Sodium profiling in elderly haemodialysis patients

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**Abstract** Intradialytic vascular instability continues to be one of the most frequent complications in elderly haemodialysis patients. Signs of impending hypotension such as sweating, apprehension, tachycardia, nausea, or vomiting may be infrequent in the geriatric population. The onset of hypotension in the elderly may be sudden and profound and may lead to serious consequences such as myocardial infarction, stroke, or aspiration if not treated promptly.

Prevention of vascular instability is extremely important in the elderly. Avoiding rapid ultrafiltration, sedatives, or antihypertensive medications and food intake may be beneficial. Optimal dialysate composition (dialysate sodium, bicarbonate, and calcium concentration) is important. Dialysate sodium profiling may be useful in the elderly to reduce intradialytic hypotension. Step sodium profiles result in better plasma volume refilling in early dialysis, while linear dialysate sodium profiles have greater plasma volume in late dialysis, suggesting that dialysate sodium profiles may need to be individualized for optimal response. Sodium profiling could also result in sodium retention, and long-term studies are needed in the elderly before their widespread use is recommended.

Use of newer modalities such as continuous monitoring of plasma volume with Crit Line, and determination and monitoring of body-fluid compartments with bioimpedance may further improve vascular stability in the elderly.

**Introduction**

Despite the various improvements in dialysis technology, intradialytic morbidity continues to be a major problem. Substitution of bicarbonate for acetate, use of high dialysate sodium, dialysate sodium and ultrafiltration profiling, and increasing use of biocompatible membranes and volumetric dialysis machines have resulted in improvement in dialytic vascular stability [1]. However, the increasing number of older and sicker patients on dialysis, and use of shorter and more efficient dialysis may have had a negative impact on intradialytic adverse effects.

The dialysis population is progressively growing older. In the United States the median age at the onset of end-stage renal disease had reached 61 years in 1990 and the fraction of patients older than 65 years will approach 60% by the year 2000. The primary treatment in 78% of the geriatric population with end-stage renal failure is centre haemodialysis [2].

**Vascular stability in geriatric dialysis patients**

Intradialytic vascular instability is one of the most frequent complications in elderly haemodialysis patients. Hypotension occurs in 20–40% of the dialysis treatments in the geriatric population and its frequency increases with age [3–5], although some studies report similar incidence in older and younger patients [6,7].

The signs and symptoms of impending hypotension (sweating, apprehension, yawning, tachycardia, nausea, vomiting), which are often present in younger dialysis patients, are usually infrequent in the geriatric population. The onset of hypotension in the elderly can be sudden and profound and may be associated with impaired sensorium, loss of consciousness, and/or seizures. If not treated promptly, hypotension could result in cardiac arrhythmias, hypoventilation, and cardiopulmonary arrest. In the geriatric patient, sequela of hypotension may include myocardial ischaemia or infarction, cerebral infarct, aspiration pneumonia, and vascular access clotting [4].

Hypotension in the elderly can occur with minimal extracellular fluid loss and may be more difficult to reverse than hypotension occurring in the younger dialysis patients.

The aetiology of dialysis-associated hypotension is multifactorial and complex but the major determinant seems to be plasma volume depletion due to removal of fluid from the intravascular space more rapidly than the plasma refilling rate [1]. Impaired normal responses to volume depletion may be more marked in the elderly patient. These include autonomic dysfunction and low cardiac reserve [8–10]. Autonomic dysfunction may be even more common in elderly diabetics. Postprandial hypotension is more common in the...
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We studied the plasma volume changes with sodium and ultrafiltration profiling in 10 patients on chronic haemodialysis (6 male, 4 female) with a mean age of 61 years [47–70]. Group A was linear decreasing dialysate Na (160–140 mEq/l) and linearly decreasing ultrafiltration. Group B was stepwise decreasing dialysate sodium profile (160–140 mEq/l) with mirror ultrafiltration, while group C was constant dialysate Na 150 mEq/l with constant ultrafiltration. Group D was constant dialysate Na (140 mEq/l) with constant ultrafiltration. All strategies were used in each patient during mid-week dialysis in a random fashion. Qd, Qo total UF, dialyser, Td, and Kt/V were kept constant. Changes in plasma volume were calculated every hour as:

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\text{Change in PV (\%)} = \frac{\text{Change in Hct}}{\text{Pre – Hct}} \times 100
\]

Hct, BUN, serum Na, and osmolality were determined before and hourly thereafter.

The serial changes in plasma volume are given in Figure 1 for various groups. It is shown that plasma volume changes are less marked for A, B and C versus D (P < 0.05). Group C (constant dialysate Na 150 mEq/l with constant UF) seems to be better than A and B for plasma volume changes. The serial changes in mean blood pressure are given in Figure 2. It is shown that blood pressure changes parallel the changes in plasma volume. It is interesting to note that step profile (group B) has less marked changes in plasma volume and blood pressure during early dialysis which linear profile (group A) has better preservation of plasma volume and blood pressure during late dialysis. Further studies are needed in elderly patients to evaluate the short and long-term effects of dialysate sodium profiles on plasma volume and blood pressure.

**Plasma volume changes with sodium profiling**

**Prevention of vascular instability in the elderly**

Because of these considerations it is mandatory that the elderly patients have careful attention paid to volume status and dry weight in order to avoid intradialytic vascular instability and/or volume overload. Avoiding rapid ultrafiltration (<1 l/h), medications before dialysis (sedatives, antihypertensives), and food intake may reduce intradialytic hypotension. Optimal correction of anaemia (Hct >30%) with the use of erythropoietin is important. Use of biocompatible dialysers may be helpful. Optimal dialysate composition (dialysate bicarbonate, calcium concentration) is important, especially in the elderly patient prone to intradialytic hypotension [2,8].

Increased dialysate sodium has been shown to reduce intradialytic complications, but increased intradialytic thirst, weight gain, and hypertension may be deleterious in the elderly, resulting in frequent heart failure.

**Dialysis sodium profiling in the elderly**

Sodium profiling has been reported to improve intradialytic vascular instability [13–15]. The effect of sodium profiles on intradialytic thirst, weight gain, and aggravation of hypertension are controversial. Some studies report no change in intradialytic weight gain or blood pressure with sodium profiling [13–15], while others report increased thirst, weight gain, and aggravation of hypertension, and suggest that sodium profiling shifts the problem from the intradialytic to the intradialytic period. More studies are needed in geriatric dialysis patients with various sodium profiles to resolve these issues.

**Fig. 1. Serial changes in plasma volume using linear decreasing dialysate sodium (160–140 mEq/l) with linear decreasing ultrafiltration (group A), step sodium profile (160–150–140 mEq/l) with step ultrafiltration (group B), constant dialysate sodium 150 mEq/l with constant ultrafiltration (group C), and constant dialysate sodium 140 mEq/l with constant ultrafiltration (group D).**

elderly, most probably because of autonomic impairment [11,12]. This may have implications to problems with intradialytic food intake in the elderly dialysis patient. It has been suggested that the intradialytic coffee intake may have a beneficial effect on vascular stability.

The limited cardiac reserve in the elderly may have a diverse aetiology, including left ventricular hypertrophy, dilated cardiomyopathy (systolic dysfunction with low ejection fraction), hypertrophic and/or ischaemic cardiomyopathy. Predialysis blood pressure may be lower in the elderly than younger patients [2]. The elderly may have impairment of the cardiopulmonary pressor/receptor reflex function, especially with coexisting diabetes, heart failure, and various drugs (clonidine, α adrenergic blockers, diltiazem). Slower refilling of plasma volume in the elderly than the younger patients has also been speculated as an aetiological factor. Elderly patients are less able to tolerate volume shifts in either positive or negative direction, are unable to maintain blood pressure at sudden volume loss, and are also vulnerable to heart failure or pulmonary oedema with volume excess.

Changes in Plasma Volume (%)

<table>
<thead>
<tr>
<th>Group</th>
<th>Changes in Plasma Volume (%)</th>
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**Changes in Plasma Volume (%)**

**Fig. 1.** Serial changes in plasma volume using linear decreasing dialysate sodium (160–140 mEq/l) with linear decreasing ultrafiltration (group A), step sodium profile (160–150–140 mEq/l) with step ultrafiltration (group B), constant dialysate sodium 150 mEq/l with constant ultrafiltration (group C), and constant dialysate sodium 140 mEq/l with constant ultrafiltration (group D).
Changes in Mean Blood Pressure (mmHg)

- Group A
- Group B
- Group C
- Group D

Fig. 2. Serial changes in mean atrial blood pressure using linear decreasing dialysate sodium (160–140 mEq/l) with linear decreasing ultrafiltration (group A), step sodium profile (160–150–140 mEq/l) with step ultrafiltration (group B), constant dialysate sodium 150 mEq/l with constant ultrafiltration (group C), and constant dialysate sodium 140 mEq/l with constant ultrafiltration (group D).

Sodium kinetics with dialysate sodium profiling

To evaluate the effect of sodium profiling on the kinetics of sodium between dialysate of constant 140 mEq/l sodium concentration to step profile of 160–140 mEq/l, we studied five elderly patients over 65 years old. Convective sodium transport, diffusive sodium, extracellular sodium and intracellular sodium shifts, and net sodium flux were calculated for step Na profile (A) and constant Na of 140 mEq/l (B) as reported earlier [16]. The data in Figure 3 show that net sodium removal is markedly reduced with the step profile, primarily due to high diffusive influx.

It would appear from these data that prolonged continuous use of step profile (160–140 mEq/l) might result in sodium retention. Long-term studies with sodium profiles are needed with sodium balance and their effects on intradialytic blood pressure and weight gain in the elderly before their widespread use can be recommended. Alternatively we might need lower profile values during dialysis to ensure adequate Na removal and control of blood pressure.

Conclusions

These data suggest that dialysate sodium profiles may need to be individualized. The step dialysis Na profile may be preferred in patients with lower blood pressure or early intradialytic hypotension, while linear profile may be better for those with late dialysis or post-dialytic hypotension. Combining dialysate sodium profiles with ultrafiltration profiling may be helpful in selected patients.

Use of newer modalities such as continuous monitoring of plasma volume with Crit-Line, determination and monitoring of body fluid compartments with bioimpedance, and measurement of Na kinetics may further improve the dialysis vascular stability. The use of these advancements will be especially rewarding in dialysis of elderly, unstable, and sicker patients.

References

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