Pre-emptively pausing ultrafiltration to minimise dialysis hypotension

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Abstract

Background Intradialytic hypotension (IDH) is a significant complication in haemodialysis (HD), occurring in between 15 and 55% of all treatments. IDH has been associated with increased mortality, increased morbidity, decreased quality of life and increased health care costs.

Aim To minimise IDH by pre-emptively pausing ultrafiltration (UF) during dialysis, in response to changes in mean arterial pressure (MAP).

Method Interventional pre- and post-test study. Data were collected over two eight week periods, each including 864 individual dialysis treatments. Intervention consisted of pausing UF (UF=0) for a minimum of 10 minutes. The intervention was performed immediately following: (1) MAP less than or equal to 70 mmHg: (2) decreased MAP of 30 mmHg or more (compared to pre-dialysis MAP).

Results UF was paused for 59 patients, including 35 (59.3%) with MAP less than or equal to 70 mmHg, five (8.5%) with decreased MAP of 30 mmHg or more, and 19 (32.2%) where both criteria were met. There were 20 IDH episodes recorded during the exploratory phase and eight during the intervention. The odds of IDH decreased by 61% (OR=0.39, CI=0.17 – .90) (χ^2_1 =5.23, p< .05).

Conclusion Pre-emptively pausing fluid removal according to specific MAP parameters may be a method to decrease intradialytic hypotensive episodes. This may be particularly useful for dialysis units without biofeedback or profiling machine technology.

Keywords
Hypotension, IDH, haemodialysis, nursing, mean arterial pressure MAP.

Introduction

Intradialytic hypotension (IDH) remains the most frequent haemodialysis (HD) complication, occurring in approximately 25% of dialysis sessions (Palmer & Henrich, 2008) and may be an independent predictor of cardiovascular mortality in this patient group (Shoji *et al.*, 2004; Tisler *et al.*, 2003). IDH is a decrease in systolic blood pressure (BP) by ≥20 mmHg or a decrease in mean arterial pressure (MAP) by 10 mmHg (National Kidney Foundation, 2005).

IDH occurs as the consequence of an inadequate cardiovascular compensatory response to reduced blood volume (during HD) with a resulting fall in vascular resistance. The combination of decreasing intravascular volume, cardiac output, vascular tone and peripheral resistance makes fluid removal a difficult clinical challenge for dialysis clinicians (Straver, 2006).

Current IDH preventative strategies include patient education emphasising dietary sodium restriction (Daugirdas, 2001; Davenport *et al.*, 2008; Sulowicz & Radziszewski, 2007), and encouragement in oral restrictions to minimise interdialytic fluid gains. In some dialysis units there is utilisation of volume assessment techniques including bioimpedance technology (Palmer & Henrich, 2008) and low dialysate temperature (Chesterton *et al.*, 2009; Maggiore, 2002; Ramos *et al.*, 2007; van der Sande *et al.*, 2001). Sodium profiling (Coli *et al.*, 2003; Moret *et al.*, 2006), and ultrafiltration (UF) profiling (Sulowicz & Radziszewski, 2007) are often used independently or in combination.

Intradialytic hypotension can lead to nausea, vomiting and anxiety while on dialysis (Basile, 2006), is associated with increased mortality (Shoji *et al.*, 2004; Tisler *et al.*, 2003), increased cardiac events (Imai *et al.*, 2006), increased aortic stiffness (Duman *et al.*, 2008), increased frontal lobe atrophy (Mizumasa *et al.*, 2004) and decreased quality of life (Okada *et al.*, 2005). It has flow-on effects in increased morbidity (hospital admissions) leading to increased health care costs.

The first line of treatment for symptomatic IDH is pausing ultrafiltration (UF) (Davenport, 2009), placing the patient into a reclined

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position, with possible administration of IV solutions such as normal saline (Knoll *et al.* 2004). Other pharmaceutical treatments for IDH, whilst available, are less commonly practised and are outside the scope of this paper.

The effectiveness of pre-emptively pausing UF to reduce the incidence of IDH has not been clearly reported. Despite the National Kidney Foundation using MAP as part of its IDH definition, we found no studies making reference to the use of intradialytic MAP measurements in regard to patient assessment. MAP represents the constantly regulated pressure necessary to maintain end-organ tissue perfusion for adequate cellular oxygenation and is mainly used for patients requiring close haemodynamic monitoring, but not frequently in HD units (Bradshaw, 2010). We report the following study exploring the effect of pre-emptively pausing UF based on the MAP of patients receiving dialysis.

Method

Prior to the study we undertook an eight-week exploratory phase measuring MAP during HD and found that patients have individual MAP values that appear to stay fairly consistent during times of wellness. We also found that decreasing MAP can precede symptomatic hypotension, with 20 IDH episodes recorded during the exploratory phase. We found that an MAP of 70 mmHg or less, or an MAP decrease of more than 30 mmHg (or greater than 30%) from the pre-dialysis MAP value, was associated with IDH. Therefore, our hypothesis was: the incidence of IDH would decrease if UF was paused in response to a change in patient MAP that met the previous one or two criteria.

Sample

This project was conducted at a metropolitan satellite unit in Victoria, Australia. At the time of the study the unit had 36 patients on its list. These patients ranged from 37 to 82 years of age (M=63.67, SD=10.17) and the majority (63.9%) were men. On average, patients had been receiving treatment for 4.67 years (range: 1 to 13 years) and they received thrice-weekly dialysis, averaging 12 hours (range: 9 to 15 hours) of treatment per week.

Ethics

This project was reviewed and approved in June 2010 as a Quality Assurance Project by the Human Research Ethics Committee of the health care organisation.

Procedure

Data were collected over an eight week period between March and May 2010. The findings of the exploratory phase (collected March to May 2009) were presented to nursing staff in the unit and served as an introduction to the project. As per usual practice, sitting and standing BPs were taken pre- and post-dialysis, as well as at hourly intervals during the treatment. For the duration of the project, nursing staff were additionally requested to calculate MAP based on intradialytic BP data and on sitting BP only for pre- and post-BPs. Calculation used was (systolic BP x 0.33) + (diastolic BP x 0.66) (Abdelfatah *et al.,* 2001)

In the intervention period, staff were instructed to pause UF (that is, temporarily stop the machine from removing fluid) for 10 minutes, using a timer, if a patient had an MAP less than or equal to 70 mmHg, or had an MAP that was lower than their pre-dialysis MAP by a value of 30 mmHg or more. After 10 minutes, the BP was rechecked and MAP calculated. If the MAP had improved to a level that was considered adequate by staff, in consultation with the nurse in charge of that shift, UF was resumed. An improved MAP was defined as one that had a greater value than 70 mmHg, or was closer to the pre-dialysis MAP value (irrespective of BP). A patient identification sticker, noting the date and time of the intervention, was placed on the intervention page of the study log.

If any patient had a sudden, unexpected episode of hypotension that required any intervention additional to UF pause (for example, reclining, receiving oxygen, requiring IV N/Saline), or complained of feeling unwell (which would automatically necessitate a UF pause), a patient identification label noting the date and time was placed on the hypotensive episode study log.

After the eight-week period, all worksheets from both the intervention and hypotensive episode pages of the study log were checked by the project coordinator to ensure they adhered to the protocol. All patients and IDH episodes were allocated a consecutive number to preserve their anonymity for the project and their specific BP and MAP details were entered into an Excel spreadsheet.

Data analysis

Simple frequency and descriptive analyses were conducted using SPSS. Chi-square analysis was conducted to compare the incidence of IDH recorded during the exploratory phase with those occurring during the intervention phase, including an odds ratio and confidence interval.

Results

Over the eight-week period, a total of 864 dialysis treatments were included. Based on a change in a patient's MAP, staff intervened in a total of 59 cases

(6.8%), as outlined in Figure 1. All of the interventions were performed on asymptomatic patients.

Prior to dialysis, the mean MAP for the 59 cases requiring intervention was 93.59 (SD=12.76). The mean MAP prior to the intervention (that is, that prompted UF pause) was 66.12 (SD=4.22). This was a mean reduction in MAP of 27.47 points (SD=12.00), or 26.1%.

In 16 cases (24.6%), the MAP recovered to >70 mmHg within 10 minutes and in a further 18 cases (27.7%) the MAP recovered to >70 mmHg within 30 minutes; the remaining cases all recovered by the end of the treatment. The mean MAP following recovery was 77.59 (SD=9.25) and by the time the patients completed dialysis the mean MAP had increased to 84.15 (SD=11.24).

There were a total of eight IDH episodes recorded during the intervention period. In three cases, UF was paused as per the intervention protocol, but nevertheless progressed to become symptomatic. One patient accounted for two of these episodes with slight fluctuations in the MAP throughout the runs prior to the intervention, but the patient experienced nausea and required oxygen and further UF pauses before completing the treatments. In the third case the patient reported feeling hot as BP was taken and, though MAP was 73, UF was paused but the patient later required normal saline before recovering. For the remaining five cases, UF was not paused. In three cases, the patients' MAP did not meet the criteria for intervention. For the remaining two cases, the patients' MAP decreased by more than 30 mmHg, which should have triggered intervention in accordance with the project protocol, but this did not occur.

Impact of the intervention on IDH

There were 20 IDH episodes recorded during the exploratory phase and eight during the intervention (Figure 2). Based on these data, the odds of IDH decreased by 61% (OR=0.39, CI=0.17 – .90) which was both statistically significant ($\chi^2_1 = 5.23$, $p< .05$) and clinically important.

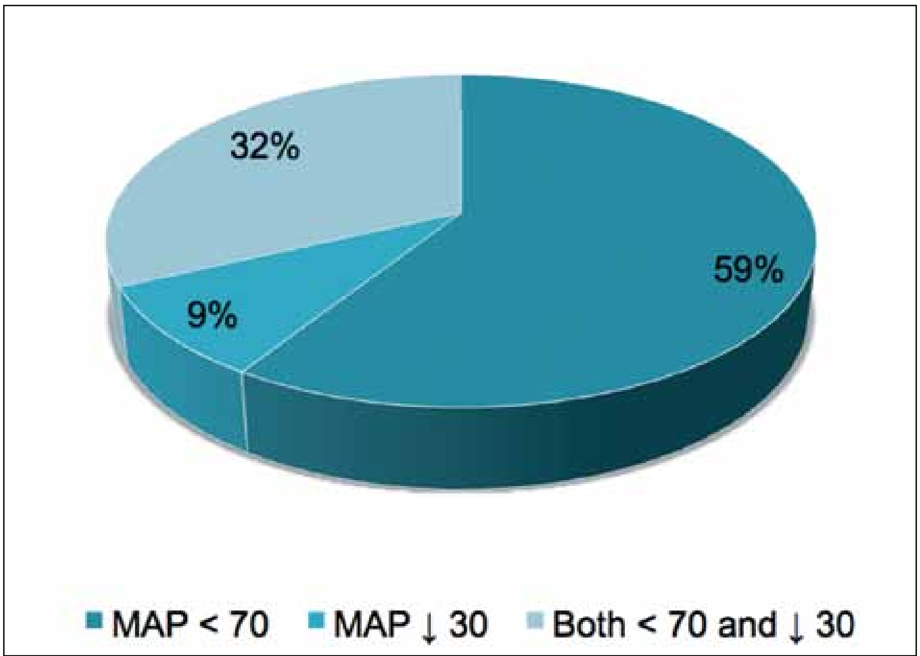

Figure 1. Percentage of interventions based on criteria (n=59).

Discussion

Proactively pausing intradialytic UF has not been reported to any great extent in the clinical dialysis literature. Our study provides one method of pre-emptively pausing the UF rate, with the aim of preventing IDH, in accordance with the identified MAP measurement criteria. We have shown in this study, using a pre- and post-intervention design, an association between pausing UF and a reduction in IDH.

Many methods of decreasing IDH have been demonstrated. Dialysis machine technology facilitates sodium profiling (Moret *et al.*, 2006), UF profiling (Sulowicz & Radziszewski, 2007) and bioimpedance measurement (Palmer & Henrich, 2008) to assist fluid removal and reduce IDH. These measures have shown improvements in IDH; however, they require varying amounts of expensive technology. Proactively pausing UF does not require extra technology apart from the dialysis machine itself and thus may be a simple method of reducing IDH.

Decreasing the required UF rate is associated with lower rates of IDH. This can be achieved by reducing intradialytic fluid gains by adhering to sodium and fluid regimen (Davenport *et al.*, 2008; Sulowicz & Radziszewski, 2007). Although adherence can improve IDH prevalence it is problematic and challenging for many people requiring dialysis. Other measures such as longer treatment times and more frequent dialysis are also methods to reduce the UF rate and decrease IDH prevalence (Saran *et al.*, 2006) but may meet with patient resistance (Chazot & Jean, 2009). Thus, individualised strategies or combination of strategies may be used to facilitate decreased IDH.

The translation into practice of this finding may be challenging and require a measured approach to practice implementation. Terms used to describe this process of research implementation have included research utilisation, knowledge utilisation, research transfer, knowledge transfer, implementation science and knowledge translation (Kent *et al.*, 2009). Whatever the process used, encouraging nurses to change practice and proactively pause UF may require additional education, motivation and the strategic use of change management principles. Given that nurses have demonstrated resistance to change (Sitzia, 2002) providing the evidence is not the only component to achieve practice change and improvement.

Patients may exhibit some resistance to proactively pausing UF in response to a decreased MAP. People on dialysis often are advised to adhere to a strict medical regimen that includes a 500 mL to 2 L fluid restriction (Denhaerynck *et al.*, 2007). If UF is paused and less fluid is removed during dialysis, a patient may feel that they will have less capacity to drink interdialytically. This may also, in turn, contribute to nurses negotiating and collaborating with patients over the fluid loss goal which may influence the adherence to a proactive UF pause regimen. Thus, these practice issues would need to be addressed prior to the implementation of this regimen.

The understanding of MAP by both nurses and patients may be a further barrier to the implementation of this regimen. A decreasing MAP may appear unremarkable, especially if the value is close to 70 mmHg. The MAP formula used in this study emphasises the diastolic value, which is often overlooked in simple BP assessment. For example, the difference between a BP of 110/75 and 110/45 could be clinically significant in a 70 kg person requiring the UF of four litres in a haemodialysis session. By assessing MAP as well as BP, consideration is given to the importance of MAP as the end organ/tissue perfusion pressure, or the physiological product of cardiac output and peripheral resistance. Further education may be required to increase nurses' and patients' understanding of the relevance of intradialytic MAP.

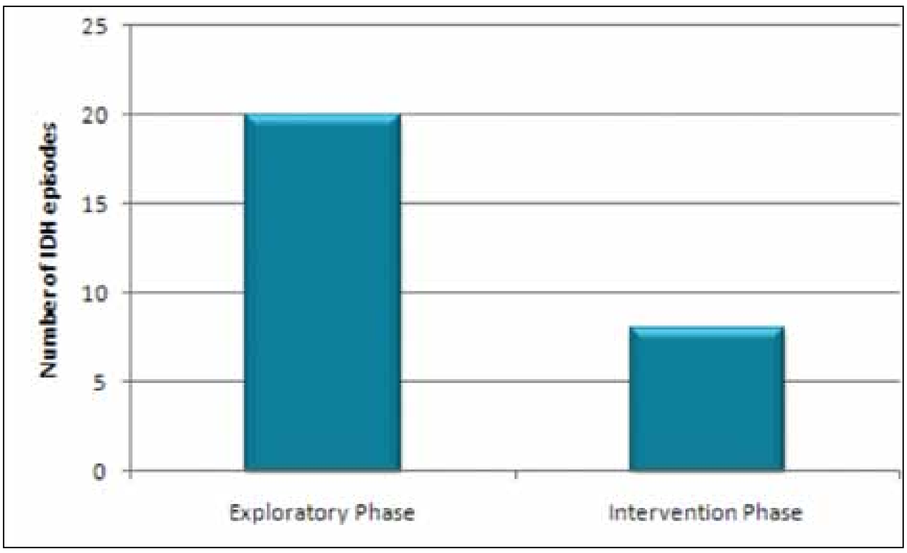

Figure 2. Number of IDH episodes recorded during each phase.

As a result of this study an intervention tool has been developed for use within our satellite HD unit. The tool consists of an algorithm in flow chart form to give direction to pre-emptive UF pausing in the event of a low MAP in asymptomatic patients. Further evaluation of this tool will provide more evidence of the clinical effectiveness to reduce IDH in our dialysis unit.

Limitations of study

The generalisability of our findings should be used with caution given the small numbers used in the study. A further limitation was that two of the hypotensive episodes may have been prevented had staff intervened according to protocol. This error may have been associated with ambiguity in the wording of the protocol. Furthermore, the design of the pre- and post-test is not as rigorous as a randomised controlled trial.

Conclusion/clinical implications/potential for future research

Pre-emptive, proactive pausing of UF, according to specific MAP parameters may be a way of decreasing IDH. This method may be particularly useful for dialysis units without biofeedback or profiling machine technology. Future research exploring nurses' perceptions related to BP assessment and IDH prevention and treatment would further enhance this line of inquiry. In addition, a larger powered study measuring the effect of proactively pausing fluid removal is needed to confirm these pilot study results.

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