Original Article

Kidney Res Clin Pract [Epub ahead of print]
pISSN: 2211-9132 • eISSN: 2211-9140
https://doi.org/10.23876/j.krcp.23.188

KIDNEY RESEARCH AND CLINICAL PRACTICE

Intradialytic hypotension and worse outcomes in patients with acute kidney injury requiring intermittent hemodialysis

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Background: Intradialytic hypotension (IDH) is a critical complication related to worse outcomes in patients undergoing maintenance hemodialysis. Herein, we addressed the impact of IDH on mortality and other outcomes in patients with severe acute kidney injury (AKI) requiring intermittent hemodialysis.

Methods: We retrospectively reviewed 1,009 patients who underwent intermittent hemodialysis due to severe AKI. IDH was defined as either dialysis discontinuation due to hemodynamic instability or a decrease in systolic blood pressure (BP) of ≥30 mmHg, with or without a nadir systolic BP of <90 mmHg during the first session. The primary outcome was all-cause mortality, and transfer to the intensive care unit (ICU) due to unstable status was additionally analyzed. Hazard ratios (HRs) of outcomes were calculated using a Cox regression model after adjusting for multiple variables. Risk factors for IDH were evaluated using a logistic regression model.

Results: IDH occurred in 449 patients (44.5%) during the first hemodialysis session. Patients with IDH had a higher mortality rate than those without IDH (40.3% vs. 23.0%; HR, 1.30; 95% confidence interval [CI], 1.02–1.65). The rate of ICU transfer was higher in patients experiencing IDH than in those without IDH (17.5% vs. 11.5%; HR, 1.43; 95% CI, 1.02–2.02). Factors such as old age, high BP and pulse rate, active malignancy, cirrhosis, and hypoalbuminemia were associated with an increased risk of IDH episodes.

Conclusion: The occurrence of IDH is associated with worse outcomes in patients with AKI requiring intermittent hemodialysis. Therefore, careful monitoring and early intervention of IDH may be necessary in this patient subset.

Keywords: Acute kidney injury, Hypotension, Intensive care units, Mortality, Renal dialysis

Received: July 16, 2023; **Revised:** October 15, 2023; **Accepted:** November 9, 2023

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Introduction

Acute kidney injury (AKI) frequently occurs in critically ill patients and is associated with significant mortality and morbidity [1]. In patients with severe AKI requiring renal replacement therapy, the rate of in-hospital mortality has been reported to be 50% to 60% over the past two decades [2,3]. For those who survive, the AKI episode confers a risk of several complications, including progression to chronic kidney disease and subsequent events such as myocardial infarction and congestive heart failure [4–8].

Either intermittent hemodialysis or continuous kidney replacement therapy (CKRT) may be provided to patients who have severe AKI. CKRT is often the initial option in critically ill patients with AKI due to its superior hemodynamic stability and continuous removal of water and uremic solutes [9]. Despite the merit of CKRT, the survival benefit has not been conclusively documented in comparison to intermittent hemodialysis [10–13]. Given the high costs, prolonged immobilization, and requirement of admission to the intensive care unit (ICU) for CKRT, intermittent hemodialysis may become a viable therapeutic alternative for both hemodynamically stable and sometimes unstable patients [13,14].

Intradialytic hypotension (IDH) is a prevalent complication of hemodialysis. The pathophysiological mechanisms underlying IDH include decreased organ perfusion, particularly in the heart and brain, leading to ischemic injury and further exacerbation of cardiovascular disease [15]. Maintenance hemodialysis with IDH has been linked to severe adverse events, including major cardiac events, stroke, loss of residual kidney function, and mortality [16–19]. However, studies investigating the association between IDH and adverse outcomes in AKI are scarce. Herein, we addressed this issue using a cohort of AKI patients receiving intermittent hemodialysis as their initial modality and further identified risk factors related to IDH occurrence.

Methods

The study protocol was approved by the Institutional Review Board (IRB) of the Seoul National University Hospital (No. H-2110-085-1262) and was conducted in accordance with the ethical standard outlined in the Declaration of Helsinki. The IRB waived the need for informed consent because of the retrospective design.

Patient and data collection

This study is a retrospective analysis involving a cohort of 1,460 patients who were diagnosed with severe AKI and received intermittent hemodialysis as their initial modality at Seoul National University Hospital between November 2004 and June 2022. The hemodialysis modality was determined based on the patient's status, such as vital instability. The study patients did not require care from the ICU at the time of initiating hemodialysis. Criteria for exclusion included patients under the age of 18 (n = 121), those who were initially admitted to the ICU (n = 270), those who had end-stage kidney disease (ESKD) (n = 24), and those with missing data (n = 36). Accordingly, a total of 1,009 patients were included in the final analysis.

Baseline data at the first session of hemodialysis were obtained, such as age, sex, weight, initial vital signs (e.g., systolic [SBP] and diastolic blood pressures [DBP] and pulse rate), hemodialysis duration, blood flow rate, ultrafiltration volume, diagnosis of septic AKI, and comorbidities (e.g., diabetes mellitus, hypertension, coronary heart disease, liver cirrhosis, chronic kidney disease, and active malignancy). Blood findings included blood urea nitrogen, creatinine, sodium, potassium, chloride, bicarbonate, bilirubin, albumin, and C-reactive protein. During each hemodialysis session, blood pressure (BP) was regularly monitored, essentially every hour, and was measured more often in cases of hemodynamic instability. Subsequently, IDH of the first session of hemodialysis was incorporated into the analysis.

Because there is no consensus on defining IDH when patients have AKI rather than maintenance hemodialysis, we referred to the methods used in previous studies, as follows [20]: discontinuation of dialysis as a result of hemodynamic instability plus a nadir SBP less than 90 mmHg and/or a decrease in SBP of ≥30 mmHg.

Outcomes

The primary outcome was all-cause mortality following the initiation of hemodialysis, up to the point of either hospital discharge or death. Additionally, we assessed the rate of transfer to the ICU due to hemodynamic instability subsequent to the initial hemodialysis session.

Statistical analysis

Categorical and continuous variables are presented as proportions and means ± standard deviations when exhibiting a normal distribution and as medians with interquartile ranges (IQRs) when lacking a normal distribution. The Kolmogorov-Smirnov test was employed to analyze the distribution's normality. Categorical variables were compared using the chi-square test or Fisher exact test, while continuous variables with or without normal distribution were compared using the Student t test or the Mann-Whitney U test, respectively.

Survival curves were generated using the Kaplan-Meier method and compared between groups through a log-rank test. Hazard ratios (HRs) and 95% confidence intervals of outcomes were determined using the Cox proportional hazard regression model. IDH events at multiple time points, adhering to the stated definition, were incorporated as a time-dependent variable to examine the impact of IDH on outcomes. To pinpoint risk factors for IDH, logistic regression with backward stepwise selection was utilized. All statistical analyses were conducted using IBM SPSS version 27 (IBM Corp.) and R version 4.1.1 (R Foundation for Statistical Computing). A p-value below 0.05 was deemed

Table 1. Baseline characteristics of the patients

Characteristic	Total	No IDH group	IDH group	p-value
No. of patients	1,009	560	449	
Age (yr)	60.9 ± 16.0	58.9 ± 16.4	63.4 ± 15.1	<0.001
Male sex (%)	61.4	63.7	58.5	0.09
Body weight (kg)	64.3 ± 13.5	65.1 ± 13.6	63.4 ± 13.2	0.04
Initial SBP (mmHg)	135.0 ± 26.6	133.4 ± 23.1	137.1 ± 30.4	0.03
Initial DBP (mmHg)	75.4 ± 15.3	75.0 ± 14.1	75.9 ± 16.6	0.34
Initial pulse rate (beats/min)	89.9 ± 19.6	86.7 ± 18.2	94.0 ± 20.6	<0.001
Dialysis duration (hr)	2.2 ± 0.3	2.1 ± 0.3	2.2 ± 0.3	0.01
Blood flow rate (mL/hr)	137.4 ± 21.6	138.8 ± 22.6	135.7 ± 20.3	0.02
Ultrafiltration volume (L)	1.2 ± 0.9	1.2 ± 0.9	1.2 ± 0.9	0.41
Diagnosis of sepsis (%)	47.8	44.1	52.2	0.009
Use of vasopressor (%)	28.0	26.7	29.6	0.32
Comorbidities (%)				
Diabetes mellitus	23.7	21.8	26.0	0.11
Hypertension	3.9	3.0	4.8	0.13
Coronary artery disease	12.5	12.6	12.2	0.84
Atrial fibrillation	7.3	7.8	6.7	0.48
Liver cirrhosis	16.0	13.3	19.3	0.009
Chronic kidney disease	30.0	33.4	25.8	0.009
Active malignancy	51.3	46.3	57.7	<0.001
Blood findings				
BUN (mg/dL)	74 (48–101)	73 (46–100)	75 (50–104)	0.05
Creatinine (mg/dL)	4.3 (2.8–5.9)	4.5 (2.9–6.2)	4.0 (2.6–5.7)	0.02
Sodium (mmol/L)	134.0 ± 7.4	133.8 ± 6.5	134.4 ± 8.4	0.20
Potassium (mmol/L)	4.6 ± 1.2	4.5 ± 1.0	4.7 ± 1.3	0.009
Chloride (mmol/L)	100.8 ± 8.8	100.3 ± 8.0	101.5 ± 9.6	0.04
Bicarbonate (mmol/L)	18.3 ± 5.7	18.7 ± 5.6	17.7 ± 5.7	0.003
Total bilirubin (mg/dL)	0.9 (0.5–3.8)	0.9 (0.5–3.2)	1.1 (0.5–5.4)	0.03
Albumin (g/dL)	2.9 ± 0.7	3.0 ± 0.6	2.8 ± 0.7	<0.001
CRP (mg/dL)	5.3 (1.9–11.8)	5.1 (1.8–10.9)	5.4 (2.0–12.8)	0.19

Data are expressed as number only, mean ± standard deviation, percentage only, or median (interquartile range).)
BUN, blood urea nitrogen; CRP, C-reactive protein; DBP, diastolic blood pressure; IDH, intradialytic hypotension; SBP, systolic blood pressure.

statistically significant.

Results

Patient characteristics

The mean patient age was 60.9 ± 16.0 years, and 61.4% of the patients were male. The proportion of patients with septic AKI was 47.8%. Median value of sessions was 4 (IQR, 2–9), and this value did not differ between the IDH and no IDH subgroups. Based on the first session, IDH occurred in 449 patients (44.5%). The IDH group was more likely to have a high initial BP and pulse rate and more comorbidities, such as liver cirrhosis and active malignancy. Other baseline characteristics are shown in Table 1.

Relationship between intradialytic hypotension and mortality

During a median follow-up period of 17 days (IQR, 9–33 days), 310 patients (30.7%) died. The incidence rate of mortality was 10.0 deaths per 1,000 person-days. Kaplan-Meier survival curves indicate the disparity in survival rates between patients who experienced IDH and those who did not (Fig. 1). Notably, the survival rate was lower in the group with IDH ($p < 0.001$). After adjustment for multiple variables, IDH was found to be an independent risk factor for all-cause mortality (Table 2).

Relationship between intradialytic hypotension and intensive care unit transfer

The study further examined the risk of transfer to the ICU due to hemodynamic instability after hemodialysis application. Of the patients, 144 (14.3%) were transferred to the ICU. Fig. 2 presents Kaplan-Meier curves illustrating the cumulative rates of ICU transfer in groups with and without IDH. Patients experiencing IDH were more likely to be transferred to the ICU than the counterpart group, and this finding remained consistent after adjustment for multiple variables (Table 3).

Factors related to intradialytic hypotension

Upon application of a multivariable logistic regression model with backward stepwise selection, several factors, including old age, elevated BP and pulse rate, hypoalbuminemia, and comorbidities, such as liver cirrhosis and active malignancy, were associated with the occurrence of IDH (Table 4).

Discussion

IDH occurrence is associated with adverse outcomes in

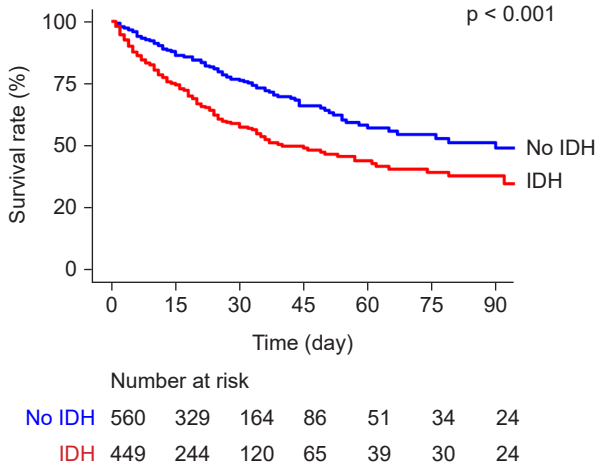

Figure 1. Kaplan-Meier survival curves according to the presence of intradialytic hypotension (IDH).

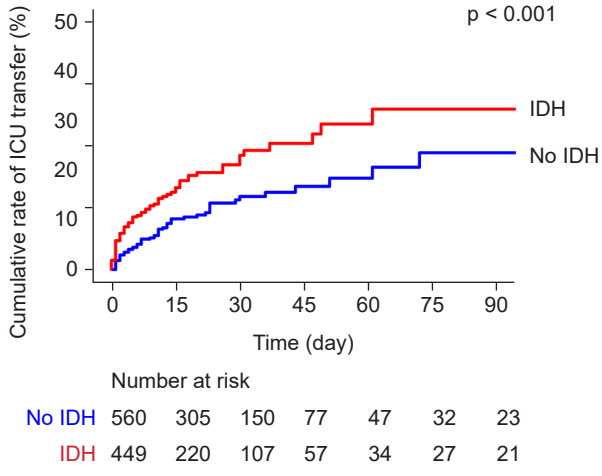

Figure 2. Kaplan-Meier curves of the risk of transfer to the intensive care unit (ICU) according to the presence of intradialytic hypotension (IDH).

Table 2. Variables related to the risk of all-cause mortality

Variable	Unadjusted HR (95% CI)	p-value	Adjusted HR[a] (95% CI)	p-value
Age (per 10 yr)	1.00 (0.94–1.08)	0.90	1.08 (1.00–1.17)	0.049
Male (vs. female)	1.29 (1.03–1.63)	0.03	1.30 (1.03–1.66)	0.03
Weight (per 1 kg)	1.00 (1.00–1.01)	0.33		
Initial SBP (per 10 mmHg)	0.93 (0.89–0.97)	0.001		
Initial DBP (per 10 mmHg)	0.98 (0.98–1.05)	0.51		
Pulse rate (per 10 beats/min)	1.20 (1.14–1.27)	<0.001	1.17 (0.10–1.25)	<0.001
Dialysis duration (per 1 hr)	1.07 (0.73–1.57)	0.70		
Blood flow rate (per 1 mL/hr)	0.99 (0.98–0.99)	<0.001		
Ultrafiltration volume (per 1 L)	0.92 (0.82–1.04)	0.20		
Diagnosis of sepsis (vs. none)	1.60 (1.28–2.01)	<0.001	1.26 (1.00–1.60)	0.05
Use of vasopressor (vs. none)	1.39 (1.10–1.75)	0.005		
Diabetes mellitus (vs. none)	0.96 (0.73–1.26)	0.77		
Hypertension (vs. none)	1.17 (0.67–2.04)	0.58		
Coronary artery disease (vs. none)	0.93 (0.64–1.35)	0.71	1.43 (0.97–2.12)	0.07
Atrial fibrillation (vs. none)	0.84 (0.55–1.29)	0.40		
Liver cirrhosis (vs. none)	1.75 (1.34–2.29)	<0.001		
Chronic kidney disease (vs. none)	0.67 (0.51–0.87)	0.003		
Active malignancy (vs. none)	2.99 (2.33–3.85)	<0.001	2.32 (1.78–3.02)	<0.001
BUN (per 1 mg/dL)	1.00 (1.00–1.01)	<0.001	1.00 (1.00–1.01)	0.02
Creatinine (per 1 mg/dL)	0.92 (0.88–0.96)	<0.001	0.85 (0.80–0.91)	<0.001
Sodium (per 1 mmol/L)	1.00 (0.98–1.01)	0.70	1.06 (1.04–1.09)	<0.001
Potassium (per 1 mmol/L)	0.94 (0.84–1.05)	0.30		
Chloride (per 1 mmol/L)	0.98 (0.96–0.99)	<0.001	0.92 (0.90–0.95)	<0.001
Bicarbonate (per 1 mmol/L)	0.97 (0.95–0.99)	<0.001	0.93 (0.91–0.95)	<0.001
Total bilirubin (per 1 mg/dL)	1.04 (1.03–1.05)	<0.001	1.03 (1.02–1.04)	<0.001
Albumin (per 1 g/dL)	0.71 (0.61–0.84)	<0.001	0.78 (0.66–0.93)	0.005
CRP (per 1 mg/dL)	1.02 (1.01–1.03)	<0.001		
IDH (vs. none)	1.88 (1.50–2.36)	<0.001	1.30 (1.02–1.65)	0.04

BUN, blood urea nitrogen; CI, confidence interval; CRP, C-reactive protein; DBP, diastolic blood pressure; HR, hazard ratio; IDH, intradialytic hypotension; SBP, systolic blood pressure.
[a]Adjusted for all variables with backward stepwise selection.

patients on chronic or maintenance dialysis. However, this relationship has never been established in AKI patients requiring intermittent hemodialysis. According to our cohort analysis, IDH occurrence was associated with subsequent high risks of mortality and transfer to the ICU. Several factors were identified to be associated with IDH occurrence. These findings will help clinicians cope with AKI patients at risk of IDH to prevent worse outcomes.

IDH in patients with severe AKI requiring intermittent hemodialysis has been reported to occur in 30% to 90% of cases depending on the timing and protocol of hemodialysis as well as the definition of IDH [21,22]. We reported that approximately 45% of patients suffered IDH in the initial hemodialysis session, which ranges within the previous report and is a relatively high proportion in comparison to maintenance hemodialysis. Several mechanisms may further increase the risk of IDH in patients with AKI, such as fluid overload due to resuscitation in hemodynamic instability, insufficient support of nutrition, and use of nephrotoxic antibiotics [23]. Furthermore, IDH can occur because of an impaired response to physiological stress during hemodialysis, such as increased vascular resistance or decreased cardiac reserve due to critical illness [24,25].

A previous cohort study involving patients with AKI who underwent hemodialysis at outpatient units for 3 to 6 months after discharge showed that frequent occurrence of

Table 3. Variables related to the risk of transfer to the intensive care unit

Variable	Unadjusted HR (95% CI)	p-value	Adjusted HR[a] (95% CI)	p-value
Age (per 10 yr)	0.96 (0.87–1.06)	0.46		
Male (vs. female)	1.10 (0.79–1.54)	0.58		
Body weight (per 1 kg)	1.02 (1.01–1.03)	<0.001	1.02 (1.01–1.03)	<0.001
Initial SBP (per 10 mmHg)	0.95 (0.89–1.01)	0.10		
Initial DBP (per 10 mmHg)	0.94 (0.84–1.04)	0.22		
Pulse rate (per 10 beats/min)	1.17 (1.08–1.27)	<0.001	1.14 (1.04–1.25)	0.004
Dialysis duration (per 1 hr)	1.10 (0.59–2.04)	0.77		
Blood flow rate (per 1 mL/hr)	0.99 (0.99–1.00)	0.06		
Ultrafiltration volume (per 1 L)	1.09 (0.91–1.29)	0.35		
Diagnosis of sepsis (vs. none)	1.22 (0.88–1.69)	0.23		
Use of vasopressor (vs. none)	1.42 (1.01–2.00)	0.045		
Diabetes mellitus (vs. none)	0.89 (0.60–1.33)	0.57		
Hypertension (vs. none)	0.56 (0.18–1.75)	0.32		
Coronary artery disease (vs. none)	1.16 (0.74–1.88)	0.55	1.60 (0.97–2.65)	0.07
Atrial fibrillation (vs. none)	0.74 (0.38–1.46)	0.39		
Liver cirrhosis (vs. none)	1.44 (0.94–2.20)	0.10		
Chronic kidney disease (vs. none)	0.84 (0.59–1.22)	0.36		
Active malignancy (vs. none)	1.23 (0.88–1.71)	0.23		
BUN (per 1 mg/dL)	1.00 (1.00–1.01)	0.047	1.00 (1.00–1.01)	0.10
Creatinine (per 1 mg/dL)	0.91 (0.85–0.98)	0.01	0.86 (0.79–0.94)	<0.001
Sodium (per 1 mmol/L)	0.99 (0.98–1.02)	0.99	1.06 (1.03–1.10)	<0.001
Potassium (per 1 mmol/L)	0.88 (0.75–1.04)	0.13		
Chloride (per 1 mmol/L)	0.98 (0.96–1.00)	0.03	0.94 (0.91–0.97)	<0.001
Bicarbonate (per 1 mmol/L)	0.98 (0.95–1.01)	0.22	0.94 (0.91–0.97)	<0.001
Total bilirubin (per 1 mg/dL)	1.03 (1.02–1.05)	<0.001	1.03 (1.01–1.05)	<0.001
Albumin (per 1 g/dL)	0.85 (0.66–1.08)	0.17		
CRP (per 1 mg/dL)	1.01 (1.00–1.03)	0.16		
IDH, (vs. none)	1.70 (1.22–2.36)	0.002	1.43 (1.02–2.02)	0.04

BUN, blood urea nitrogen; CI, confidence interval; CRP, C-reactive protein; DBP, diastolic blood pressure; HR, hazard ratio; IDH, intradialytic hypotension; SBP, systolic blood pressure.
[a]Adjusted for all variables with backward stepwise selection.

IDH led to a higher incidence of ESKD [26]. Another observational study involving patients on CKRT found that IDH occurring within the first hour of treatment initiation, defined by a drop in BP from the baseline, significantly elevated the mortality risk [27]. Similar but unlike the above two studies, our study compared the outcomes of patients with acute illness who had intermittent hemodialysis initiated in the ward, which might have an advantage in selecting vulnerable patients in the ward setting.

There is still no clear consensus on whether to choose intermittent hemodialysis or CKRT in critically ill patients with AKI, except in some situations such as cerebral edema [28]. We also found that the incidence of ICU transfer was closely related to IDH events after adjusting for potentially relevant known confounders. It seemed that for close monitoring of patients who developed IDH and had hemodynamical instability, the patients were transferred to the ICU, but this study could not determine whether this transition to CKRT as a dialysis modality could improve the prognosis by this observational study design.

Previous research has explored risk factors for IDH in patients undergoing maintenance hemodialysis, such as in patients who have diabetes mellitus or cardiovascular disease, including systolic and diastolic dysfunction, ischemic heart disease, and arrhythmias [29,30]. In addition to a large volume of ultrafiltration, rapid diffusive solute remov-

Table 4. Variables related to the risk of intradialytic hypotension

Variable	Unadjusted OR (95% CI)	p-value	Adjusted OR[a] (95% CI)	p-value
Age (per 10 yr)	1.23 (1.12–1.35)	<0.001	1.26 (1.15–1.37)	<0.001
Male (vs. female)	0.83 (0.62–1.12)	0.23	0.81 (0.62–1.06)	0.13
Body weight (per 1 kg)	0.99 (0.98–1.00)	0.17		
Initial SBP (per 10 mmHg)	1.11 (1.05–1.17)	<0.001	1.10 (1.04–1.16)	<0.001
Pulse rate (per 10 beats/min)	1.25 (1.16–1.35)	<0.001	1.26 (1.17–1.35)	<0.001
UF volume (per 1 L)	1.09 (0.93–1.29)	0.27		
UF volume per weight (mL/hr/kg)	1.01 (1.00–1.02)	0.09		
Diagnosis of sepsis (vs. none)	1.27 (0.92–1.76)	0.15		
Use of vasopressor (vs. none)	1.15 (0.87–1.52)	0.32		
Diabetes mellitus (vs. none)	1.24 (0.88–1.75)	0.22		
Hypertension (vs. none)	1.64 (0.80–3.35)	0.17		
Coronary artery disease (vs. none)	1.04 (0.67–1.63)	0.85		
Liver cirrhosis (vs. none)	1.62 (1.07–2.47)	0.02	1.81 (1.24–2.65)	0.002
Active malignancy (vs. none)	1.39 (1.05–1.84)	0.02	1.34 (1.02–1.77)	0.03
Total bilirubin (per 1 mg/dL)	1.01 (1.00–1.03)	0.14		
Albumin (per 1 g/dL)	0.61 (0.49–0.76)	<0.001	0.60 (0.49–0.74)	<0.001
C-reactive protein (per 1 mg/dL)	0.99 (0.98–1.01)	0.57		

BUN, blood urea nitrogen; CI, confidence interval; CRP, C-reactive protein; OR, odds ratio; SBP, systolic blood pressure; UF, ultrafiltration.
[a]Adjusted for all variables with backward stepwise selection.

al during hemodialysis precipitates IDH occurrence due to a swift decline in serum osmolality, consequently reducing extracellular fluid [31]. However, there is a gap in understanding regarding patients with AKI requiring intermittent hemodialysis. In critically ill patients, as mentioned above, compensatory mechanisms such as increasing sympathetic tone and cardiac output can be compromised, thereby contributing to IDH. Hemodialysis itself can also induce IDH through mechanisms unrelated to fluid removal, such as electrolyte imbalances such as hypokalemia or hypophosphatemia. These imbalances, which are commonly seen as complications of CKRT, can lead to diminished myocardial performance and arrhythmia [32–34]. In a multivariate analysis of this cohort, predialytic hemodynamic status and underlying liver cirrhosis, as well as hypoalbuminemia, were identified as independent risk factors for subsequent IDH. In maintenance hemodialysis, both low and high predialytic SBPs are considered as risk factors of IDH, which are dependent on the definition of IDH. Low SBP may contribute to the risk of IDH with nadir SBP of <90 mmHg, while high SBP seems to be associated with the risk of IDH with ΔSBP of >20 mmHg. According to the complex association between predialytic SBP and the risk of IDH, recent studies suggest variability in BP and DBP itself as an alternative risk factor of IDH [35,36]. Regarding the AKI condition, research on the risk factor of IDH does not exist. The present study did not show ultrafiltration volume as a risk factor, in conflict with previous studies [37]. Future work should validate these findings, particularly in the AKI condition requiring intermittent hemodialysis.

Although the study provides insightful information, it presents certain limitations. Due to its retrospective design, there may be unaccounted bias and confounders that could have influenced the results. The study did not consider the potential impact of continuous fluctuations in specific biochemical parameters, nor did it account for practice-related alterations, both of which could be correlated with the outcomes. Data on cardiac function such as echocardiography and brain natriuretic peptide, were not available, which would be fruitful to understand the causality between observations. Recovery of kidney function or the transition to acute kidney disease has recently been considered important for outcome [38], but the present study did not depict these factors. Future evaluation of the transition from such a setting to acute kidney disease or ESKD is needed. This study did not categorize nonseptic patients into their specific causes and could not determine the cause of death.

The present study shows that IDH occurring during the initial session in patients undergoing intermittent hemodialysis due to AKI independently contributed to the risk of mortality and subsequent transfer to the ICU. Certain laboratory hemodynamic factors and comorbidities were found to be associated with the occurrence of IDH. These findings lay the groundwork for future studies aimed at elucidating the clinical implications of IDH and developing strategies to prevent its occurrence during the initiation of intermittent hemodialysis in patients with AKI.

Conflicts of interest

All authors have no conflicts of interest to declare.

Data sharing statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Authors' contributions

Conceptualization: SGK SSH
Formal analysis: YWP, DY, SGK, SSH
Investigation: DY, YY, SP, YCK, DKK, KHO, KWJ, YSK, SSH
Methodology: SHK, SGK, SSH
Writing–original draft: YWP, DY
Writing–review & editing: SGK, SSH
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