

# Evaluation of Reliability of Pre- and Post-Dialytic Measurements through Home Blood Pressure Monitoring

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## Abstract

There is a significant dispute about the ideal moment for the taking the blood pressure and the target values. The aim of our study was to assess the sensitivity, specificity, positive predictive value and negative predictive value of the blood pressure measurement before and after hemodialysis, at a hemodialysis center in sub-Saharan Africa. It was a multicenter, cross-sectional study, conducted from 25 April 2016 to 18 June 2016. All chronic hemodialysis patients who take home blood pressure, pre- and post-dialytic session for one week were included. We calculated sensitivity, specificity, positive predictive value and negative predictive value. The mean age of patients was 45.57 years  $\pm$  14.11 with a sex ratio of 1.42. The mean duration of hemodialysis was 57.96 months  $\pm$  34.86. Predialytic measures: sensitivity was 72.7 % and specificity 53.8%; positive predictive value 80% and negative predictive value 43.8 %. Post-dialytic measures: sensitivity was 90.9 % and specificity of 38.5%; positive predictive value 78.9% and negative predictive value 62.5%. Pre- and post-dialytic measures are not reliable in the diagnosis of hypertension in hemodialysis.

**Keywords:** reliability - HBPM - hemodialysis - Dakar;

## Introduction

Hypertension (HTN) is defined as blood pressure (BP) greater than 140 mmHg for systolic and / or greater than 90 mmHg for diastolic [1]. Pre-dialysis HTN is defined by BP values greater than or equal to 140 mmHg for systolic and / or 90 mmHg for diastolic [2] and post-dialysis HTN with BP values greater than or equal to 130 mmHg for systolic and / or 80 mmHg for diastolic [2]. BP control is important for reducing cardiovascular morbidity and mortality in chronic hemodialysis (CHD) patients [3]. However, there is strong difference of opinion among this population regarding the ideal timing for BP measurement. The accurate diagnosis of hypertension in hemodialysis patients is difficult because of the large fluctuations in BP during the hemodialysis session [3]. Thus, there is uncertainty about the development of an accurate diagnosis of HTN in CHD patients by conventional measurement at the center [4]. Now, home blood pressure

monitoring (HBPM) and ambulatory blood pressure monitoring (ABPM) remain essential in the diagnosis of hypertension. No work has been done on this subject in Senegal, due to which we undertook this study with the aim of assessing sensitivity (Sen), specificity (Spe), positive predictive value (PPV) and negative predictive value (NPV) of BP measurement before and after hemodialysis sessions in sub-Saharan African hemodialysis centers.

## Patients and method

### Design of study

This was a cross-sectional and multicenter observational study that took place over a month and 23 days (25 April 2016 to 18 June 2016) in the hemodialysis units of the Aristide Le Dantec Hospital and the Grand Yoff General Hospital. All patients who could take BP at home using an electronic BP machine and put it on a self-measurement form, and who signed written consent after receiving an explanation, were included in the study. Patients with chronic hypotension were not included and those with less than 50% of records were excluded.

### BP measurement

Patients would independently take home BP twice a day, per the usual criteria for validity of the measure and write it on a pre-established statement form [5]. They performed three consecutive measurements at one minute intervals, at least five minutes rest, morning before breakfast, and before bedtime and taking medication. Compared to the traditional 3 day HBPM, we asked patients to perform 6 days of HBPM to analyze the different interdialytic periods [6]. The measurements of the first day were excluded from the interpretation. The average of the other values was calculated and represents the average BP obtained by HBPM.

Usual measurements made by early-stage dialysis nurses taken after five minutes of rest just before the session is connected; the end of session BP after restitution were collected

on a pre-established survey sheet during the same 6 days. The same electronics BP machine (OMRON or SPENGLER) was used by the patient in HBPM and by the nurse in conventional measurement (CM).

**Parameters setting**

The definitions used for the diagnosis of pre- and post-dialytic HTN are those of KDOQI 2005 [2], viz., in HBPM, an average weekly BP greater than or equal to 135 mmHg for systolic and / or 85 mmHg for diastolic [7]. Based on these definitions, patients were classified into four groups: permanent hypertensive (PH), permanent normo-tensive (PN), hypertensive white coat (WC) and masked hypertensive (MH). MH was defined by normal BP in CM and high BP in HBPM, WC with high BP in CM and normal BP in HBPM. PH was defined by high BP in HBPM and in CM and PN by normal BP in HBPM and in CM.

**Statistical analyzes**

Data was captured and analyzed utilizing the Sphinx software, version 5.1.0.2. A descriptive study was performed with the calculation of frequencies and proportions for qualitative variables and calculation of the means and standard deviation for quantitative variables.

Sensitivity (Sen), specificity (Spe), positive predictive value (PPV) and negative predictive value (NPV) were calculated as per the following formulas [8]:

$$\text{sen} = \frac{TP}{TP+FN}; \quad \text{Spe} = \frac{TN}{TN+FP}; \quad \text{PPV} = \frac{TP}{TP+FP}; \quad \text{NPV} = \frac{TN}{TN+FN}$$

TP (true positive) = PH; TN (true negative) = PN; FP (false positive) = WC; FN (false negative) = MH

**Results**

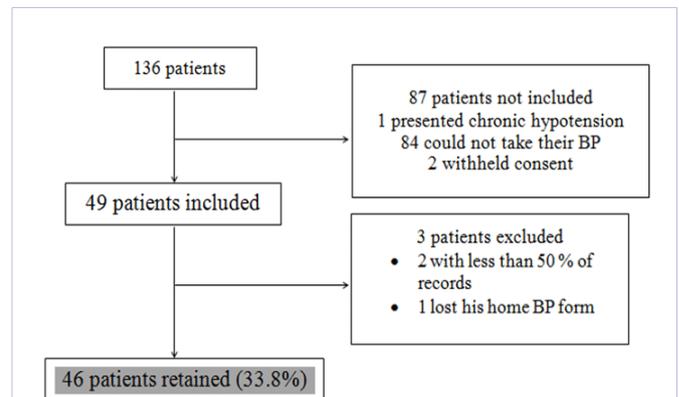
The number of patients included in the study was 49 which is 33.8% of the total of 136 patients. Of these patients, 3 were excluded: 2 with less than 4 measures and 1 having lost their HBPM record. A total of 46 patients were retained [Graphic 1]. The main characteristics of these patients are shown in [Table 1]. The mean-age was 45.57 years ± 14.11 with a sex ratio of 1.42. The mean duration of dialysis was 57.96 months ± 34.86. Hypertensive nephropathy was more common, noted in 20 patients or 43.5%, while nephropathy was indeterminate in 7 patients, accounting for 15.2%. Residual diuresis was present in 14 patients (30.4%). Of the 46 patients, 17 (37%) were on erythropoietin, 4 patients (8.7%) on iron and 31 patients (67.4%) on anti-hypertensive drugs [Graphic 2], with an average of 2 molecules ± 1.06. The mean hemoglobin level was 9.65 g / dl ± 2.20. Left ventricular hypertrophy (LVH) was noted in 15 patients (36.6%). HBPM compliance was 100% in 71.7%.

The mean pre-dialysis BP was 145.98 / 86.03 mmHg and post-dialysis BP was 140.79 / 85.6 mmHg. The mean BP in HBPM was 137.61/ 87.37 mmHg [Table 2]. BP was elevated in 38 patients (82.6%) in pre- and post-dialysis. It was systolo-diastolic in 68.4% in predialysis and 63.2% in post-dialysis.

For pre-dialysis measurements, Sen was 72.7%, Spe 53.8%,

PPV 80% and NPV 43.8%.

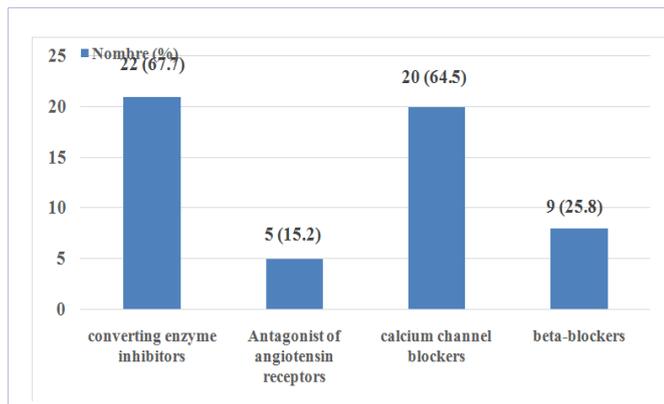
For post-dialysis measurements: Sen was 90.9%, Spe 38.5%, PPV78.9% and NPV 62.5% [Table 3].



**Graphic 1:** Study design

**Table 1:** Clinical, biological and therapeutic characteristics of 46 patients in the hemodialysis units of the Aristide Le Dantec Hospital and the Grand Yoff General Hospital.

Parameters	All patients, n=46
Mean-age (years)	45.57 ± 14.11
Duration in dialysis (months)	57.96 ± 34.86
Gender, n (%)	
Men	27 (58.7)
Women	19 (41.3)
Interdialytic weight gain, n (%)	3,52 ± 1.72
MBI, mean (Kg/m <sup>2</sup> )	21.88 ± 4.06
Overweight, n (%)	3 (6.5)
Obesity, n (%)	1 (2.2)
Thinness, n (%)	6 (13)
Intradialytic Hypotension, n (%)	6 (13)
Hemoglobin, mean (g/dl)	9.65 ± 2.20
Serum calcium, mean (mg/l)	88.79 ± 6.75
LVH, n (%)	15 (32.6)
Erythropoietin, n (%)	17 (37)
Antihypertensive drugs, n (%)	31 (67.4)
Number of antihypertensive drugs, mean	2 ± 1.06
Monotherapy, n (%)	11 (35.5)
Bitherapy, n (%)	13 (41.9)
Tritherapy, n (%)	5 (16.1)
Pentatherapy, n (%)	2 (6.5)



**Graphic 2:** Main drugs used in the treatment of hypertension in 46 chronic hemodialysis patients in 2 hemodialysis centers in Dakar

**Table 2:** Mean blood pressure in home blood pressure measurement, predialysis and postdialysis measurement of 46 patients in the hemodialysis units of the Aristide Le Dantec Hospital and the Grand Yoff General Hospital.

		Mean SBP	Mean DBP
<b>HBPM (mm Hg)</b>		137.61 ± 21.45	87.37 ± 13.93
<b>CM (mm Hg)</b>	Predialysis	145.98 ± 18.78	86.03 ± 13.22
	Postdialysis	140.79 ± 24.20	85.60 ± 14.52

**Table 3:** Sensitivity, specificity and predictive value of the measures of 46 patients in the hemodialysis units of the Aristide Le Dantec Hospital and the Grand Yoff General Hospital.

	Predialysis (%)	Postdialysis (%)
<b>Sen</b>	72.7	90.9
<b>Spe</b>	53.8	38.5
<b>PPV</b>	80.0	78.9
<b>NPV</b>	43.8	62.5
<b>Definition of HTN (mm Hg)</b>	≥ 140/90	≥ 130/80

## Discussion

In our study, the predialysis measurement was less sensitive, but more specific than the post-dialysis measurement. Thus, the post-dialysis measurement had less false-negative, while the predialytic measurement had fewer false positives. The same result is reported by Kaze Folefack F et al. in Lomé and Doukkali et al. in Morocco [9, 10]. The ideal threshold of blood pressure for the diagnosis should have a Sen and Spe of 100% [3]. These measures should ideally give an unequivocal answer to the diagnostic question relating to the presence of HTN if the measurement is positive, and its absence, if negative. Our study shows that BP measurements at the center have limited performance in the diagnosis of HTN in hemodialysis patients.

If BP is elevated pre- or post-dialysis, what is the probability

that the patient is truly hypertensive; and if BP is normal pre- or post-dialysis, what is the probability that the patient is not hypertensive? We calculated the PPV and the NPV. Our study revealed that a patient with pre- or post-dialysis HTN was respectively 80% and 78.9% likely to have HTN. In addition, a patient with pre- or post-dialysis normal BP had respectively 43.8% and 62.5% probability of not being hypertensive.

The results of CM should be confirmed by HBPM or at best by ABPM. These results also show that all hemodialysis patients should benefit from HBPM or ABPM, even if their BP is normal at the center. Moreover, it would be better for them to evaluate inter-dialytic BP, adopt the dry weight and the anti-hypertensive drugs, and estimate the level of overall cardiovascular risk of the patient [11]. However some authors like Zoccali, feel that it is of little use considering ABPM as the gold standard for definition of hypertension in the dialysis population, because there is no solid evidence that ABPM is superior to repeated pre-dialysis measurements (the average monthly value) [12].

## Conclusion

In our study, pre-dialysis measurement was less sensitive, but more specific than post-dialysis measurement. Both measurements have low specificity. This result confirms the difficulties in the diagnosis of hypertension in hemodialysis by pre- and post-dialysis measures. However, these measures do have their place in the supervision of the tolerance of the hemodialysis sessions. Thus, the HBPM makes it possible to better estimate the inter-dialytic BP, is extremely useful for adapting the dry weight and anti-hypertensive drugs, and for estimating the level of overall cardiovascular risk of the patient. Policies must be put in place to make electronic devices accessible.

## Limitation of the Study

All the same, our study has limitations of cohort size and selection bias, as only educated patients were included.

## Conflicts of interest

The authors declare not to have any conflict of interest in relation to this article.

## Contributions of the authors

All authors have read and approved this version of the manuscript.

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