**Renal Data from Asia–Africa**

**Intradialytic Hypotension and Associated Factors among Patients on Maintenance Hemodialysis: A Single-Center Study in Cameroon**

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**ABSTRACT.** Intradialytic hypotension (IDH), one of the most frequent acute complications of hemodialysis (HD), is associated with increased patient’s morbidity and mortality. The aim of this study was to determine its prevalence and associated factors among patients on maintenance HD in Cameroon. This was a prospective longitudinal study carried out from June 20, to July 30, 2016 (5 weeks), including adult patients on HD ≥3 months at a tertiary hospital in Douala. During this period, patients were followed up at each HD session, and their blood pressure and occurrence of clinical events possibly related to IDH were recorded. In this study, IDH was defined as a decrease in systolic BP by ≥20 mm Hg or a decrease in mean arterial pressure by ≥10 mm Hg, associated to a clinical event. Logistic regression analysis was used to determine associated factors. We included 104 patients (69 males) with a mean age of 50.74 ± 15.18 years and a median duration on HD of 30.5 (interquartile range: 12.25–58.75) years. Hypertension 99/104 (95.2%) and diabetes 32/104 (30.8%) were the main comorbidities encountered. A total of 1032 HD sessions were followed up with an average of 9.88 ± 1.57 sessions per patient. IDH occurred in 11.6% of HD sessions. Associated factors were age, female sex, HIV infection, feeding during dialysis, and use of antihypertensive drug during or within 2 h before dialysis. The prevalence of IDH in our study was low. Associated factors were mainly related to patient’s characteristics and comorbidities.

**Introduction**

Hemodialysis (HD) is the most commonly used renal replacement therapy of end-stage kidney disease (ESKD). Despite all the progresses, this therapy is associated with various acute complications, of which some can have
life-threatening outcomes. Intradialytic hypotension (IDH) is one of the most frequent complications of HD, and it occurs in 5%–32.5% of HD sessions. No consensus definition of IDH exists, but three main criteria are used to define it, of which only the first one is constant: lowering of systolic blood pressure (SBP) or mean arterial pressure (MAP) during dialysis, presence of clinical event, need for therapeutic intervention. The mechanism of IDH is multifactorial; it is caused by an imbalance between decrease in plasma volume during HD and the counter regulatory cardiovascular mechanisms. Plasma volume change during HD is determined by the interplay of ultrafiltration rate, decrease in plasma osmolality, and the rate of plasma refill from the interstitium. Factors that impair cardiovascular counter regulatory response such as decrease in vascular and left-ventricular compliance, failure to sufficiently increase cardiac output, and peripheral vascular resistance may all contribute to IDH. Therefore, besides factors directly related to the dialysis procedure, several patient-related characteristics and comorbidities such as age, presence of diabetes, ischemic heart disease, left ventricular hypertrophy, and autonomic neuropathy increase the risk of IDH. IDH alters patient’s quality of life and induces ischemic brain injury and myocardial stunning in dialyzed population. Other consequences include volume overload and inadequate clearance due to suboptimal ultrafiltration and interruption of dialysis. For all these reasons, IDH has a strong association with mortality. In sub-Saharan Africa (SSA), ESKD mainly affects young adults, predominantly men. Due to lack of infrastructure and financial constraints, majority of the patients receive only two HD sessions per week, and the reported prevalence of IDH varies from 8.5% to 11.1% of HD sessions. Little is known about the predictive factors of IDH in this population. The aim of this study was, therefore, to determine the prevalence and associated factors of IDH among patients on maintenance HD in Cameroon.

Materials and Methods

Study setting and participants
This was a prospective longitudinal study carried out from June 20 to July 30, 2016 (5 weeks) in the HD unit of the Douala General Hospital, a tertiary referral hospital in Cameroon. The unit operated at the time of the study with 18 HD generators (Fresenius® 4008S Fresenius Medical Care Germany, Bad Homburg, Germany). Synthetic polysulfone membrane dialysis and bicarbonate buffer were used. Dialysate temperature was kept constant at 36.5°C during the study period for all patients. The dialysate composition was as follows: sodium 138 mmol/L, potassium 2.0 mmol/L, calcium 1.75 mmol/L, magnesium 0.5 mmol/L, chloride 109.5 mmol/L, bicarbonate 32 mmol/L, acetate 3 mmol/L, and glucose 1.0 g/L. The center operated from Monday to Saturday from 6 a.m. to midnight, with four shifts of dialysis a day. All consenting patients aged 18 years and above on maintenance HD for more than three months were included in the study. At the center, the majority of patients received two HD sessions of 4-h duration each per week. The center was staffed with two nephrologists and 12 nurses. Dry weight was evaluated clinically (peripheral edema, signs of pulmonary congestion, pre- and post-dialytic BP, and muscle cramps) and also based on the cardiopulmonary aspect on chest X-ray.

Data collection
Information on general characteristics (age, gender, dialysis vintage, and dry weight) and comorbid conditions [diabetes, hypertension (HTN), and heart failure] were obtained from medical records. Dialysis-related characteristics [pre-, intra-, and post-dialysis blood pressures, pre- and post-dialysis weight, intradialytic weight gain (IDWG), ultrafiltration rate, occurrence of clinical events possibly related to intradialytic hypotension (IDH), and nursing interventions] were collected at each dialysis session. BP was measured with an automatic oscillometric monitor integrated in the dialysis generator at standardized intervals: 5 min
before HD and every hour until the end of the HD session (5 measures per dialysis).

Definitions
IDH was primarily defined according to the Kidney Disease Outcomes Quality Initiative (KDOQI) as a decrease in SBP $\geq 20$ mm Hg or a decrease in MAP by $\geq 10$ mm Hg associated with a clinical event.\(^{13}\) In order to compare our prevalence to other study, we additionally used the definition of the European Best Practice Guideline on hemodynamic instability (EBPG): decrease in SBP $\geq 20$ mm Hg or in MAP $\geq 10$ mm Hg associated with a clinical event and the need for nursing intervention.\(^{14}\)

Clinical events were defined as fatigue, cramps, nausea, vomiting, dizziness, loss of consciousness, abdominal pain, and headache, occurring during the dialysis session.

Patients were considered as having frequent IDH if it occurred in $\geq 30\%$ of dialysis sessions.

### Statistical Analysis

Data analysis was done with the aid of the software IBM SPSS Statistics version 23.0. (IBM Corp., Armonk, NY, USA). Categorical variables were reported as frequency and percentages and compared with Chi-square test or Fisher’s exact test, when appropriate. Continuous variables with normal distribution were reported as mean ± standard deviation, and skewed data were reported as median with 25\(^{th}\) and 75\(^{th}\) percentiles (interquartile range). Logistic regression models were used to determine the predictive factors of IDH. The basic models included each candidate predictor of interest. Multivariate regression model included all significant variables in basic models. $P <0.05$ was considered statistically significant.

| Table 1. Baseline characteristic of the population. |  
|------------------|------------------|
| **Characteristics** | **n (%)** |
| **Gender** |  
| Female | 35 (33.7) |
| Male | 69 (66.3) |
| **Age (years) mean±SD** | 50.74±15.18 |
| **Comorbidities n (%)** |  
| Hypertension | 99 (95.2) |
| Diabetes | 32 (30.8) |
| Heart failure | 13 (12.5) |
| HIV infection | 6 (5.8) |
| **Hypertension, n=99** |  
| Duration (years), median (IQR) | 7 (4–15) |
| Use of antihypertensive drugs | 82 (82.8) |
| Class of antihypertensive drugs |  
| Calcium channel blockers | 71 (71.7) |
| ACEI/ARB | 50 (50.5) |
| Central-acting agents | 18 (18.2) |
| Beta-blockers | 17 (17.2) |
| **Vascular access n (%)** |  
| Arteriovenous fistulae | 100 (96.2) |
| Central venous catheter | 4 (3.8) |
| **Number of dialysis/week n (%)** |  
| 2 | 99 (95.2) |
| 3 | 5 (4.8) |
| **Duration on dialysis (month) Median (IQR)** | 30.5 (12.25–58.75) |

SD: Standard deviation, HIV: Human immunodeficiency virus, IQR: Interquartile range, ACEIs: Angiotensin-converting enzyme inhibitors, ARB: Angiotensin receptor blocker.
Results

Baseline characteristics

Baseline characteristics of the participants are reported in Table 1. A total of 104 patients were included, with 69/104 (66.3%) male. The mean age was 50.74 ± 15.18 years. The median duration on HD was 30.5 (12.25–58.75) months, and arteriovenous fistula (96.2%) was the main vascular access. HTN 99/104 (95.2%) and diabetes 32/104 (30.8%) were the main comorbidities encountered. Among patients with HTN, 82/99 (82.8%) were on antihypertensive drugs, with calcium channel blockers (71.7%) and renin–angiotensin–aldosterone system inhibitors (50.5%) been the main class of drugs used.

Dialysis parameters

As reported in Table 2, the median inter-

| Table 2. Dialysis parameters.                                      |
|-------------------------------------------------------------|
| Interdialytic interval (days), median (IQR)                | 2 (2–3)          |
| Dry weight (kg), mean±SD                                    | 69.68±12.99      |
| Weight before dialysis, mean±SD                             | 73.13±13.44      |
| Weight after dialysis, mean±SD                              | 70.05±13.32      |
| IDWG (kg), mean±SD                                          | 3.14±1.33        |
| Ultrafiltration rate (mL/h), mean±SD                        | 807.05±251.33    |
| Ultrafiltration rate (mL/kg/h), mean±SD                     | 11.26±3.91       |
| Ultrafiltration rate> 1000 mL/h, n (%)                      | 10 (1.0)         |
| Ultrafiltration volume (mL), mean±SD                        | 3210.53±1020.69  |

IQR: Interquartile range, SD: Standard deviation, IDWG: Interdialytic weight gain.

Figure 1. Course of systolic, diastolic, mean, and pulse blood pressure during the 1032 hemodialysis sessions.

IDH: Intradialytic hypotension.
Dialytic interval was two days, with an average IDWG of 3.14 ± 1.33 kg. The average ultrafiltration rate was 807.05 ± 251.33 mL/h. The average course of BP during HD is shown in Figure 1. The curves highlight a rapid fall of blood pressure, from the 1st hour of dialysis during the sessions complicated with IDH.

Prevalence of blood pressure drop, clinical event, and intervention in all dialysis sessions

A total of 1032 HD sessions were followed up with an average of 9.88 ± 1.57 sessions per patient. Of these sessions, 597 (57.8%) were complicated with a decrease of SBP ≥20 mmHg or in MAP ≥10 mm Hg (Table 3). Of these 597 sessions, 120 (11.6%) were complicated with a clinical event related to BP drop. Therefore, according to the KDOQI definition, the prevalence of IDH was 11.6% (120/1032 dialysis sessions) and 7.2% (74/1032) using the EBPG definition. During the five weeks of follow-up, a total of 43/104 (41.3%) patients had at least one episode, 26/104 (25%) patients had 1%–30%, and 17/104 (16.3%) had more than 30% of their dialysis sessions complicated by IDH, with a range of 0%–90% (Table 3).

Predictive factors of intradialytic hypotension according to the Kidney Disease Outcomes Quality Initiative definition

On multivariate logistic regression analysis (Table 4), independent predictive factors of IDH where age [odds ratio (OR): 1.027; 95% confidence interval (CI): 1.008–1.047; \( P = 0.006 \)], female sex (OR: 2.443; 95% CI: 1.525–3.913; \( P < 0.001 \)), HIV infection (OR: 2.593; 95% CI: 1.107–6.073; \( P = 0.028 \)), feeding during dialysis (OR: 1.947; 95% CI: 1.208–3.137; \( P = 0.006 \)), and antihypertensive drug during/within 2 h before dialysis (OR: 1.253; 95% CI: 1.065–1.475; \( P = 0.007 \)).

Discussion

The aim of this study was to determine the prevalence and predictive factors of IDH among patients on maintenance HD in a resource-limited country in SSA, where most of the patients

| Decrease of SBP ≥20 mmHg or in MAP ≥10 mm Hg | Number of dialysis session (%) |
|---------------------------------------------|-------------------------------|
| Clinical events                             |                               |
| Any clinical event                          | 154 (14.9)                    |
| Fatigue                                     | 63 (6.1)                      |
| Cramps                                      | 48 (4.7)                      |
| Dizziness                                   | 43 (4.2)                      |
| Headache                                    | 22 (2.1)                      |
| Nausea                                      | 8 (0.8)                       |
| Vomiting                                    | 7 (0.7)                       |
| Abdominal pain                              | 6 (0.6)                       |
| Loss of consciousness                       | 2 (0.2)                       |
| Nursing interventions                        |                               |
| Any intervention                            | 137 (13.3)                    |
| Trendelenburg                               | 57 (5.5)                      |
| Administration of isotonic saline           | 32 (3.1)                      |
| Increase in sodium concentration in dialysate| 22 (2.1)                      |
| Decrease/stop of ultrafiltration            | 23 (2.2)                      |
| Interruption of dialysis session            | 13 (1.3)                      |
| KDOQI definition                            | 120 (11.6)                    |
| Full EBPG definition                        | 74 (7.2)                      |

SBP: Systolic blood pressure, MAP: Mean arterial pressure, KDOQI: Kidney Disease Outcomes Quality Initiative, EBPG: European Best Practice Guideline for hemodynamic instability.
Table 4. Predictive factors of intradialytic hypotension.

|                               | Univariate analysis |                  | Multivariate analysis |                  |
|-------------------------------|---------------------|------------------|-----------------------|------------------|
|                               | OR (95% CI)         | P                | aOR (95% CI)          | P                |
| Age (per year increase)       | 1.029 (1.015–1.044) | <0.001           | 1.027 (1.008–1.047)   | 0.006            |
| Female                        | 1.669 (1.135–2.454) | 0.009            | 2.443 (1.525–3.913)   | <0.001           |
| Diabetes                      | 1.764 (1.990–2.594) | 0.004            | 1.030 (0.620–1.711)   | 0.909            |
| Heart failure                 | 0.963 (0.533–1.740) | 0.901            |                       |                  |
| HIV infection                 | 2.325 (1.215–4.449) | 0.011            | 2.593 (1.107–6.073)   | 0.028            |
| Dialysis vintage              | 1.000 (0.995–1.006) | 0.975            |                       |                  |
| Body mass index (kg/m^2)      | 1.091 (1.038–1.146) | 0.001            | 1.040 (0.980–1.104)   | 0.193            |
| Three dialysis/week vs two    | 2.101 (1.150–3.839) | 0.016            | 1.468 (0.753–2.860)   | 0.259            |
| Interdialytic interval (days) | 0.992 (0.814–1.210) | 0.939            |                       |                  |
| Dry weight (kg)               | 0.993 (0.978–1.009) | 0.361            |                       |                  |
| Intradialytic weight gain (kg)| 0.899 (0.777–1.040) | 0.152            |                       |                  |
| Ultrafiltration rate (mL/kg/h)| 1.036 (0.986–1.089) | 0.161            |                       |                  |
| Blood flow rate (mL/h)        | 0.998 (0.990–1.005) | 0.529            |                       |                  |
| Predialysis systolic BP (mm Hg)| 1.001 (0.992–1.009) | 0.893            |                       |                  |
| Predialysis diastolic BP (mm Hg)| 0.991 (0.979–1.003) | 0.126            |                       |                  |
| Feeding during dialysis       | 1.614 (1.045–2.493) | 0.031            | 1.947 (1.208–3.137)   | 0.006            |
| Antihypertensive drug during/within 2 h before dialysis | 1.842 (1.180–2.877)   | 0.007            | 1.253 (1.065–1.475)   | 0.007            |

OR: Odds ratio, CI: Confidence interval, aOR: Adjusted odds ratio, HIV: Human immunodeficiency virus, BP: Blood pressure.
receive fewer than the recommended HD sessions per week. In our study, IDH occurred in 11.6% of HD sessions. Age, female sex, HIV infection, feeding during dialysis, and antihypertensive drug during or within 2 h before dialysis were independent associated factors.

Various studies reported a prevalence of IDH ranging from 5% to 32.5% depending on the definition used. In our study, using the EBPG definition, we found a prevalence of 7.1%. This is similar with the findings of Akhmouch et al and Kuipers et al, who reported a prevalence of 5% and 6.7%, respectively. Using the KDOQI definition which does not include the notion of nursing intervention, the prevalence of IDH in the present study was 11.6%, in the range with studies reported in the SSA. Kaze et al, Amira et al, and Okoye et al reported a prevalence of 11.1%, 8.5%, and 8.6%, respectively, in Cameroon and Nigeria. Our result is lower to the prevalence of 20%–30% found in developed countries. This difference could be explained by the fact that in many SSA countries, due to lack of infrastructure and financial constraints, patients receive only two HD sessions per week. Indeed, Lei et al reported that the risk of IDH is higher in patients receiving three-weekly dialysis than in those receiving two. Another explanation could be the profile of patients; our patients are relatively younger and may present less cardiovascular diseases (CVDs), a potential risk factor of IDH that is known to increase with aging. Factors independently associated with IDH were age, female sex, HIV infection, feeding during dialysis session, antihypertensive drug during/within 2 h before dialysis. Similarly, studies reported age as an associated factor of IDH. This could be explained by the increasing frequency of CVDs with aging. Moreover, an alteration of vascular response to plasma volume decrease related to arterial stiffness or vascular calcification may be involved. In addition, female sex is found to be associated with IDH. Several mechanisms could be involved such as a direct vaso-
dilator effect of estrogen on vascular smooth muscles and lower mean resting muscle sympathetic nerve activity in women compared with men that leads to lower peripheral resistance. Feeding less than 2 h or during dialysis could lead to IDH by the decrease in cardiac output and vascular resistance secondary to splanchnic sequestration and vasodilatation. It is easy to conceive that taking antihypertensive medication close before HD start can lead to hypotension. The association between HIV infection and IDH was unexpected and to the best of our knowledge not previously described. HIV infection itself may increase cardiovascular risk. In addition, increase in arterial stiffness that has been associated with HIV infection could be involved. In contradiction with various study, factors related to HD (IDWG and ultrafiltration) were not associated with the occurrence of IDH in this study.

**Limitations**

We acknowledge some limitations to this study. Data were collected from a single center, which could raise issues regarding the generalization of the findings.

**Conclusion**

The prevalence of IDH according to KDOQI in our study is relatively low. Associated factors are mainly related to patient’s characteristics and comorbidities. This first result can serve as a basis for further studies with a large sample and longer follow-up period.

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**Ethics Approval and Consent to Participate**

Ethical approval was obtained from the University of Mountains, and consent for participation was obtained from each patient.
Conflict of interest: None declared.

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