ACCURACY OF FIXED 24-H AMBULATORY BLOOD PRESSURE RECORDINGS FOR DIAGNOSING HIGH 48-H AMBULATORY BLOOD PRESSURE IN HEMODIALYSIS PATIENTS

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Diagnosis of hypertension in dialysis patients

Box 1: Diagnosis of hypertension in dialysis patients

Hypertension in dialysis patients should be defined on the basis of home BP or ABPM measurements. Thresholds and methods proposed by the ASH/ASN [5], the EURECA-m working group of ERA-EDTA [11] and the relevant ESH Guidelines [24, 40, 41] can be used as follows:

- Home BP in haemodialysis: an average BP ≥135/85 mmHg for measurements collected in the morning and in the evening over 6 non-dialysis days (covering a period of 2 weeks). Measures should be performed in a quiet room, with the patient in seated position, back and arm supported, after 5 min of rest and with two measurements per occasion taken 1–2 min apart.
- Home BP in peritoneal dialysis: an average BP ≥135/85 mmHg over 7 consecutive days with measurements collected as above.
- ABPM in haemodialysis: an average BP ≥130/80 mmHg over 24-h monitoring during a mid-week day free of haemodialysis. Whenever feasible, ABPM should be extended to 44 h, that is, covering a whole mid-week dialysis interval.

Sarafidis P et al, Nephrol Dial Transplant 2017

Chapter 1: Blood pressure measurement

Recommendation 1.1: We recommend standardized office BP measurement in preference to routine office BP measurement for the management of high BP in adults *(1B)*.

Practice Point 1.1: An oscillometric BP device may be preferable to a manual BP device for standardized office BP measurement; however, standardization emphasizes adequate preparations for BP measurement, not the type of equipment.

Practice Point 1.2: Automated office BP (AOBP), either attended or unattended, may be the preferred method of standardized office BP measurement.

Practice Point 1.3: Oscillometric devices can be used to measure BP among patients with atrial fibrillation.

Recommendation 1.2: We suggest that out-of-office BP measurements with ambulatory BP monitoring (ABPM) or home BP monitoring (HBPM) be used to complement standardized office BP readings for the management of high BP *(2B)*.

KDIGO 2021 Clinical Practice Guideline for the Management of Blood Pressure in Chronic Kidney Disease

ABPM

(-) absence of reimbursement in most countries
(-) patient discomfort
(-) previous upper-limb AVF

Sarafidis P et al, Nephrol Dial Transplant 2017
Flythe ..Sarafidis et al. Kidney Int 2020

48h ABPM feasibility and tolerability in hemodialysis

440 participants
119 (27%) refused to undergo ABPM recording.

- Reasons for refusal were fear of discomfort (*n* = 30, 25%), measurement too long (*n* = 22, 18%), logistic problems (*n* = 17, 14%), previous negative experience (*n* = 13, 11%), clinical reasons (*n* = 12, 10%), other reasons (*n* = 25).

321 patients performed the 48h ABPM recording,
29 (9%) did not complete it

- main reason for interrupting the recording were discomfort [12 patients (41%)], followed by device failure [10 patients (34%)]. Among symptoms developed during the ABPM study, frequent interruption of sleeping because of noise or discomfort was reported by 32% of patients, followed by itching (24%) and pain during the measurements (20%).

era edta
EURECA-m working group
European Renal and Cardiovascular Medicine

6 hemodialysis centers

Torino et al, Nephrol Dial Transplant 2022

Diagnosis of hypertension in dialysis patients

www.kidney-international.org KDIGO executive conclusions

Blood pressure and volume management in dialysis: conclusions from a Kidney Disease: Improving Global Outcomes (KDIGO) Controversies Conference

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Flythe ..Sarafidis et al. Kidney Int 2020

Table 1 | Research recommendations[a]

Modality	Recommendations
BP measurements, targets, and pathophysiology	
HD and PD	Investigate the optimal BP target/threshold for hypertension treatment
HD and PD	Assess the agreement and prediction of standardized (attended or unattended) in-office BP readings, averaged intradialytic BP readings, and scheduled home BP readings with ABPM and clinical outcomes
HD and PD	Assess the acceptability and feasibility of ABPM
HD and PD	Investigate strategies to reduce BP variability
BP agent selection	
HD and PD	Hypertension: Conduct head-to-head RCTs of different medication classes on BP, including 44-h ABPM, and clinical and patient-reported outcomes (i.e., ARB vs. BB or ARB vs. BB vs. CCB)
HD and PD	Hypertension: Conduct RCTs on the effect of diuretics on RKF, BP, and CV outcomes
HD	Hypotension: Conduct larger, longer RCTs on effectiveness of midodrine
Dialysis prescription	
HD and PD	Perform studies that incorporate patient preferences and test individualized treatment approaches
HD and PD	Compare outcomes of strategies that focus on volume control vs. those that focus on RKF preservation
HD and PD HD	Investigate strategies for preserving RKF, including: • Impact of incremental dialysis on RKF • Impact of frequent/long hours dialysis on RKF
HD and PD	Investigate whether routine monitoring of RKF impacts clinical outcomes
HD and PD	Investigate spot biomarkers and urine volume for simple assessment of RKF
HD	Assess how to establish an individualized, *safe* UF rate for patients with different risk profiles
HD	Investigate the roles of dialysate composition—sodium, magnesium, and calcium—in intradialytic hypotension
PD	Evaluate whether minimizing dialysate glucose is preferable to reducing antihypertensive medication in PD patients with hypotension
PD	Assess whether routine monitoring of peritoneal membrane function impacts clinical outcomes
Technologies	
HD and PD	Investigate whether bioimpedance-guided volume management improves patient-centered and hard clinical outcomes
HD and PD	Investigate whether lung ultrasound-guided volume management improves patient-centered and hard clinical outcomes
HD	Investigate whether blood volume monitoring, temperature cooling, hemodiafiltration, UF profiling, and isolated UF have a benefit in hemodynamic stability, and whether this translates into benefits in hard outcomes
Volume-related patient symptoms and experiences	
HD and PD	Collect data on quality of life and symptoms in all future studies related to BP and/or volume management
HD and PD	Investigate the underlying physiology of symptoms[27]
HD and PD	Test different approaches to routine symptom assessment (e.g., smartphones, tablets)
HD and PD	Investigate correlations between symptoms and intradialytic or ambulatory BP, imaging (e.g., ultrasound, cardiac magnetic resonance), cerebral blood flow measurements, and bioimpedance spectroscopy
HD and PD	Develop symptom surveys that utilize computerized adaptive testing to decrease burden and tailor questions to individual patient priorities

ABPM, ambulatory blood pressure monitoring; ARB, angiotensin receptor blocker; BB, ß-blocker; BP, blood pressure; CCB, calcium channel blocker; CV, cardiovascular; HD, hemodialysis; PD, peritoneal dialysis; RCT, randomized controlled trial; RKF, residual kidney function; UF, ultrafiltration.
[a]Research recommendations within each topic area are listed in order of priority, stratified by modality type.

Objective

This study assessed the diagnostic accuracy of fixed 24-h ABPM recordings during both the 1st and the 2nd 24h period of the interdialytic interval, with 44-h BP in hemodialysis patients.

Methods (1)

- **242 patients**
- **5 dialysis centers**

- **Inclusion criteria:**
    1. age> 18 years and
    2. ESKD treated with a standard thrice-weekly hemodialysis schedule for >3 months
    3. Informed written consent
- **Exlusion criteria:**
    1. chronic AF or other arrhythmia
    2. nonfunctional AVF in the contralateral brachial arm area of the one used for vascular access
    3. modification of dry weight or antihypertensive treatment during 1 month prior to enrollment
    4. MI, angina pectoris and stroke during 1 month before study initiation
    5. history of malignancy or any other condition with poor prognosis

Methods (2)

- **48h ambulatory BP monitoring (Mobil-O-Graph NG)**
  - 4h dialysis session+ 44h interdialytic interval

- **Surrogate metrics of BP tested**
  - 44h SBP/DBP reference method
    - 1st 24h without hemodialysis period (20h-1st)
    - 1st 24h including hemodialysis period (24h-1st)
    - 2nd 24h periods (24h-2nd).

Statistical Analysis

1. Pearson coefficients of correlation (r) between each of the examined index and 44h BP were calculated to assess the validity of the respective indexes.
2. Bland-Altman plots, where the difference between the values of each metric and 44h BP readings was plotted against their average.
3. Diagnostic accuracy analyses: examinination of sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) for each of the studied BP metrics at prespecified cut-offs of SBP/DBP≥130/80 mmHg in diagnosing 44h SBP/DBP≥130/80 mmHg. Concordance between each different BP metric and 44h BP at the above thresholds was assessed using κ-statistic.
4. ROC analyses of each of the studied BP metrics examined as a continuous variable for the diagnosis of 44h SBP/DBP≥130/80 mmHg, respectively. A p-value of <0.05 (two-tailed) were considered statistically significant for all comparisons performed.

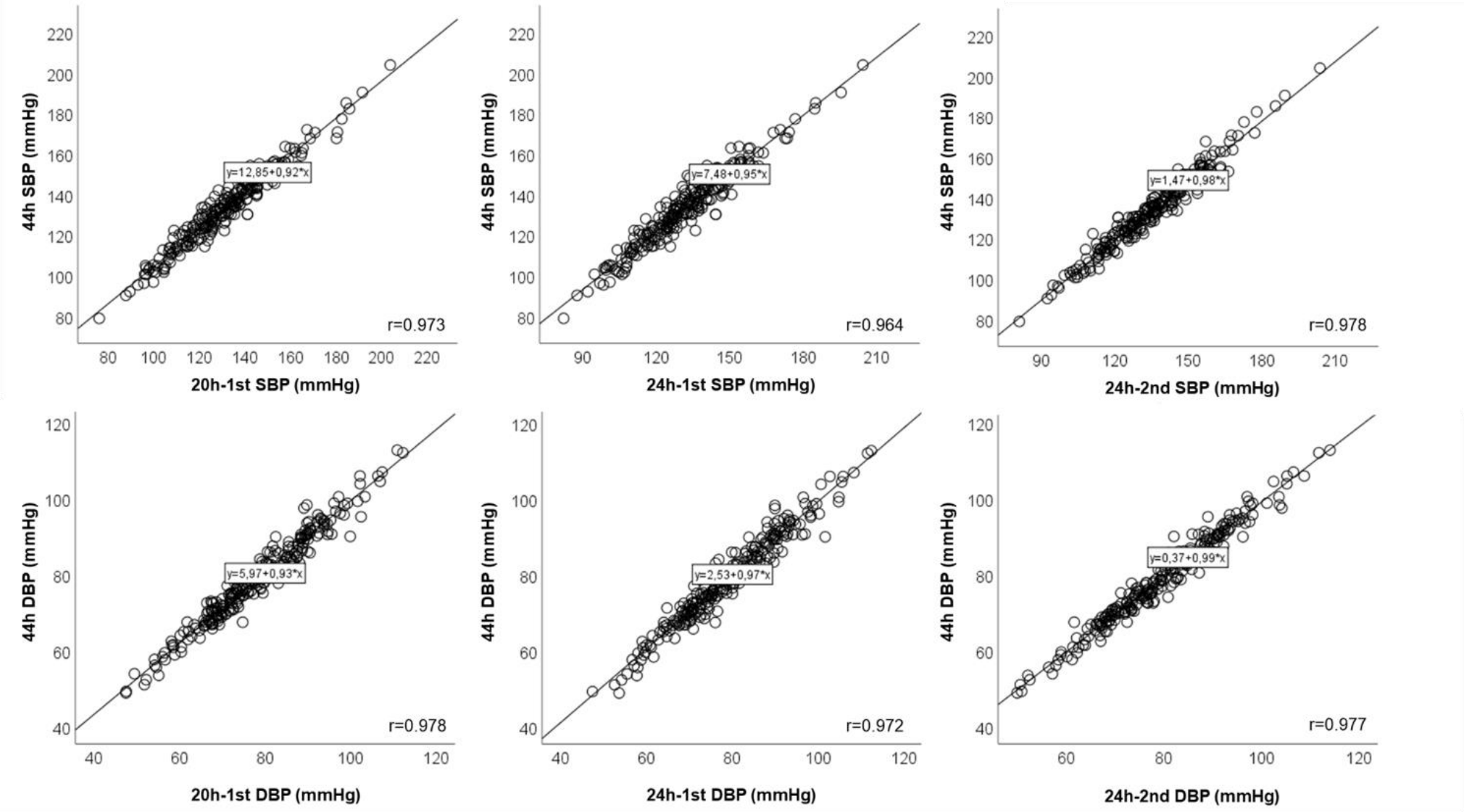
Baseline Characteristics

Parameter	Value
N	242
Caucasian race (n, %)	242 (100%)
Age (years)	62.71±14.23
Male sex (n, %)	151 (62.4%)
Dialysis vintage (months)	27.8 (3-292.6)
Smoking (n, %)	50 (20.8%)
Diabetes mellitus (n, %)	71 (29.3%)
Hypertension (n, %)	220 (90.9%)
Dyslipidemia (n, %)	57 (23.8%)
Heart failure (n, %)	98 (40.5%)
Primary cause of ESKD	
Diabetic kidney disease (n, %)	59 (24.4%)
Hypertension or ischemic renal disease (n, %)	23 (9.5%)
Glomerulonephritis (n, %)	42 (17.4%)
Inherited diseases (n, %)	19 (7.9%)
Other (n, %)	33 (13.2%)
Unknown (n, %)	67 (27.7%)
Weight (kg)	73.01±15.09
URR (%)	69.2 (40.0–96.0)
Interdialytic weight gain (kg)	1.89±1.03
UF rate (ml/kg per h)	7.01±3.47

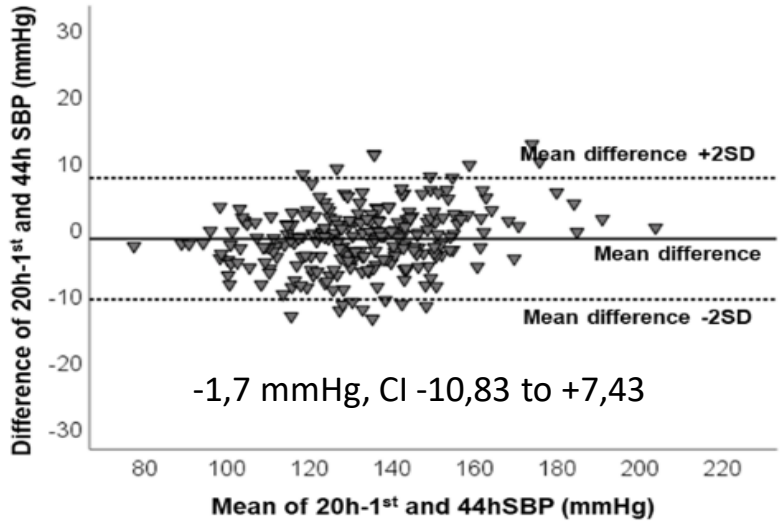
Baseline Characteristics

Parameter	Value
Antihypertensive medication	
ACEI (n, %)	24 (9.9%)
ARB (n, %)	37 (15.3%)
Aldosterone blockers (n, %)	3 (1.2%)
Renin inhibitors (n, %)	1 (0.4%)
CCB (n, %)	113 (46.7%)
b-blockers (n, %)	126 (52.1%)
Centrally active agents (n, %)	39 (16.1%)
Loop diuretics (n, %)	79 (32.6%)
Laboratory values	
Hemoglobin (g/dl)	11.4±1.3
Blood urea nitrogen (mg/dl)	64.97±16.21
Serum creatinine (mg/dl)	8.42±2.60
Serum sodium (mg/dl)	137.5±3.2
Serum potassium (mg/dl)	4.89±0.65
Serum calcium (mg/dl)	8.98±0.71
Serum phosphate (mg/dl)	5.15±1.44
Parathormone (ng/dl)	263.0 [227.0]

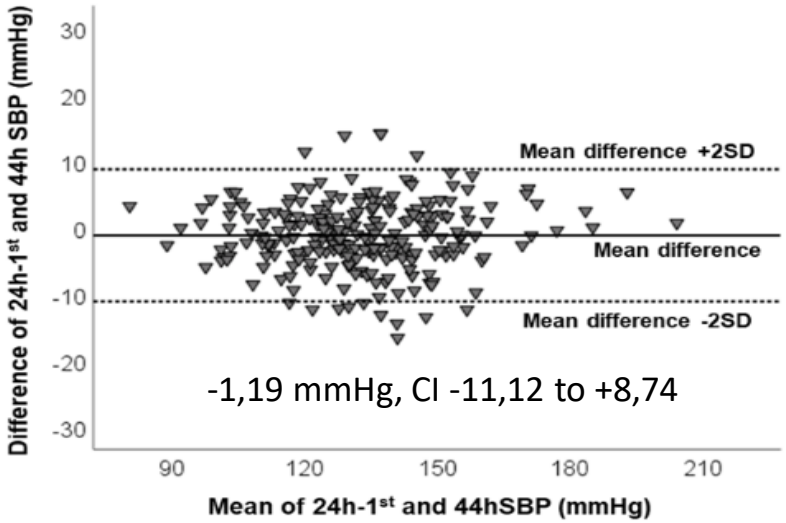
Correlation analyses



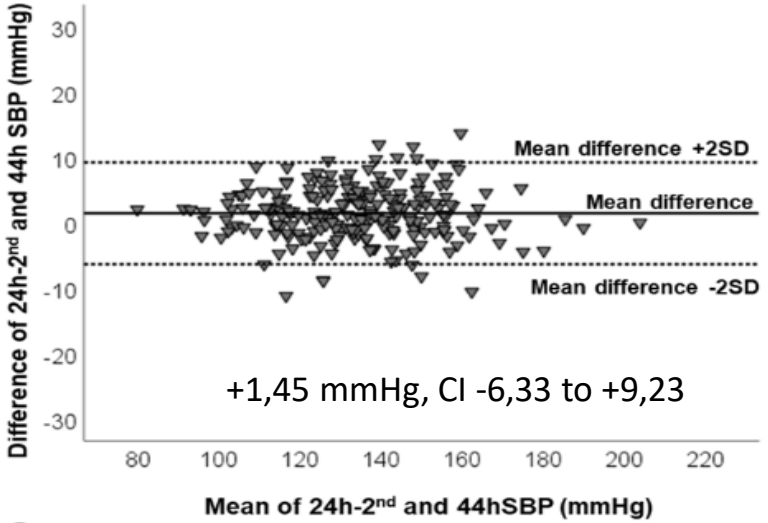
Bland-Altman analyses



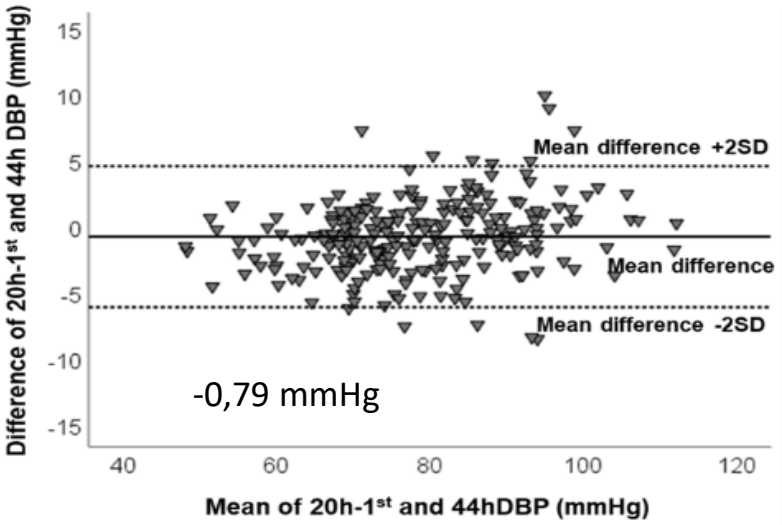
-1,7 mmHg, CI -10,83 to +7,43



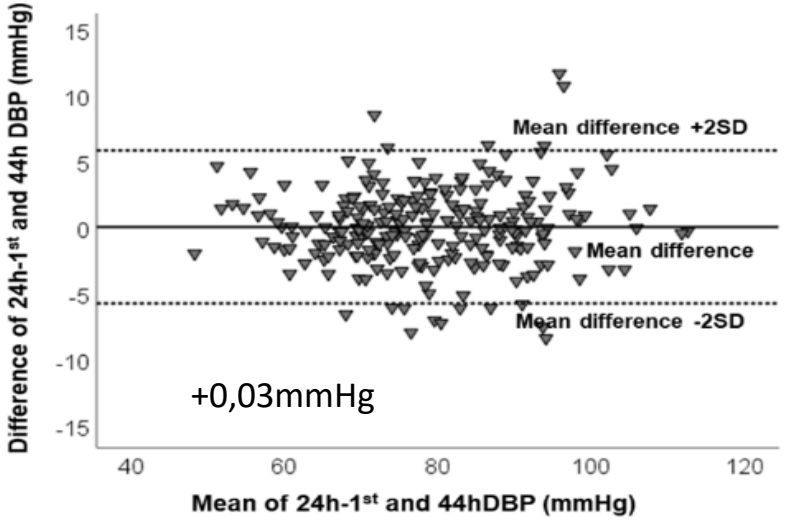
-1,19 mmHg, CI -11,12 to +8,74



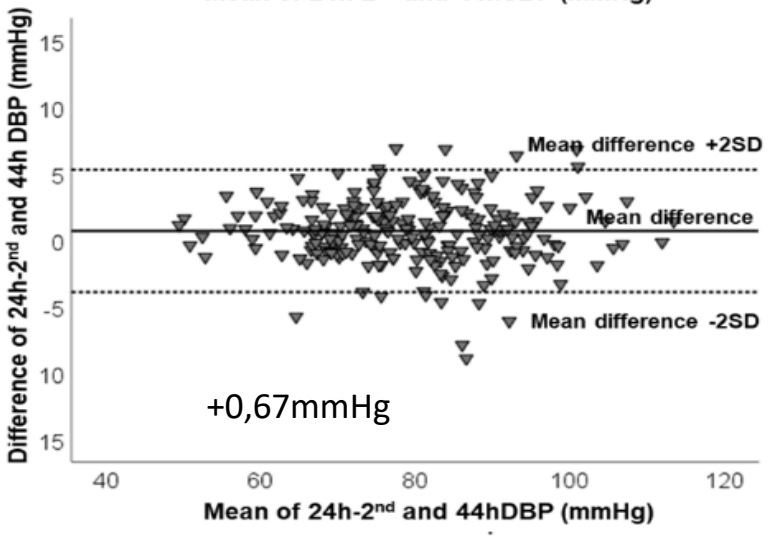
+1,45 mmHg, CI -6,33 to +9,23



-0,79 mmHg



+0,03mmHg



+0,67mmHg

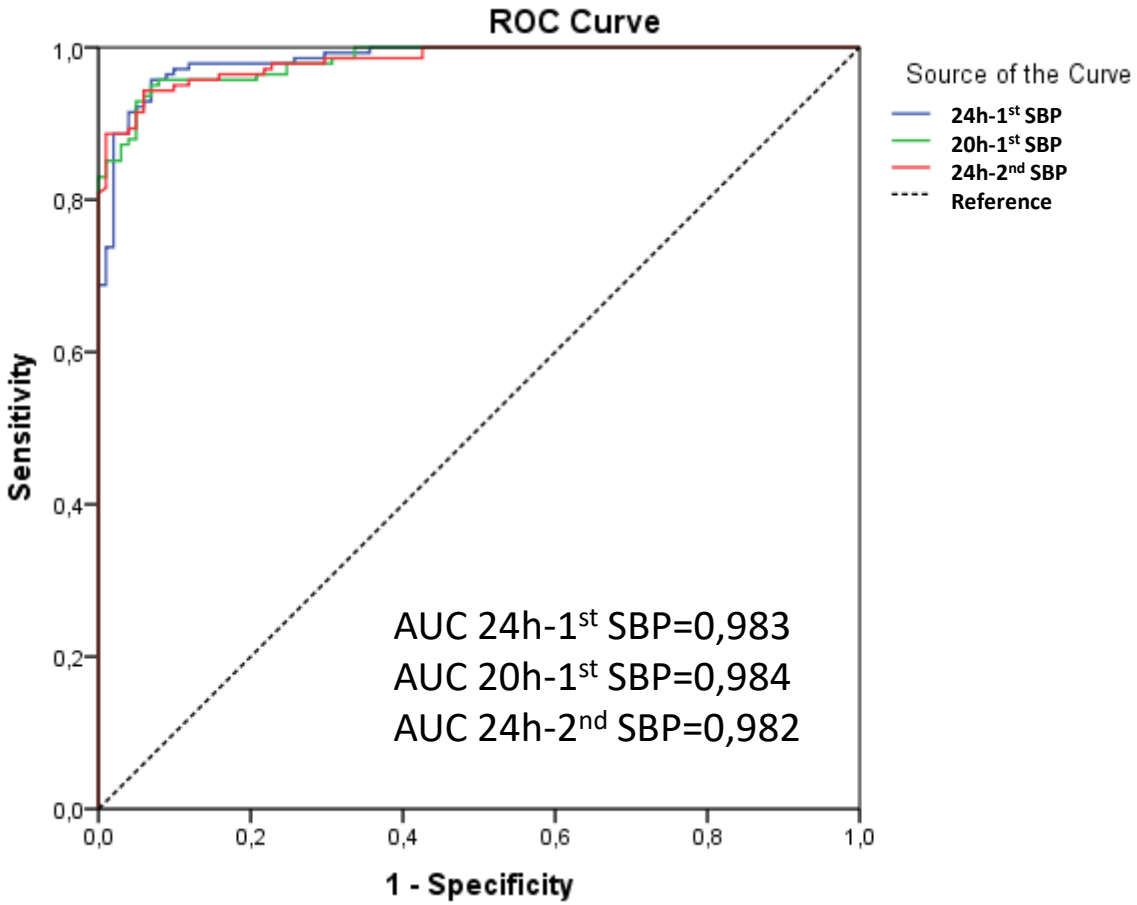
Diagnostic Performance of studied BP metrics
Sensitivity, Specificity, Positive/Negative prognostic value

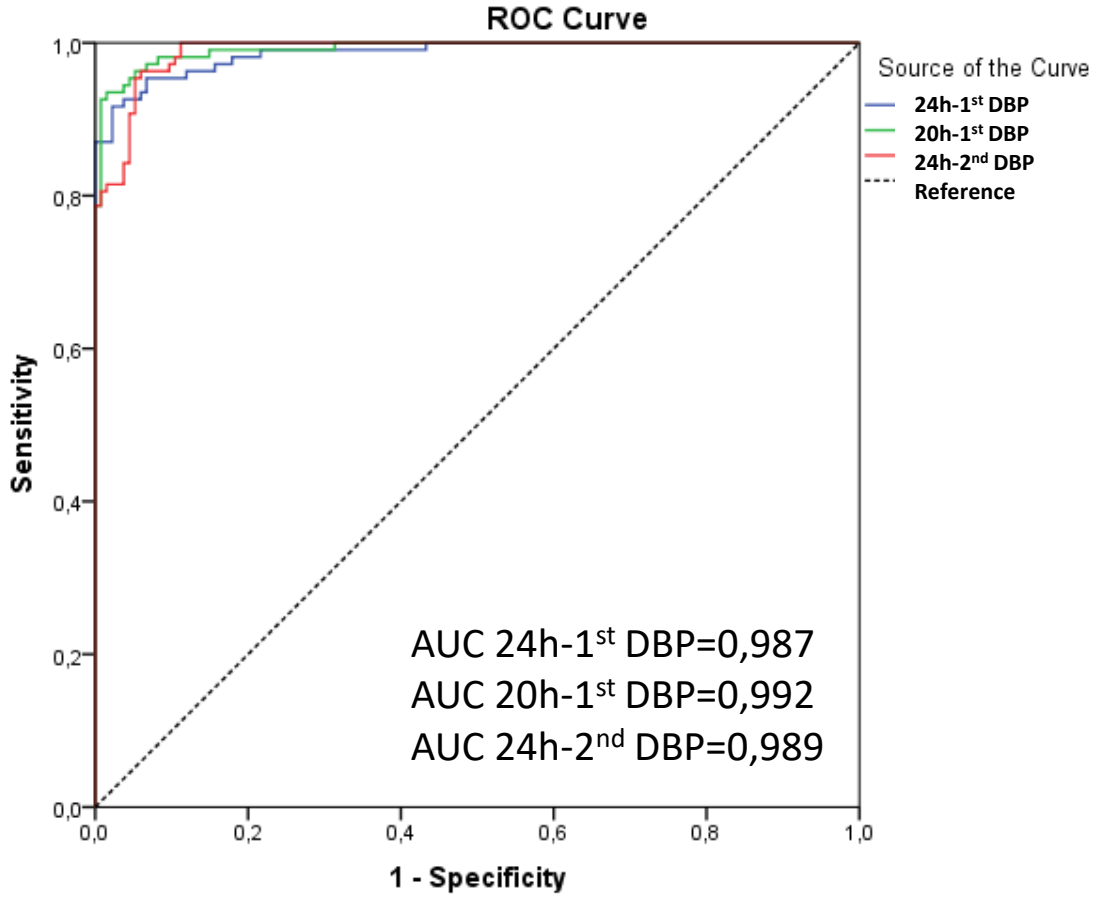
pre specified cut-offs SBP≥130 mmHg for diagnosing high 44-h SBP≥130 mmHg

	Sn(%)	Sp (%)	PPV (%)	NPV (%)	κ-statistic
SBP					
20h-1st	87.2	96.0	96.9	84.3	0.817 (p<0.001)
24h-1st	88.7	96.0	96.9	85.8	0.833 (p<0.001)
24h-2nd	95.0	88.1	91.8	92.7	0.837 (p<0.001)
DBP					
20h-1st	92.7	98.5	98.1	94.2	0.916 (p<0.001)
24h-1st	91.7	94.7	93.5	93.3	0.866 (p<0.001)
24h-2nd	96.3	94.7	93.8	96.9	0.908 (p<0.001)

ROC analyses

ROC curves for diagnosing high 44h SBP/DBP≥130/80 mmHg





Conclusions

- 24h ABPM recordings during either the first or the second day of interdialytic interval are strongly correlated with, show high specificity and sensitivity combinations for and display excellent agreement according to κ-statistic with 44h BP.

- These findings suggest that ABPM recordings of either the first or the second interdialytic day could be used for hypertension diagnosis and management in hemodialysis patients.

- Future research efforts are needed to assess the associations of these BP metrics with cardiovascular events and all-cause mortality in this population with high-burden of cardiovascular disease.