THE EFFECT OF PROFILING DIALYSATE SODIUM AND ULTRAFILTRATION ON PATIENT COMFORT AND CARDIOVASCULAR STABILITY DURING HAEMODIALYSIS

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SUMMARY

The aim of this study was to investigate what affect profiling dialysate sodium and ultrafiltration rate had on cardiovascular stability during haemodialysis, and if there was any effect on patients' fluid balance, thirst, serum sodium levels, blood pressure, or comfort and tolerance.

The past decade has seen major advances in haemodialysis machine technology. Parallel developments have included profiling dialysate sodium levels and fluid removal during dialysis. However, some dialysis centres do not use profiling due to fears of long-term detrimental effects, especially with regard to hypertension and fluid control. Within my own workplace, approximately 30% of haemodialysis treatments utilise either sodium or ultrafiltration profiling, or a combination of both. Anecdotally, we have seen an increase in cardiovascular stability and haemodialysis tolerance. The aim of this study was to identify the effects of profiling haemodialysis, to ensure that the treatment we offer patients is safe and effective.

KEY WORDS

- Haemodialysis
- Ultrafiltration & sodium profiling
- Cardiovascular stability
- Patient comfort

Thirty-one patients with end-stage renal failure, on haemodialysis for at least three months, underwent a three-phase, randomised, cross-over trial (four weeks sodium profile, four weeks ultrafiltration profile and four weeks no profile), with washout periods. The results of pre- and post-dialysis blood pressure, weight gain between sessions, achievement of target weight, thirst, serum sodium levels, and episodes of complications during dialysis were compared using one-way analysis of variance. At the end of each trial period, participants were asked to describe the subjective impact of these techniques on self-reported comfort and well-being during and after dialysis. Twenty-seven participants completed the 18 week trial period. The findings, a combination of quantitative and qualitative data, have suggested that profiling is not a universal panacea. For some patients it can improve their comfort and tolerance of haemodialysis without apparent detriment to their blood pressure, serum sodium or weight gain, whilst for others, sodium profiling may significantly increase the incidence of cramp. Haemodialysis treatments need to be tailored to the individual. The specialist nurse within the haemodialysis unit is ideally placed to do this.

BIODATAS

Martin Gerrish *qualified in 1985 and has worked as a haemodialysis nurse for over 14 years. He is the senior nurse/unit manager of the Lincoln renal unit. He completed his MSc in Advanced Nursing Practice, with distinction, in 2001. He was presented with the scholarship for 'best manuscript' at the EDTNA conference in The Hague 2002 for his presentation of this study.*

INTRODUCTION

Symptomatic hypotension and dialysis disequilibrium syndrome are the two most frequent complications occurring during haemodialysis sessions (1). Evidence suggests that fluid shifts from the extracellular into the intracellular space due to intradialytic changes in plasma osmolarity are major contributing factors for cardiovascular instability (2). Variations in the dialysate sodium concentration have been reported to increase cardiovascular stability during haemodialysis (3,4). Raising dialysate sodium concentration increases plasma sodium concentration and leads to a fluid shift from the intracellular space into the extracellular space (5).

Research suggests that the direct pathophysiological cause of intradialytic hypotension is a reduction in the circulating volume induced by ultrafiltration (2). This is facilitated by the fall in extra-

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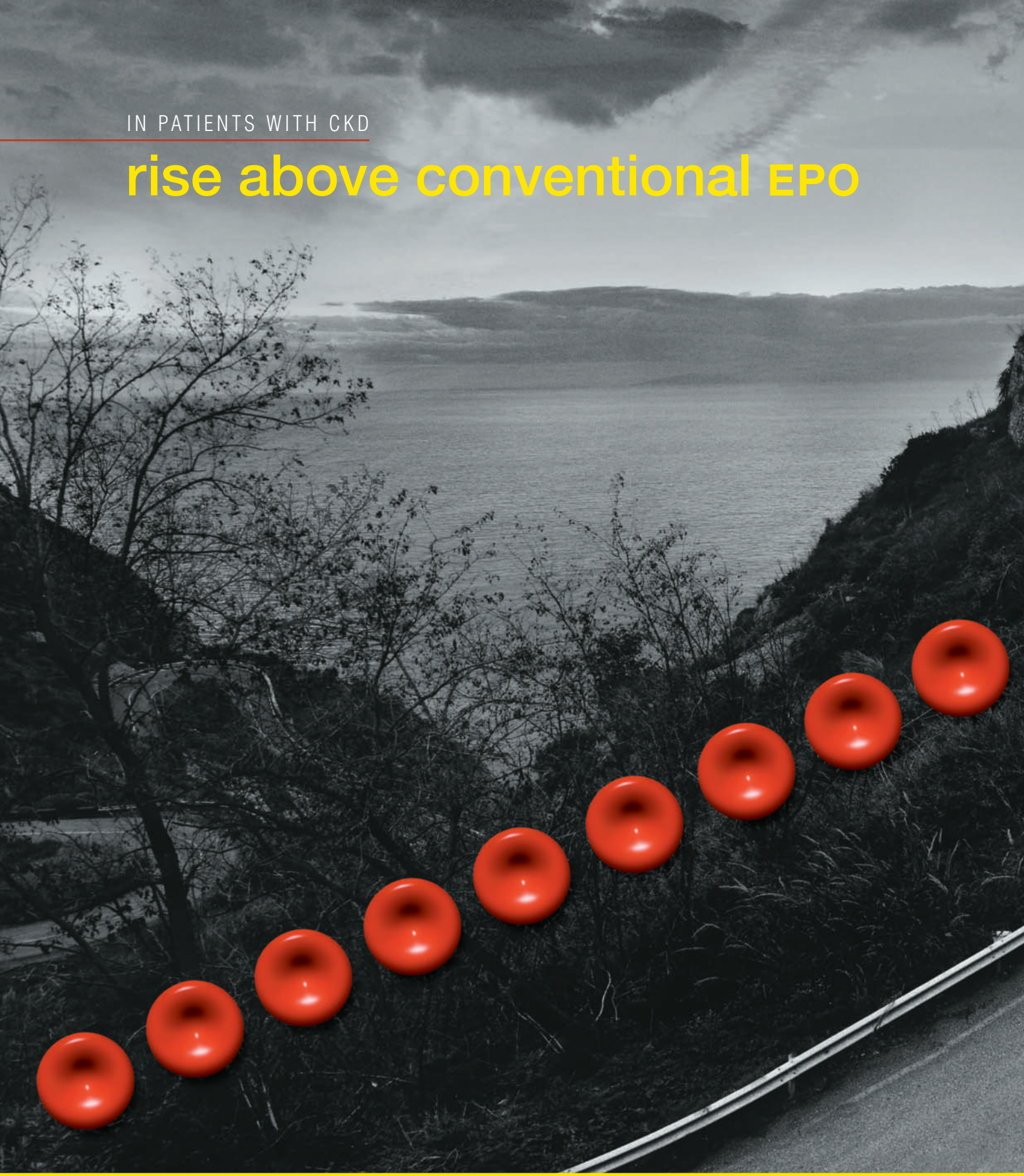

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References

1. Locatelli F, on behalf of the NESP 990748 Study Group. ARANESP® (darbepoetin alfa) unit dosing is effective in the treatment of renal anaemia in patients with end-stage renal disease. Poster presented at: XXXIX ERA-EDTA Congress; July 14-17, 2002; Copenhagen, Denmark.
2. Egrie JC, Browne JK. Development and characterization of novel erythropoiesis stimulating protein (NESP). *Nephrol Dial Transplant*. 2001;16(suppl 3):3-13.

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Date of preparation: June 2002.

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cellular volume caused by removing osmotically active solutes, mainly sodium. The resultant shift of fluids from the outside to the inside of the cell increases the intracellular and decreases the extracellular volume. The most common approach to solving this problem is to raise the dialysate sodium level throughout the session to curb the drop in plasma osmolality. However, it has been demonstrated that this increases the plasma sodium level, often resulting in clinical complications due to water and sodium retention such as hypertension, thirst and fluid overload; exacerbating the very problems the treatment is attempting to resolve (6,7,8). However, 'variable sodium' dialysis can assist in fluid removal, preserve vascular stability, prevent hypotensive episodes and reduce blood pressure in hypertensive patients (9).

Despite the evidence to support the advantages of profiling in increasing cardiovascular stability some studies criticise its use, or the evidence upon which it is based[(1)]. Sang and colleagues (10) consider that profiling can decrease the overall number of side effects, but increases interdialytic symptoms, weight gain and hypertension; reporting patients complained of more fatigue and thirst, interdialytic weight gains were higher between dialysis sessions and blood pressure was raised following profiling.

Raja and Po (11) support the view that plasma refilling and vascular stability are enhanced during haemodialysis using sequentially decreasing ultrafiltration and high to low dialysate sodium.

As a technique for reducing hypotensive episodes, Chamney (12) recommends bolus ultrafiltration, which involves switching on the ultrafiltration for short periods of time at high ultrafiltration rates throughout the dialysis, as these 'rest periods' allow for vascular refilling. However, this view is not supported by the findings of Donauer et al (13) who conclude that high ultrafiltration pulses cannot be recommended.

Critique of research by Meers et al (4) highlights that inclusion of actual comments from research participants concerning their well-being, comfort level, ability to function and activity level after leaving the dialysis unit may help to validate the theory that profiling sodium and ultrafiltration during dialysis is better for the patient. The majority of research concentrates on quantitative analysis of data. Subjective analysis of how the patient feels should also be considered.

Despite the large amount of existing research on the subject, the findings of the literature search supported the need to conduct further research within my own workplace. Our work builds upon the literature and may be unique in that it compares (i) sodium profiling with (ii) ultrafiltration profiling and (iii) no profiling as separate therapies. Washout periods are included between trial periods. Patient parameters are recorded including plasma sodium levels, blood pressure, inter- and intra-dialytic symptoms, weight gain and thirst. Questionnaires are used to describe the subjective impact of these techniques on self-reported patient comfort and well-being during and after dialysis.

MATERIAL & METHODS

The study was conducted in a ten-station dialysis unit. All patients on haemodialysis for longer than three months, on bicarbonate-based therapy and requiring fluid removal during dialysis, were invited to take part. 31 patients consented to participate and underwent a two-week washout period receiving a standard haemodialysis treatment with constant linear ultrafiltration and a baseline dialysate sodium of 135 $mmoll^{-1}$. The washout periods allowed participant parameters to return to a baseline between trial periods. They then entered a three-phase trial, with a two-week washout period between each phase. Participants were randomised according to one of six possible orders in which they would receive the treatment.

Phase 1: Four weeks of high to low sodium profile
(145–125 $mmoll^{-1}$; mean Na^+ 135 $mmoll^{-1}$)
Phase 2: Four weeks using a three-step decreasing ultrafiltration profile
(Fresenius 4008H machine profile 3: Na^+ 135 $mmoll^{-1}$)
Phase 3: Four weeks of standard haemodialysis treatment
(constant linear ultrafiltration, Na^+ 135 $mmoll^{-1}$), i.e., no profiling.

Patient demographic and treatment parameters were recorded and compared for the three trial periods:

- Pre- and post-dialysis serum sodium sample on commencing and completing trial period.
- Patient medication (antihypertensives & EPO therapy).
- Patient questionnaire distributed at the end of each treatment period.
- Dialysis record sheet for each session completed by nurse responsible for treatment (three per week x four weeks for each trial period). Including:
  - Pre- and post-dialysis blood pressure.
  - Pre- and post-dialysis weight.
  - Fluid removed during session.
  - Intradialytic problems: hypotension, cramp, nausea etc. and action taken.
  - Interdialytic problems: headache, cramp, nausea, thirst, dizziness and action taken.

In this study, data has been collected from observations of the same subjects undergoing three different courses of treatment. To detect any relationship trends and patterns, the data was statistically analysed using a one-way analysis of variance (ANOVA). With this technique, it is possible to determine whether there is significant difference between means simultaneously. A P value of <0.05 is considered significant.

RESULTS

Our findings support studies (7,14,15) that show patients' weight gain did not increase between dialysis and that blood pressure was not adversely affected, despite increased thirst sensation reported. The mean weight loss (Figure 1) was highest during the ultrafiltration period, and lowest during the sodium profile. Comparison of weight loss data showed no statistical significance between the treatments and their effect on weight gain. The weight loss correlates with the responses to questionnaires (Figure 14), with a higher incidence of thirst reported between dialysis sessions during the ultrafiltration profile. Comparison of urea reduction ratio showed no statistical difference between the three treatments (Figure 8).

Hypertension is a common, multifactorial, problem in patients undergoing haemodialysis. The majority of dialysis patients are on antihypertensive therapy (71% in this study). The effect of any dialysis treatment upon blood pressure is important. It is the reported increase in hypertension attributed to sodium profiling which has persuaded some units to abandon its use. Blood pressure was the primary outcome measure in this study. Pulse pressure (Figure 2), mean arterial pressure (MAP) (Figure 3), and the difference between the pre and post blood pressure (Figure 4) showed no statistical significance. Pulse pressures were consistent between the three treatments. MAP was slightly higher, and there was less difference between pre and post MAP during the no profile trial period. No patients had their antihypertensive medication increased during the trial period. An increase in antihypertensive therapy may have affected the validity of the results of the study, as it would have been an alternative explanation for stability of blood pressure. EPO doses, which may also affect blood pressure, remained relatively constant.

Hypotension occurred more often (Figure 11), and was most severe (Figure 12), during the ultrafiltration phase of the trial, and least often during the sodium profile phase; but, comparison using ANOVA found no statistical significance.

Sodium profiling may increase the incidence of cramp in some patients. The incidence of cramp was higher during sodium profiling than with the other two profiles (Figure 9). Comparison, using ANOVA, detected a statistical significance (P: 0.0044). This finding was reflected in the questionnaire responses, which also reported a higher incidence of cramp during this profile period. In contrast to the study that found that profiling could improve patient tolerance of haemodialysis and decrease the number of nursing interventions, we found that in some cases it increased the incidence of cramp. However, other respondents reported that sodium profiling gave them less cramp during dialysis (Figure 13) than the other profiles.

The severity of cramp (Figure 10) was greater in sodium profiling and least in no profile treatment; but no statistical significance was detected. Sodium profiling appeared to cause more cramp during a session (Figure 13), but decreased the amount reported between sessions (Figure 14). Respondents recorded less cramp between sessions during the sodium trial than they did during the other two profiles.

Analysis of the total scores for the perceived positive and negative side-effects recorded on the questionnaires (Figure 13) indicated that sodium profiling has a positive effect on improving comfort during dialysis, with less cramp, headache, thirst and sickness recorded. However, for another group of respondents the reverse was true. Cramp and thirst had a higher incidence with sodium profiling than with ultrafiltration or no profile, but there was less sickness recorded.

Self-reported problems between haemodialysis sessions (Figure 14) reflected conflicting opinions regarding the perceived side-effects. Sodium profiling was reported to cause more cramp in some respondents, but others reported a lot less than with the other two treatments. Sodium profiling appeared to cause more headaches in one group, and less in another equal sized group. Other studies report the positive improvements due to profiling which we observed in one group of patients, but do not appear to have observed the level of negative side effects, which we also identified. The base sodium concentrate within our unit is 135 $mmoll^{-1}$, which is lower than other studies (3, 4), where the base is reported around 140 $mmoll^{-1}$. This may be a factor in the differences in outcome.

Comparison of data identified no statistical significance between the pre and post sodium levels. Pre and post levels were slightly higher in the no profile treatment phase (Figure 5 and 6). The biggest pre and post sodium difference was observed in the sodium profile phase (Figure 2), but it was not statistically significant. The evidence of sodium retention reported in previous studies (10,17,18) was not observed. No statistical significance was detected in the difference in pre and post serum sodium levels (Figure 7).

An observation made during the study was that the range of predialysis serum sodium levels (Figure 5) varied greatly, between 131–143 $mmoll^{-1}$, with some participants' sodium level falling by up to 8 $mmoll^{-1}$ during a session, whilst others rose by up to 5 $mmoll^{-1}$. This variation may account for the difference in response to the three profiles, and the wide range of reported symptoms observed in the questionnaire responses. It may be this change in serum osmolarity that cause the problem of cramp, identified with sodium profiling. Further research is required to investigate whether there is a connection between the pre serum sodium level and the perceived benefits, or side-effects, of profiled treatment. The contrast in opinion of well-being between sessions with

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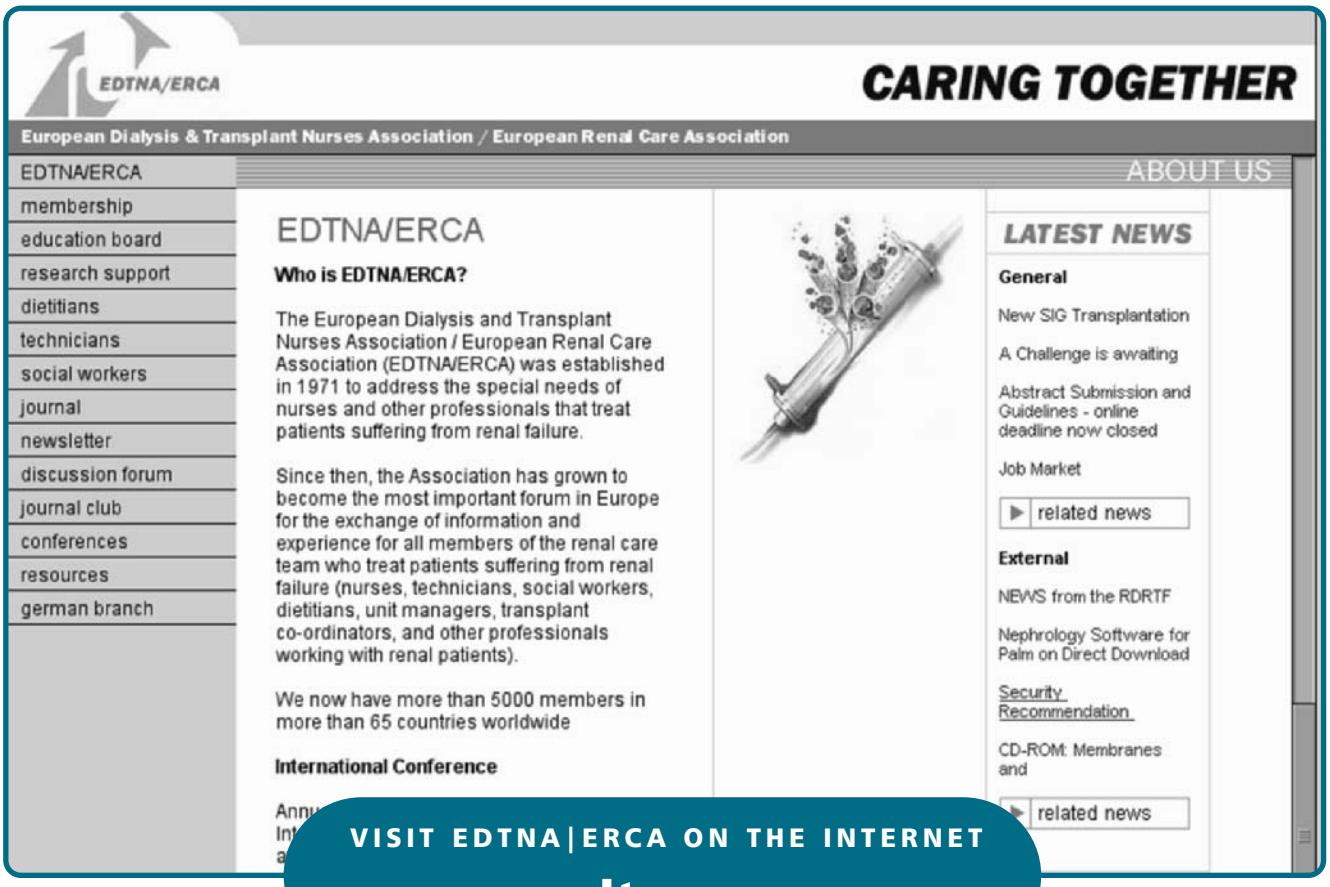

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A: Sodium profile — B: Ultrafiltration profile — C: No profile

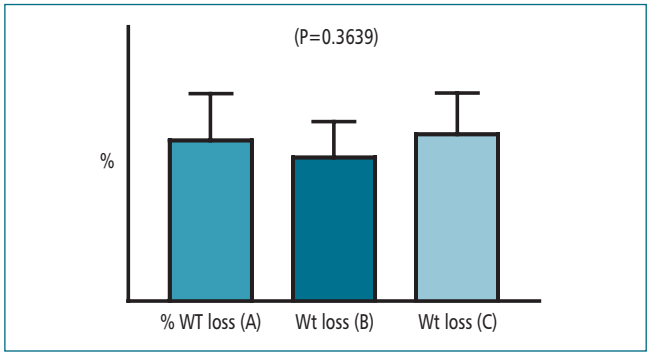

Figure 1: Comparison of Mean % Body Weight loss.

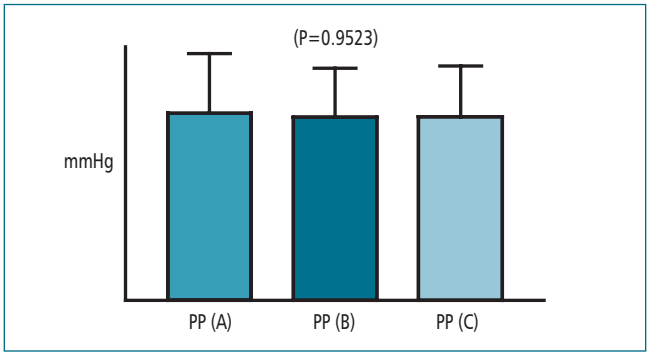

Figure 2: Comparison of Mean Pulse Pressure.

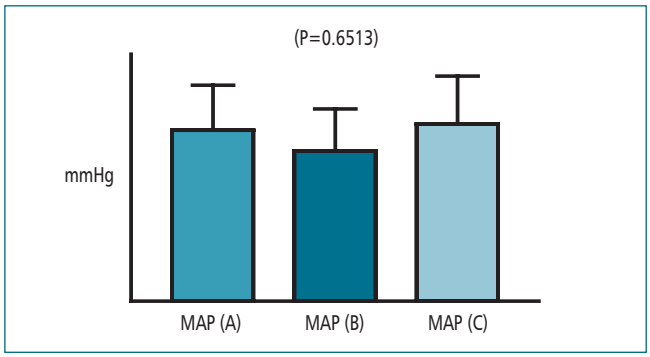

Figure 3: Comparison of Mean Arterial Pressure.

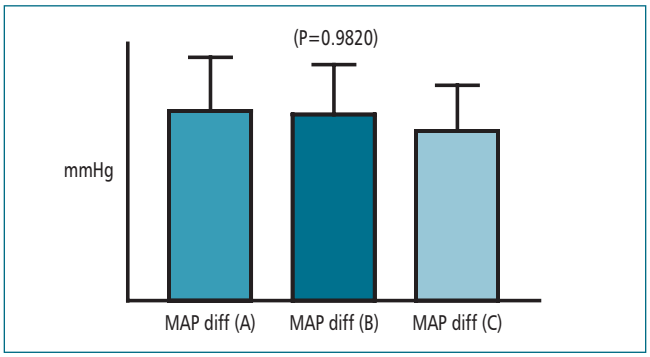

Figure 4: Comparison of Difference between Pre & Post MAP.

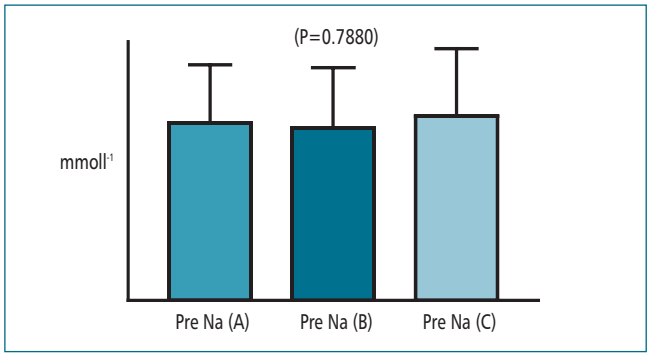

Figure 5: Comparison of Pre-dialysis sodium level.

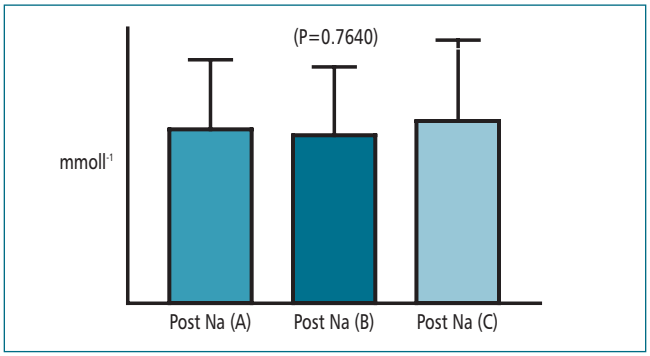

Figure 6: Comparison of Post dialysis sodium level.

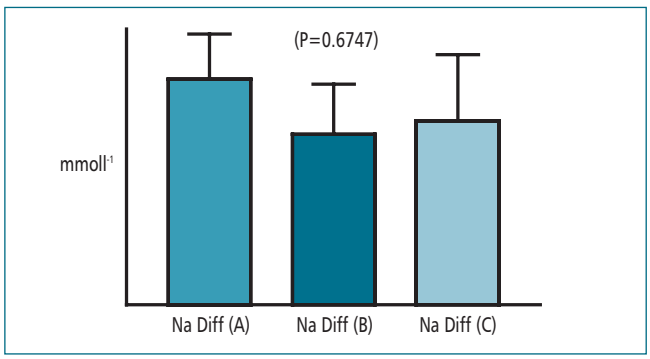

Figure 7: Comparison of Pre - Post serum sodium level.

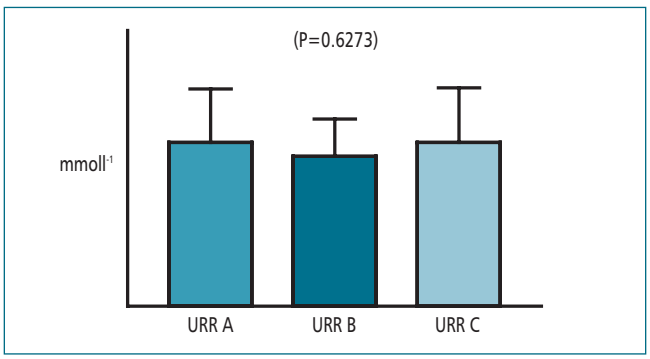

Figure 8: Comparison of Urea Reduction Ratio.

A: Sodium profile — B: Ultrafiltration profile — C: No profile

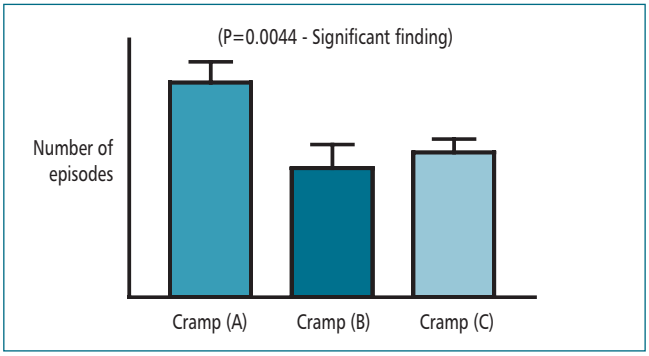

Figure 9: Comparison of the Episodes of Cramp During HD.

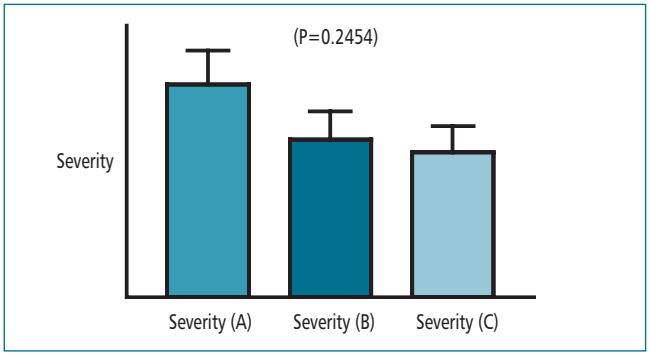

Figure 10: Severity of Cramp during HD.

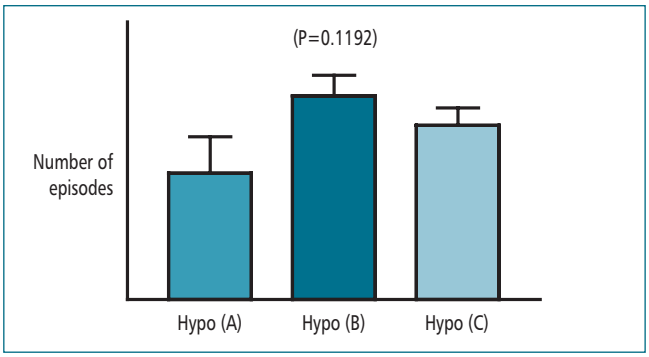

Figure 11: Comparison of the Episodes of Hypotension during HD.

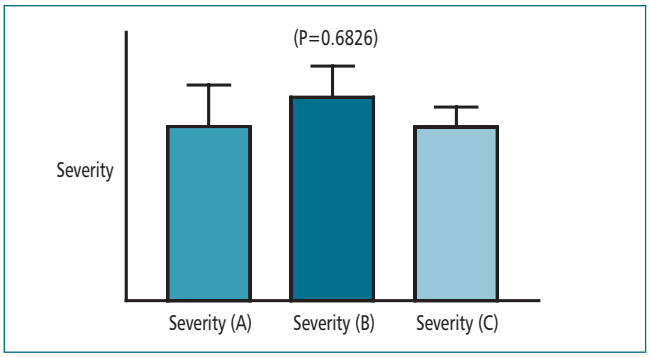

Figure 12: Comparison of the Severity of Hypotension during HD.

regard to sodium profiling was evident (Figure 14). Some participants in this study found that it increased side effects and disliked it, whilst others found it beneficial. Sodium profiling scored the highest for all the positive effects, as well as for all the negative effects.

This was reflected in the 'no change noticed' question (Figure 15). Sodium profiling had the lowest score, indicating that participants appeared to be noticeably affected by this profile, either positively or negatively. Sodium profiling had a much higher score than the other two treatments recorded for an improvement in 'feeling well' between sessions (Figure 15).

An interesting, and unexplained finding, is that some patients recorded an increase in 'well-being' between sessions, despite recording increased levels of cramp, and slower recovery rates following dialysis.

DISCUSSION

Hypotension, muscle cramps, headache and nausea are common patient problems during haemodialysis. Living with a chronic illness and maintaining compliance with dialysis therapy can be difficult even under optimal conditions. Painful cramps and hypotensive incidents are a strong disincentive to dialyse (16). They may set a chain of events in motion that can exacerbate the situation, with the patient lurching between overload and dehydration (17).

The results of this study indicate that profiling has no significant affect on the patients' interdialytic weight gain, blood pressure, thirst or serum sodium level. Profiling may help improve some patients comfort and tolerance of haemodialysis. However, sodium profiling may increase the incidence of cramp in some patients. It would appear satisfactory to continue our current practice of individualising treatments, using profiles, to improve patient comfort and tolerance.

The findings, a combination of quantitative and qualitative data, have proved useful. For some patients profiling can improve comfort and tolerance of haemodialysis without apparent detriment to blood pressure, serum sodium or weight gain; whilst for others, sodium profiling may increase the incidence of cramp. Nurses need to individualise haemodialysis treatments to maximise patient comfort.

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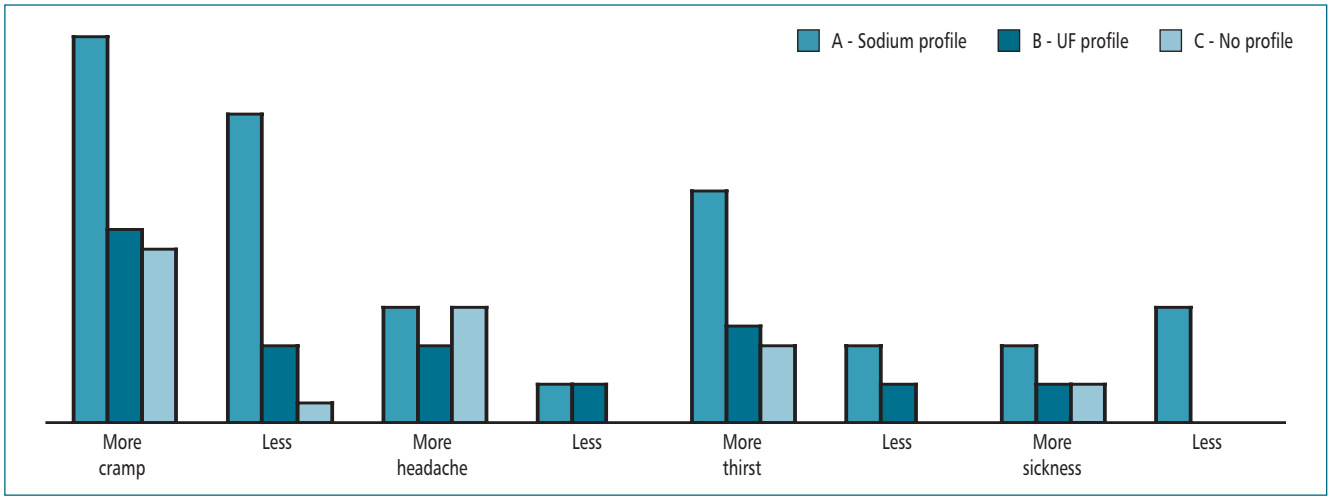

Figure 13: Self-reported problems during dialysis sessions.

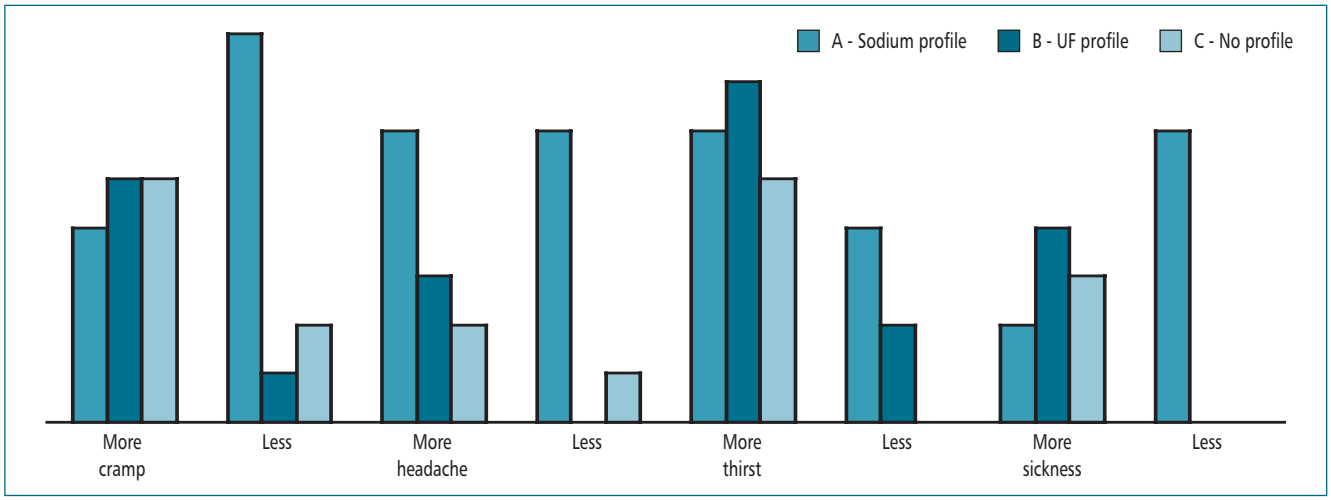

Figure 14: Self-reported problems between dialysis sessions.

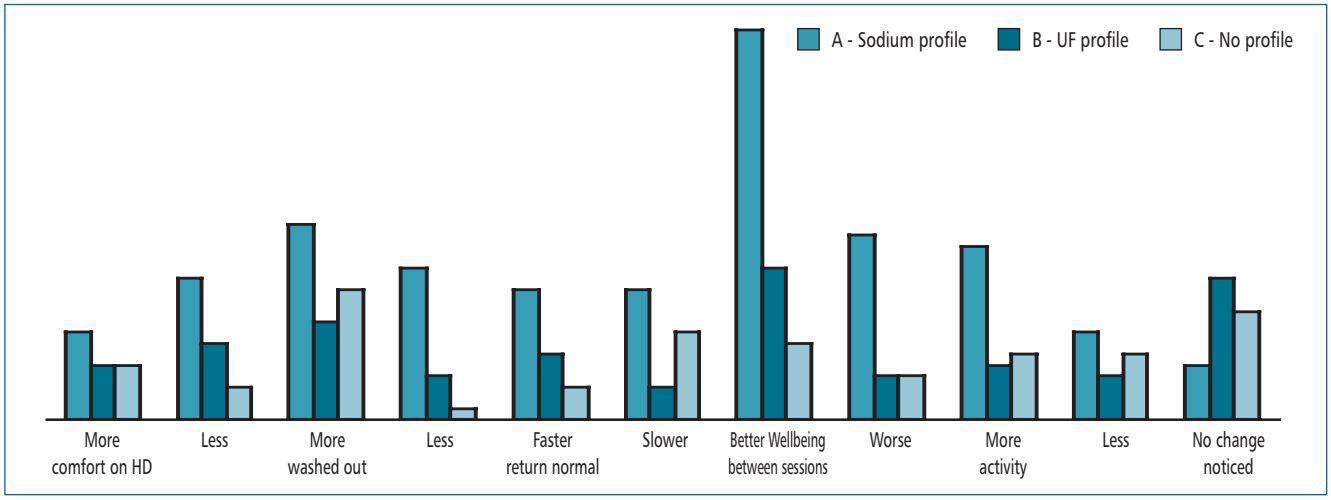

Figure 15: Self-reported feelings of well being.

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