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MINIREVIEWS

Cold dialysis and its impact on renal patients' health: An evidence-based mini review

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Abstract

Chronic renal disease is associated with advanced age, diabetes, hypertension, obesity, musculoskeletal problems and cardiovascular disease, the latter being the main cause of mortality in patients receiving haemodialysis (HD). Cooled dialysate (35 ℃-36 ℃) is recently employed to reduce the incidence of intradialytic hypotension in patients on chronic HD. The studies to date that have evaluated cooled dialysate are limited, however, data suggest that cooled dialysate improves hemodynamic tolerability of dialysis, minimizes hypotension and exerts a protective effect over major organs including the heart and brain. The current evidence-based review is dealing with the protective effect of cold dialysis and the benefits of it in aspects affecting patients' quality of care and life. There is evidence to suggest that cold dialysis can reduce cardiovascular mortality. However, large multicentre randomized clinical trials are urgently needed to provide further supporting evidence in order to incorporate cold dialysis in routine clinical practice.

Key words: Mortality; Cardiovascular diseases; Fatigue; Hypotension; Shivering; Renal failure

Core tip: Cooled dialysate (35 ℃-36 ℃) is recently employed to reduce the incidence of intradialytic hypotension in patients on chronic haemodialysis. The studies to date that have evaluated cooled dialysate are limited, however, data suggest that cooled dialysate improves hemodynamic tolerability of dialysis and exerts a protective effect over major organs. There is evidence to suggest that cold dialysis can reduce cardiovascular mortality and improve patients' levels of post-dialysis fatigue further improving general health and quality of life.

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INTRODUCTION

Chronic renal disease is nowadays recognised as a worldwide public health problem[1] while cardiovascular diseases are the main cause of mortality in end-stage renal patients receiving haemodialysis (HD) therapy[2]. HD *per se* is associated with cardiovascular and haemodynamic stress that could lead to recurrent and cumulative ischemic events to vital organs such as the brain and the myocardium. This stress is associated with perfusion abnormalities leading to myocardial hypoperfusion and myocardial stunning during HD sessions[3].

One of the most common HD complications, affecting 20%-30% of chronic HD patients, is intradialytic hypotension (IDH) which significantly impacts patients' quality of life and overall health[4]. Moreover, hypotensive episodes, together with the commonly experienced post-dialysis fatigue as well as myopathy and arrhythmias, contribute to an increased risk for falls and long lasting disabilities[5]. It seems that one of the most effective, inexpensive and low risk interventions to improve haemodynamic stability during HD therapy is to lower the dialysate temperature by one or two degrees Celsius[6,7]. This is called "cold" dialysis and it is gradually becoming a popular way of managing HD side effects to prevent IDH and post dialysis fatigue.

WHAT IS COLD DIALYSIS?

The dialysate temperature is traditionally set to 37 ℃ as a means of keeping stable the HD patient's body core temperature and maintain isothermia (between 36.5 ℃-36.9 ℃). In reality however, the "warm dialysis" does not maintain isothermia but induce a mild hyperthermic effect which on average, rise the core temperature by approximately 0.5°-0.7° Celsius[8], which contributes further to high incidence of hypotensive episodes (as eloquently discussed in Pizzarelli[7] 2007). In "cold" dialysis the temperature of the dialysate is set at least one degree below the standard dialysate temperature, with the majority of the cold dialysis studies using dialysate temperatures between 35 ℃-36 ℃[9,10]. A better approach would be to personalise the dialysate temperature for each patient (for example by using the changes in body core temperature or 0.5 ℃ below resting body core temperature). An attempt to offer personalised isothermic HD throughout the session may be an even better approach; however this is quite difficult to achieve (for example due to eating habits of patients or other internal or external variations)[7]. In the clinical setting, most of the times, the temperature is set one degree below the standard clinical practice and guided by the patients comfort levels[10].

The use of cold dialysis started in 1980s as an attempt to control the burden of IDH[11,12]. Since then, the extracorporeal cooling of blood on dialysis has been employed as a countermeasure to reduce episodes of IDH, however many other benefits have been observed on patients' overall health and quality of life levels[13].

BENEFITS OF COLD DIALYSIS

The benefits of the cold dialysis in patients' health are based on the fact that lowering the body core temperature will improve systemic vascular resistance and therefore improve haemodynamic stability[14]. Other reasons speculated for the observed benefits are the avoidance of heat accumulation and hence counterproductive thermoregulatory vasodilation, and the catecholamine surge (especially during shivering) which in turn stimulate peripheral vasoconstriction and cardiac inotropy[12,13]. In particular, even with modest heat storage, profound haemodynamic changes take place, including a reduction in peripheral vascular resistances, elevated heart rate, cardiac output and increased muscle sympathetic nerve activity, resulting in increased blood flow to the skin and leaving the body defenceless to hypotension[15], a phenomenon that does not take place during cold stress. It should be noted, that at least in healthy subjects, the response to heat accumulation will occur even in the face of a "hypovolaemic stress"[16], a further consideration in HD patients.

Intradialytic hypotension

IDH is an independent risk factor for cardiovascular mortality in HD patients[17] and significantly affects patients post dialysis energy levels and overall quality of life[18]. Many therapeutic interventions have been applied in order to reduce IDH, however, a single approach that would successfully prevent or solve this issue doesn't yet appear to exist. Cold dialysis is a very promising approach for the prevention of IDH with many studies reporting improvements in haemodynamic stability including reduction in heart rate, cardiac output and stroke volume leading to high arterial blood pressure maintaining thus a greater total peripheral resistance[6,15]. A study has shown that IDH occurred 7.1 times less frequently with cold dialysis while the post-dialysis mean arterial pressure was higher with cool-temperature dialysis by 11.3 mmHg[14]. In addition, cold dialysis resulted in significantly fewer nursing trips to patient's bed and even fewer interventions for the treatment of IDH, positively influencing the functionality of the HD unit[19] and the

Table 1 Pros and cons implementing "cold dialysis"

Measurable and perceived benefits	Measurable and perceived side effects
Reduce intradialytic hypotension incidences	Possible patient discomfort (shivering)
Induce hemodynamic stability	
Reduce ischemic brain injuries and preserving brain's white matter	
Improve cardiac functionality and morphology indices	
Control arterial blood pressure during and after haemodialysis	
Reduce post-dialysis fatigue	
Increase energy levels	
Dialysis efficiency is not changed	
Improve overall perception of general health	
Reduce the number of nursing interventions during HD	
Can be delivered without additional cost and is universally applicable	

HD: Haemodialysis.

level of overall care.

Cardiovascular and cerebrovascular risk

HD patients are at high risk of cardiovascular mortality which has been reported as 15%-20%[20] and 38%[2] of all cause deaths. The causes of the high cardiovascular mortality are multifactorial including traditional (diabetes, hypertension) and non-traditional (uremic-related), however, the HD *per se* is a very strong contributor into the overall mortality affecting myocardial functionality (*e.g.*, myocardial stunning and hibernation) and morphology[21]. Benefits of the long term cold dialysis (1 year) have been reported in the recent literature in both brain and heart tissues. In the brain, cold dialysis seems to induce a protective effect from injurious perfusion of the cerebral vascular beds, thus minimizing HD induced brain injuries[9]. In the heart, after a long term induction of cold dialysis (0.5 ℃ below body core temperature) positive changes in resting ejection fraction were observed accompanied with significant reductions in both left ventricular mass and left ventricular end-diastolic volumes while the aortic distensibility was preserved, thus minimizing the risk for future cardiovascular events[22].

Dialysis efficiency

Due to the vasoconstriction effect induced by the cold dialysis, it was postulated that dialysis efficiency indices would be reduced as a result of the increased compartmentalization of urea and the post-dialysis increased rebound effect[23]. Many studies including two systematic reviews concluded that cold dialysis do not change blood volume, urea rebound or effective Kt/V index leaving dialysis efficiency unchanged[6,14] while one study showed significant improvements in urea removal and Kt/V[24].

Patients perception

In general, HD patients tolerate long term cold dialysis very well, reporting high levels of satisfaction (76%-80%), less fatigue, faster recovery times after dialysis, feeling more energetic, with better cognitive capacity and having the overall sensation that their general health has dramatically improved (Table 1)[14,24,25]. Most authors reported that at the end of the trial period, a large number of patients requested to always be dialysed with a cooler dialysate[13]. It seems that cold dialysis has also a positive impact in dialysis units' functionality since many studies have reported a reduced number of nursing interventions during HD and less in-patient admissions for treating post-dialysis hypotensive symptoms[13]. The most commonly reported cold dialysis side effects are related to cold sensation with 20% of the patients reporting to be feeling cold[13] while some studies have also reported incidences of shivering[25]. No other serious disadvantages of cold dialysis have been reported in the recent literature, however, the lack of long term interventions and properly designed randomized clinical trials justifies the modest implementation of cold dialysis in the majority of the dialysis units worldwide.

CONCLUSIONS AND RECOMMENDATIONS

Lowering the dialysate temperature in HD patients' routine therapies can reduce the rate of intradialytic hypotension by increasing peripheral resistance leading to increased intradialytic mean arterial pressure without jeopardising dialysis adequacy. There is evidence to suggest that cold dialysis can reduce cardiovascular mortality and improve patients' levels of post-dialysis fatigue further improving general health and quality of life. Large, multicentre, randomized clinical trials are urgently needed to provide further supporting evidence on aspects related to mortality and major adverse cardiovascular events.

KEY POINTS

Cold dialysis is achieved by lowering the dialysate temperature to 35 ℃-36 ℃ or 0.5 ℃ below resting body core temperature. Cold dialysis can be implemented with no additional cost and is universally applicable. Cold dialysis reduces incidence of intradialytic hypotension and improve patients' "energy" levels. Cold dialysis could induce some general discomfort to the patients.

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