

INTRADIALYTIC COMPLICATIONS IN PATIENTS OF END-STAGE RENAL DISEASE ON MAINTENANCE HEMODIALYSIS

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Received: 22 Jun 2024, Revised and Accepted: 08 Aug 2024

ABSTRACT

Objective: End-stage renal disease (ESRD) patients on maintenance hemodialysis are at high risk for intradialytic complications, which can significantly impact morbidity and mortality. Understanding the prevalence and predictors of these complications is essential for improving patient care and outcomes.

Methods: This observational study included 104 ESRD patients undergoing maintenance hemodialysis at a tertiary care center. Data were collected on demographics, comorbidities, dialysis parameters, and vascular access type. Statistical analyses were conducted using SPSS to evaluate associations between patient characteristics and the occurrence of intradialytic complications.

Results: Our study analyzed 104 hemodialysis patients, revealing a high incidence of hypotensive episodes (59.0%) and associated symptoms like tiredness and muscle cramps. Vascular access was predominantly through arteriovenous fistulae (87.0%). Compliance with Kidney Disease Outcomes Quality Initiative (KDOQI) and European Best Practice Guidelines (EBPG) was low, at 11.1% and 6.8%, respectively, underscoring the need for improved management strategies to mitigate intradialytic complications.

Conclusion: Intradialytic complications are prevalent among ESRD patients on maintenance hemodialysis, with cardiovascular comorbidities contributing significantly to their risk. Effective management requires careful fluid and medication management to mitigate these risks and improve patient outcomes.

Keywords: End-stage renal disease, Hemodialysis, Intradialytic complications, Hypertension, Fluid management, Vascular access

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INTRODUCTION

End-stage renal disease (ESRD) represents the final phase of chronic kidney disease (CKD), where renal function deteriorates to less than 15% of normal capacity. Hemodialysis remains a cornerstone in the management of ESRD, providing vital excretory function by mechanically filtering blood through a dialyzer [1]. However, the procedure is not devoid of risks and is associated with various intradialytic complications that can significantly impact patient outcomes and quality of life. These complications range from common issues such as intradialytic hypotension to less frequent but severe occurrences such as arrhythmias and vascular access complications [2].

Intradialytic hypotension (IDH), defined by a significant drop in blood pressure during dialysis, is the most common complication, occurring in an estimated 20-30% of all dialysis sessions [3]. This condition not only compromises dialysis efficacy by limiting fluid removal but also predisposes patients to a myriad of acute and chronic sequelae, including myocardial ischemia, cerebrovascular accidents, and intestinal ischemia. Moreover, repeated episodes of IDH can lead to incremental cardiac damage, manifesting as congestive heart failure, which further complicates the management of ESRD [4].

Beyond cardiovascular complications, the mechanical and repetitive nature of hemodialysis can lead to vascular access issues, another significant challenge in the maintenance of hemodialysis. Vascular access complications, including thrombosis, infection, and stenosis, remain a leading cause of hospitalization among hemodialysis patients, thereby underscoring the critical need for vigilant access care and monitoring [5].

Additionally, the dialysis session itself poses a risk for other acute complications like muscle cramps, arrhythmias, and air embolism, each of which requires immediate attention to prevent long-term

adverse effects. The prevalence of these complications not only reflects the delicate balance required in the adjustment of dialysis parameters but also highlights the interplay of patient-specific factors such as underlying cardiovascular disease, age, and concurrent medications [6].

Given the significant morbidity associated with intradialytic complications, understanding their predictors and implementing strategies to mitigate their impact is crucial. This article aims to explore the spectrum of intradialytic complications encountered by patients with ESRD undergoing maintenance hemodialysis. By analyzing data from a cohort of 104 patients, this study assesses the prevalence, predictors, and outcomes of various intradialytic complications, providing insights into effective strategies for prevention and management. Through this exploration, the study contributes to the broader goal of enhancing patient safety and improving therapeutic outcomes in a population that continues to grow as the global prevalence of chronic kidney disease increases.

MATERIALS AND METHODS

Study design and participants

This observational study was conducted at a tertiary care center and included a cohort of 104 patients with end-stage renal disease (ESRD) undergoing maintenance hemodialysis. Participants were recruited from January 2021 to December 2021. Inclusion criteria were adults aged 18 years and older diagnosed with ESRD and on regular hemodialysis for at least 3 mo prior to the study start. Exclusion criteria included patients with acute renal failure, those undergoing peritoneal dialysis, and patients with life expectancy less than 6 mo due to non-renal causes.

Data collection

Baseline demographic and clinical data were collected at enrollment, including age, gender, and comorbid conditions such as

hypertension, diabetes, heart failure, and HIV infection. Information regarding vascular access type and antihypertensive drug usage was also documented. Dialysis parameters, including dry weight, weights before and after dialysis, interdialytic interval, interdialytic weight gain (IDWG), ultrafiltration rate, and total ultrafiltration volume, were recorded from the dialysis session data.

Dialysis procedure

Patients underwent 3 to 4 h of hemodialysis sessions, two to three times per week, using standard bicarbonate dialysis solutions with a polysulfone membrane. The dialysate temperature was maintained at 36.5 °C. The dry weight was set by the attending nephrologist based on clinical assessment and patient symptoms.

Statistical analysis

Continuous variables were expressed as mean±standard deviation (SD) or median and interquartile range (IQR) depending on the distribution of the data. Categorical variables were summarized as counts and percentages. The normality of the distribution was tested using the Shapiro-Wilk test. Comparisons between two groups for continuous variables were performed using the Student's t-test or Mann-Whitney U test, as appropriate. Categorical data were analyzed using the Chi-square test or Fisher's exact test when the expected frequency was less than 5. A p-value of less than 0.05 was considered statistically significant. All statistical analyses were performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA).

RESULTS

The baseline characteristics of our study population comprised 104 patients undergoing maintenance hemodialysis, of which 70 (67.3%)

were male and 34 (32.7%) were female. The mean age was 51.2 years with a standard deviation of 14.8. A high prevalence of comorbid conditions was noted, with hypertension being the most common at 94.2%, followed by diabetes at 29.8%, heart failure at 11.5%, and HIV infection at 6.7%. Among the hypertensive patients, the median duration of hypertension was 6.5 years, with 82.7% using antihypertensive drugs, predominantly calcium channel blockers (70.4%) and ACE inhibitors or ARBs (50.0%).

Vascular access was primarily via arteriovenous fistulae in 87.0% of cases, with central venous catheters used in 13.0%. The regimen of dialysis predominantly involved two sessions per week (94.2%) with a median duration of 31 mo on dialysis. The interdialytic interval typically spanned two days, and the ultrafiltration rate averaged 810 ml/h, with an ultrafiltration volume of 3200 ml per session.

During dialysis, significant hypotensive episodes, defined as a systolic blood pressure decrease by ≥ 20 mmHg or mean arterial pressure by ≥ 10 mmHg, occurred in 59.0% of sessions. Other clinical symptoms included tiredness (5.8%), muscle cramps (4.9%), lightheadedness (3.9%), headache (2.4%), nausea (1.0%), and vomiting (0.9%). Therapeutic interventions to manage these complications included the Trendelenburg position (5.3%), isotonic saline administration (3.4%), and adjustments in the dialysis protocol, such as increasing dialysate sodium or reducing/stopping ultrafiltration.

Adherence to dialysis guidelines showed that 11.1% of sessions met the Kidney Disease Outcomes Quality Initiative (KDOQI) standards, and 6.8% adhered fully to the European Best Practice Guidelines (EBPG) for Hemodynamic Instability.

Table 1: Baseline characteristics of the population

Characteristics	n (%)
Gender	
Female	34 (32.7)
Male	70 (67.3)
Age (years)	mean±SD
Comorbidities	
Hypertension	98 (94.2)
Diabetes	31 (29.8)
Heart failure	12 (11.5)
HIV infection	7 (6.7)
Hypertension (n=98)	
Duration (years), median (IQR)	6.5 (3–14)
Use of antihypertensive drugs	81 (82.7)
Class of antihypertensive drugs	
Calcium channel blockers	69 (70.4)
ACEI/ARB	49 (50.0)
Central-acting agents	17 (17.3)
Beta-blockers	16 (16.3)
Vascular access	
Arteriovenous fistulae	101 (87.0)
Central venous catheter	3 (13.0)
Number of dialysis/week	
2	98 (94.2)
3	6 (5.8)
Duration on dialysis (month) Median (IQR)	31 (11–60)

Table 2: Dialysis parameters

Parameters	Value (mean±SD or median (IQR))
Interdialytic interval (days)	2 (1–3)
Dry weight (kg)	69.2±13.2
Weight before dialysis (kg)	72.8±13.6
Weight after dialysis (kg)	69.9±13.5
IDWG (kg)	2.9±1.4
Ultrafiltration rate (ml/h)	810±250
Ultrafiltration rate (ml/kg/h)	11.1±3.8
Ultrafiltration rate >1000 ml/h, n (%)	11 (1.1)
Ultrafiltration volume (ml)	3200±1015

Table 3: Incidence of hypotension, clinical symptoms, and therapeutic measures during dialysis sessions

Category	Incident (Percentage of dialysis sessions)
Reduction in blood pressure SBP \geq 20 mmHg or MAP \geq 10 mm Hg	612 (59.0%)
Clinical manifestations	
Any Manifestation	149 (14.4%)
Tiredness	60 (5.8%)
Muscle Cramps	51 (4.9%)
Light-headedness	40 (3.9%)
Head Pain	25 (2.4%)
Sickness	10 (1.0%)
Emesis	9 (0.9%)
Nursing interventions	
Any Intervention	140 (13.5%)
Trendelenburg Position	55 (5.3%)
Isotonic Saline Administration	35 (3.4%)
Increased Dialysate Sodium	20 (1.9%)
Ultrafiltration Reduction/Stop	28 (2.7%)
Dialysis Session Interruption	15 (1.4%)
Guideline adherence	
KDOQI Standards	115 (11.1%)
Full EBPG Standards	70 (6.8%)

DISCUSSION

This study provides an in-depth analysis of intradialytic complications among patients with end-stage renal disease (ESRD) undergoing maintenance hemodialysis, highlighting significant concerns such as hypotension, vascular access issues, and the effects of various comorbidities [7]. The findings confirm the high prevalence of hypertension (94.2%) and diabetes (29.8%), underscoring the burden of cardiovascular disease in this population. Such comorbidities not only exacerbate the risk of complications during dialysis but also compound the challenges in managing ESRD [8].

Intradialytic hypotension (IDH), observed indirectly through parameters like interdialytic weight gain and ultrafiltration rates, remains a critical concern, as it can lead to dire outcomes, including myocardial and cerebral ischemia [9]. The high frequency of IDH can be partly attributed to aggressive fluid removal and underlying cardiac insufficiencies, which are prevalent in this cohort. Our findings are consistent with prior studies that have linked rapid fluid removal to an increased risk of mortality and cardiovascular events [10].

Vascular access complications were less common, with the majority of patients using arteriovenous fistulae (97.1%), which is the preferred access type due to lower complication rates compared to central venous catheters [11]. Nevertheless, the presence of even a small percentage of patients with central venous catheters (2.9%) emphasizes the need for vigilant monitoring and timely intervention to prevent serious complications like infection and thrombosis.

The utilization patterns of antihypertensive medications reveal a high dependency on calcium channel blockers and Central-acting, reflecting attempts to manage blood pressure variability and cardiovascular risks associated with ESRD. This pharmacological strategy aligns with guidelines recommending renin-angiotensin-aldosterone system inhibitors to mitigate cardiovascular risk in dialysis patients [12].

Moreover, the study's data on dialysis parameters such as ultrafiltration rate and interdialytic interval highlight the delicate balance required in fluid management to avoid both underhydration and fluid overload, which can lead to intradialytic complications. Our findings suggest that optimizing these parameters could reduce the incidence of IDH and improve patient outcomes, a notion supported by the literature emphasizing tailored dialysis care.

CONCLUSION

In conclusion, this study illustrates the complex interplay of comorbidities, dialysis parameters, and intradialytic complications

in patients with ESRD. It highlights the need for personalized care strategies that consider individual patient risks and the dynamic nature of dialysis sessions. By focusing on preventative measures and optimizing dialysis practices, we can hope to enhance patient safety and improve outcomes for those reliant on hemodialysis.

FUNDING

Nil

AUTHORS CONTRIBUTIONS

All the authors have contributed equally

CONFLICTS OF INTERESTS

Declared none

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