kinetic urea model [14].

The etiology of chronic renal failure included 18.7% glomerulonephritis, 26.1% chronic interstitial nephropathy, 9.0% vascular nephropathy, 11.9% diabetes mellitus, 10.4% polycystic disease, other in 5.2%, and unknown in 18.7%.

Patients were initially evaluated during 4 weeks, determining the IDWG and blood pressure as an average of the 12 hemodialysis sessions given during that period.

**Table 1.** Clinical and analytical characteristics of the 134 patients at the start of the study

| | Mean | SD |
|---|---|---|
| Age *years* | 60.6 | 14.5 |
| Time on HD *months* | 43.8 | 23.0 |
| Dry weight *kg* | 65.0 | 12.7 |
| Body mass index $kg/m^2$ | 23.8 | 3.4 |
| Systolic blood pressure *mm Hg* | 136.4 | 14.2 |
| Diastolic blood pressure *mm Hg* | 72.9 | 8.8 |
| Mean arterial pressure *mm Hg* | 94.1 | 9.7 |
| Antihypertensive drugs *number* | 0.78 | 0.86 |
| Interdialytic weight gain *kg* | 2.2 | 0.8 |
| Interdialytic weight gain/dry weight % | 3.5 | 1.1 |
| Albumin *g/L* | 44.7 | 4.0 |
| Prealbumin *mg/dL* | 39.1 | 7.4 |
| nPCR *g/kg/min* | 1.06 | 0.22 |
| spKt/V | 1.30 | 0.13 |
| Bicarbonate *mEq/L* | 24.0 | 2.7 |
| Calcium *mg/dL* | 9.9 | 0.7 |
| Phosphate *mg/dL* | 5.7 | 1.2 |
| Urea *mg/dL* | 155.7 | 33.2 |
| Creatinine *mg/dL* | 9.5 | 2.4 |
| Transferrin *mg/dL* | 215.4 | 39.6 |
| Ferritin *ng/mL* | 459.5 | 297.9 |

Results are expressed as mean ± standard deviation.

Mean blood pressure (MBP) was calculated as

$$\text{MBP} = [\text{systolic blood pressure} + (2 \times \text{diastolic blood pressure})]/3.$$

Patients were classified according to tertiles of MBP: group A included 44 patients with MBP <90 mm Hg; group B included 45 patients with MBP 90 to 94 mm Hg, and group C included 45 patients with MBP >94 mm Hg.

IDWG is expressed as the difference between the predialysis weight and the weight at the end of the previous dialysis session, and IDWG% is obtained using the percentage relationship between the average IDWG and the patient's dry weight. Patients were classified into 3 cohorts according to the IDWG%: <3% (Group I), 3% to 3.9% (Group II), and >3.9% (Group III). The amount of antihypertensive drugs the patients were taking daily was recorded, and we calculated the body mass index (BMI).

Table 1 shows the clinical characteristics and the analysis of the patients at the beginning of the study. The follow-up of the patients was done over 5 years.

Results are expressed as mean ± standard deviation. The comparison between the mean values was done with a Student *t* test and analysis of variance (ANOVA). The association between continuous variables was done with a univariate regression analysis. Pearson correlation coefficient was calculated to study these variables. Actuarial survival was calculated with the Kaplan-Meier method, and the comparison between groups with the log-rank test. Statistically significant data were considered to be those that had a $P < 0.05$. We used the SPSS 11.5 statistical software package (Chicago, IL, USA) for the statistical calculations.

## RESULTS

Table 2 shows the clinical results and the analysis of the 3 groups of patients according to IDWG%. We found a significant direct correlation between IDWG and dry weight ($r = 0.532$, $P < 0.01$). IDWG is significantly higher in men than in women ($2.4 \pm 0.8$ vs. $2.0 \pm 0.6$, $P < 0.005$), but this difference disappears when they are adjusted to dry weight. We found no significant differences in the IDWG according with etiology. In the linear regression analysis there was no association between IDWG and time on dialysis.

There was a significant inverse correlation between IDWG and IDWG% with age ($r = -0.428$ and $-0.384$, respectively, $P < 0.001$), serum bicarbonate ($r = -0.225$ and $-0.316$, respectively, $P < 0.001$), and a correlation between IDWG with spKt/V ($r = -0.344$, $P < 0.001$). There was a significant direct correlation between IDWG% and serum albumin levels ($r = 0.214$, $P = 0.013$), prealbumin ($r = 0.253$, $P = 0.004$), phosphate ($r = 0.228$, $P = 0.008$), urea ($r = 0.381$, $P < 0.001$), and creatinine ($r = 0.465$, $P < 0.001$), and also with the nPCR ($r = 0.287$, $P < 0.001$) and the body mass index ($r = 0.346$, $P < 0.001$). We found no significant correlation between IDWG% and either transferrin or ferritin serum levels.

On the other hand, IDWG% was associated with predialysis blood pressure, both systolic ($r = 0.314$, $P < 0.001$) and diastolic ($r = 0.309$, $P < 0.001$). Figure 1 shows the relationship between IDWG% and the predialysis MBP. Besides, there is a direct correlation between IDWG% and the daily number of antihypertensive drugs that the patients were taking ($r = 0.250$, $P < 0.005$)

After 5 years of follow-up, 59 patients (44.0%) have died, 21 patients (15.7%) have been transplanted, 4 patients (3%) have moved to another hospital, and 50 (37.3%) are still actively on hemodialysis. Figure 2 shows the influence of IDWG% on patient survival at 5 years, so that those that have the greatest IDWG% have the best survival. Survival for all 3 groups at 5 years was 0.38, 0.52, and 0.63, respectively (log-rank $P < 0.01$).

Figure 3 shows the survival of patients at 5 years in the groups set up according to the tertiles of mean blood pressure. No significant differences were found.

## DISCUSSION

Interdialytic weight gain is considered as a measurement of HD compliance. This measurement varies a great deal between patients.

While some authors find a favorable association between IDWG and the nutritional status [1–4], others relate it to the blood pressure of patients on HD, which would be unfavorable [5, 6, 8, 9, 10] The clinical implications and the medium- and long-term prognostic value are therefore unclear.