Ambulatory blood pressure is better associated with target organ damage than clinic blood pressure in patients with primary glomerular disease

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Abstract

Background: Blood pressure is an important and modifiable cardiovascular risk factor. Ambulatory blood pressure monitoring (ABPM) provides valuable prognostic information in patients with chronic kidney disease (CKD), yet little is known about the association of various types of BP measurements with target organ damage (TOD) in patients with primary glomerular disease. The goal of this study was to investigate whether ambulatory blood pressure is better associated with TOD than clinic blood pressure in patients with primary glomerular disease.

Methods: 1178 patients with primary glomerular disease were recruited in this cross-sectional study. TOD were assessed by the following 4 parameters: left ventricular mass index (LVMI or LVH, left ventricular hypertrophy), estimated glomerular filtration rate (eGFR<60ml/min/1.73m 2), albumin-to-creatinine ratio (ACR≥30mg/g) and carotid intima-media thickness (cIMT) or plaque. Receiver operating characteristic (ROC) curve and multivariate logistic regression analyses were used to evaluate the relationship between ambulatory or clinic systolic blood pressure (SBP) indexes and TOD.

Results: Among 1178 patients (mean age, 39 years,54% men), 116, 458, 1031 and 251 patients had LVH, eGFR < 60 ml/min/1.73m 2 , ACR≥30mg/g and cIMT≥0.9mm or plaque respectively. Area under ROC curves for TOD in ambulatory SBP, especially nighttime SBP, was greater than that in clinic SBP (P <0.05). Multivariate logistic regression analyses showed that 24h SBP, daytime SBP and nighttime SBP were significantly associated with LVH, eGFR<60 ml/min/1.73m 2 and ACR≥30mg/g after adjustment for clinic SBP, while the association of clinic SBP was attenuated after further adjustment for nighttime SBP.

Conclusions: Ambulatory blood pressure, especially nighttime blood pressure, is probably superior to clinic blood pressure in predicting TOD in patients with primary glomerular disease.

Background

Chronic kidney disease (CKD) is a worldwide public health problem[1]. In these patients, hypertension is prevalent and considered the leading risk factor for death, which contributes to 45% of male deaths and 46% of female deaths. [2-3][i][4] Hypertension is also among the most important modifiable risk factors for end-stage renal disease (ESRD). Therefore, appropriate evaluation and management of hypertension to achieve blood pressure (BP) goals in CKD patients is necessary and valuable.

Ambulatory blood pressure monitoring (ABPM) could provide detailed information on BP over a 24h period, and it is unanimously recommended by guidelines for BP management[5-6][ii][7]. Previously, we have reported the high prevalence and prognostic value of nighttime hypertension in CKD patients compared with clinic blood pressure[8-9][iii][10]. Recent evidence from large-scale cohort study also suggests that higher 24-hour and nighttime blood pressure measurements were significantly associated with greater risks of death and cardiovascular disease, even after adjusting for other office-based or ambulatory blood

pressure measurements[11]. All these data suggested ABPM was better than clinic blood pressure when assessing target organ damage (TOD) and prognosis in CKD patients.

However, CKD patients with different etiologies, like primary glomerular disease and diabetic kidney disease, were enrolled in prior studies at the same time. Primary glomerular disease and diabetic kidney disease were two main causes of CKD in many countries. In previous studies, the percentage of patients with diabetic kidney disease or diabetes mellitus at enrollment was 11-65%[12-15][iv][14][v][15][vi]. Compared with non-diabetic kidney disease, patients with diabetic kidney disease showed different BP characteristics and had a worse prognosis. [16-17] The systolic blood pressure control was worse and non-dipping rhythm was quite common[16] .Once in the period of massive albuminuria, the progression rate of diabetic kidney disease to ESRD is about 14 times that of other renal diseases[17], indicating patients with diabetic kidney disease would have more severe subclinical TOD, so it might be a big difference on the priority of ABPM between patients with and without diabetic kidney disease. It is very important to evaluate various types of BP measurements especially ABPM, and assess the strength of their associations with TOD, focusing on patients with primary glomerular disease considering primary glomerular disease continues to be the very common in our country[18]. Accordingly, the objective of this study is to investigate whether ambulatory blood pressure is better associated with TOD than clinic blood pressure in patients with primary glomerular disease.

Methods

Study population

The study protocol was approved by the ethics committee of the Fifth Hospital of Sun Yat-Sen University (Guangdong, China) and adhered to the Declaration of Helsinki. Informed consent was obtained from each participant. Consecutive patients were recruited from the Fifth Affiliated Hospital of Sun Yat-Sen University (Guangdong, China) between July of 2017 and Nov of 2019. Patients (14-75 years) with primary glomerular disease proved by renal biopsy or clinic findings after exclusion of secondary renal damage factors, were included. Patients were excluded from the study in case of :1) diabetes mellitus 2) acute changes in the eGFR >30% in the previous three months; 3) maintenance dialysis or history of kidney transplantation; 4) cardiovascular disorders (unstable angina pectoris, heart failure, life-threatening arrhythmia, atrial fibrillation, stroke and grade III–IV retinopathy); 5) pregnancy; 6) night work or shift-work employment; 6) intolerance to ABPM or invalid ABPM data; 7) inability to communicate and comply with all of the study requirements; Finally, a total of 1178 patients were enrolled in this study (**Figure 1**).

Ambulatory and clinic blood pressure monitoring

Patients underwent 24-hour ABPM using a Mobil-O-Graph Monitor (I.E.M. GmbH, Stolberg, Germany)[19,20].Appropriate cuff size was chosen based on the arm circumference and directly placed on the non-dominant arm. The monitor was programmed to measure every 15 minutes during the day（7：00 am to 10：00 pm）, and every 30 minutes during the night （10：00 pm to 7：00 am）. Monitoring was performed on a working day. Patients were instructed to maintain their usual but not strenuous level of activity, and to keep motionless at the time of measurement. ABPM data were invalid in cases of: 1) >30% of measurements were lacking; 2）>3 hours data were missing；3）sleep time at night was <6 or >12 hours during monitoring.[21]

Clinic BP was measured at the physician's office with a standard mercury sphygmomanometer after a 5-minute rest in a sitting position. For all patients, sphygmomanometric measurements were recorded by the same physician, who was not aware of the results of ABP recordings. Reported values of clinic BP were the mean of 2 or 3 measurements at 1-2 min intervals, recorded during the 2 days in which the ABPM device was installed and removed.

Cardiac, renal and carotid assessment

Cardiac structure and function were assessed by 2 investigators trained for this purpose before starting the study. Linear measurements of interventricular septal wall thickness (IVSd), end-diastolic left ventricular internal dimension (LVIDd), and posterior wall thickness (PWTd) were obtained from M-mode tracings，using 2-dimensional echocardiography. LVM was calculated using the Duvereux method[22]. The left ventricular mass index (LVMI) was obtained by calculating the ratio of LVM to body surface area.

Concentrations of serum creatinine (Scr) were measured by an enzymatic method traceable to isotope dilution mass spectrometry. The estimated Glomerular Filtration Rate (eGFR) was calculated using 2009 Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) creatinine equation[23]. Awaking（7：00 am to 10：00 pm）、bedtime（10：00 pm to 7：00 am）and 24-hour urine samples were collected to predict excretion levels of urinary albumin, protein, and creatinine. Patients were asked to void their bladders at 7:00 am and 10:00 pm to ensure valid results.

Carotid intima-media thickness (cIMT) was determined by averaging 3 measurements taken on each carotid artery (in anterior, lateral and posterior directions), measuring the distance between the leading edge of the lumen–intima interface, and the leading edge of the collagenous upper layer of the adventitia using high-resolution B mode ultrasonography. Measurements were taken in areas free of obvious atherosclerotic plaques around the level of the carotid bifurcation.

Collection of other data

Information including age, sex, height, weight, smoking and alcohol consumption status, antihypertensive medication were obtained at the time of the BP measurement. Laboratory data (hemoglobin, albumin, calcium, phosphorus, intact parathyroid hormone, triglycerides, total cholesterol, high-density lipoprotein cholesterol, low-density lipoprotein cholesterol, uric acid and blood urea nitrogen) were obtained at the initial study visit. Blood samples were taken in the morning and analyzed using a 7180 Biochemistry Autoanalyzer (Hitachi, Tokyo, Japan) with reagents from Roche Diagnostics (Mannheim, Germany).

Definitions

CKD was divided into 5 stages and defined as the presence of kidney damage or decreased renal function (eGFR <60 mL/min per 1.73 m2) for ≥3 months according to the Kidney Disease: Improving Global Outcomes (KDIGO) 2012 clinical practice guideline. Clinic hypertension was defined as clinic blood pressure (BP) ≥140/ 90 mmHg and ambulatory blood pressure (ABP) was defined as 24-hour BP ≥130/80 mmHg. Masked hypertension was defined as a normal clinic BP (≤140/90 mm Hg) and an elevated ABP (>130/80 mm Hg). White coat hypertension was regarded as increased clinic BP (>140/90 mm Hg) and normal ABP (≤130/80 mmHg). Normotension was defined as both clinic BP <140/ 90 mm Hg and ABP <130/80 mmHg; Sustained hypertension was regarded as clinic BP ≥140/90 mm Hg and ABP ≥130/80 mmHg. Nighttime hypertension was defined as nighttime systolic BP (SBP) ≥120 mm Hg or/and diastolic BP (DBP) ≥70 mmHg. Isolated nighttime hypertension was defined as daytime BP <135/85 mm Hg and nighttime BP ≥120/70 mmHg. Participants with a reduction in SBP of ≥10% at night-time compared with daytime were considered to have a “dipper” pattern, and an “extreme dipper pattern” referred to a >20% reduction at nighttime. A “non-dipper” pattern referred to a <10% reduction at nighttime and a “reversed dipper pattern” referred to higher SBP at nighttime compared with daytime. Target organ damage (TOD) was defined if it met any of four conditions[24]: 1) left ventricular hypertrophy (LVH), namely LVMI ≥125 g/m2 (man) or ≥120 g/ m2 (woman) ; 2) eGFR <60 mL/ min per 1.73 m^2; 3) Urinary albumin-to-creatinine ratio (ACR) ≥30mg/g; 4) cIMT ≥0.9mm or existence of carotid plaque in ultrasonography.

Statistical analysis

Statistical analysis was performed with SPSS 25.0 (IBM Corp., Armonk, NY) and Medcalc 18.9 （Broekstraat, Mariakerke, Belgium）. Descriptive statistics were mean±SD for continuous variables or median (25-75th interquartile range) for non-normality variables. Frequency and percentage were used for categorical variables. To analyze the sensitivity and specificity of different BP indexes in relationship to TOD（LVH、eGFR<60ml/min per 1.73 m^2、ACR≥30mg/g、cIMT≥0.9mm or carotid plaque）, we generated and compared receiver operating characteristic (ROC) curves, including area under the curve (AUC) and their 95% CIs. Considering each TOD may be affected by other important factors, and clinic and ambulatory SBP may have different prognostic value, we established 12 multivariate adjusted logistic

regression models in all. All these models in sequence could be divided to four parts according to the TOD categories. Model 1-3、4-6、7-9 and 10-12 corresponded with LVH、eGFR<60ml/min per 1.73 m^2、ACR≥30mg/g、cIMT≥0.9mm or carotid plaque, respectively. Model 1 included adjustment for age, sex, BMI, smoking, alcohol consumption status, hemoglobin. albumin, eGFR, number of BP medications and type of glomerular disease. Model 4 included adjustment for age, sex, BMI, smoking, alcohol consumption status. hemoglobin. albumin, ACR, iPTH, uric acid, calcium* phosphate product, number of BP medications and type of glomerular disease. Model 7 included adjustment for age, sex, BMI, smoking, alcohol consumption status, hemoglobin, albumin, uric acid, number of BP medications and type of glomerular disease. Model 10 included adjustment for age, sex, BMI, smoking, alcohol consumption status, eGFR, LDL-C, statin use, number of BP medications and type of glomerular disease. Model 2,5,8,11 included adjustment for the variables in Model 1,4,7,10 respectively and additional adjustment for clinic SBP when examining 24h/daytime/nighttime SBP as the independent variable. Model 3,6,9,12 included adjustment for the variables in Model 1,4,7,10 respectively and additional adjustment for nighttime SBP when examining clinic SBP as the independent variable. Probability values were 2-tailed and $P < 0.05$ was considered statistically significant for all comparisons.

Results

Demographic and clinical characteristics of the study population

Mean age of the study population was 38.8 years, and 53.7% was male. A total of 752 patients (63.8%) had renal biopsy reports. The number of patients with IgA nephropathy, mesangial proliferative glomerulonephritis (MsPGN), minimal change disease (MCD), membranous nephropathy (MN); focal segmental glomerulosclerosis (FSGS) and membranoproliferative glomerulonephritis (MPGN) was 354, 17, 38, 162, 36 and 9, respectively; 18.5% of patients were current smokers, and101 patients (8.6%) consumed alcohol. The prevalence of LVH, eGFR<60 ml/min/1.73m^2, ACR≥30mg/g, cIMT≥0.9mm or plaque was 9.8%, 38.9%, 87.5%, 21.3%, respectively (**Table 1**).

Characteristics of ABPM in the study population

The prevalence of nighttime hypertension in these patients was 62.2%, while 272 patients (23.1%) had isolated nighttime hypertension. A total of 609 (51.7%) patients had non dipper pattern and 197 (16.7%) patients had reversed dipper pattern, while only 341 (28.9%) patients had a dipper pattern. 129(10.9%) of patients had white-coat hypertension and 175 (14.9%) had masked hypertension. (**Table 2**) Mean BP in each category was shown in supplementary Table 1.

Receiver-Operating Curve Analysis for Prediction of target organ damages

In receiver-operating curve analysis, all SBPs were significant predictors of LVH. Areas under the curve (AUC) were 0.779, 0.770, 0.760, 0.721 for nighttime SBP, 24h SBP, daytime SBP and clinic SBP respectively. What's more, nighttime and 24h SBP ROC curves had greater AUC compared with clinic SBP in predicting LVH (***P<0.05***).

When prediction of eGFR<60 ml/min/1.73m^2, AUC were 0.756, 0.762, 0.756, 0.725 for nighttime SBP, 24h SBP, daytime SBP and clinic SBP respectively, and statistical analysis showed daytime, nighttime and 24h SBP had great AUC compared with clinic SBP in predicting eGFR<60 ml/min/1.73m^2 (***P<0.05***).

When considering ACR≥30mg/g, AUC were 0.671, 0.654, 0.647, 0.629 for nighttime SBP, 24h SBP, daytime SBP and clinic SBP respectively, and only nighttime SBP had great AUC compared with clinic SBP in predicting ACR≥30mg/g by statistical analysis(***P<0.05***).

Finally, when prediction of cIMT≥0.9mm or plaque, AUC were 0.680, 0.681, 0.676, 0.694 for nighttime SBP, 24h SBP, daytime SBP and clinic SBP respectively, and statistical analysis did not show any difference between ambulatory SBP and clinic SBP in predicting cIMT≥0.9mm or plaque. (**Figure 2 and Table 3).**

Factors associated with target-organ damage by multivariate logistic regression analyses

Multivariate logistic regression analyses were carried out to clarify factors associated with target-organ damage. Higher clinic and ambulatory BPs were significantly associated with higher prevalence of LVH, eGFR<60 ml/min/1.73m^2 and ACR≥30mg/g (***P*** <0.05). 24h SBP, daytime SBP and nighttime SBP were still significantly associated with LVH, eGFR<60 ml/min/1.73m^2 and ACR≥30mg/g (***P*** <0.05) after adjustment by clinic SBP. However, the association of clinic SBP with LVH, eGFR<60 ml/min/1.73m^2 and ACR≥30mg/g (***P*** <0.05) was attenuated after further adjustment for nighttime SBP (***P***=0.290, ***P***=0.160, ***P***=0.323, respectively). With respect to cIMT≥0.9mm or plaque, ambulatory SBP or clinic SBP was not significant in multivariate adjusted models with clinic and 24h/daytime/nighttime SBP included. (**Table 4)**

Discussion

In this cross section study, we explore and compare associations of different BP indexes with TOD in CKD patients with primary glomerular disease. We found that ambulatory SBP, especially nighttime SBP, performed better than clinic SBP when predicting TOD. What's more, higher 24h, daytime and nighttime SBP were significantly associated with TOD in these patients even adjusted clinic SBP in multivariate logistic regression analyses. All these data suggested that ABPM is superior to clinic blood pressure in estimating TOD in patients with primary glomerular disease, and we should pay special attention to the use of ABPM in these patients in clinical practice.

Over the past years, ABPM developed into the recommended technique for BP measurement, risk stratification and classification of hypertension[25,26]. Compared with clinic BP, ABPM increased the ability to identify circadian variations in BP and identify daytime and nighttime BP. Prior studies have consistently demonstrated significant and superior association of ambulatory SBP with TOD in hypertensive patients,[27,28] as well as in CKD patients[29,30]. However, all these data were from CKD patients with different causes. CKD patients mixed with different etiologies like primary glomerular disease and diabetic kidney disease, were all included in these studies. Many factors such as glucose, inflammatory, salt intake would affect blood pressure status, so studies enrolled more diabetic patients would draw different conclusion compared with studies enrolled fewer diabetic patients. In previous studies, percentage of patients with diabetic kidney disease or diabetes mellitus at enrollment is up to 65%.[12-13141516] As the high glucose influences the microenvironment of target organ, including heart, kidney and arteries, patients with diabetic kidney disease showed a more severe TOD, and progressed to ESRD more quickly than other renal disease, once in the period of massive albuminuria. It reminds us of different meanings about ABPM in CKD patients with different etiologies. So we cannot directly extend these conclusions from patients with diabetic and non-diabetic kidney disease to patients with primary glomerular disease.

Primary glomerular disease is still predominant in hospitalized rural patients in China.[31] Data of ABPM in patients with primary glomerular disease was very limited and mostly compared with secondary or diabetic kidney disease in a small sample size.[32-33][i]34[ii]35[iii]36Patients with primary glomerular disease seems to have a better control of BP and lower prevalence of abnormal circadian rhythm[16], which may lead to a big difference on the priority of ABPM between patients with and without secondary glomerular disease, especially diabetic kidney disease. Moreover, associations of ABPM with TOD were poorly declared in past studies. Thus, after recruiting a large sample of these population we evaluate various types of BP measurements especially ABPM, and assess the strength of their associations with TOD.

The current study strengthened the notion that ABPM, especially nighttime BP carries valuable prognostic information in patients with primary kidney disease. These data confirmed the importance and superiority of ABPM in these patients. Future studies are required to ascertain whether individuals could benefit from BP-lowering interventions targeting the ambulatory monitory results and ultimately reduce cardiovascular events.

Some limitations of our study deserve mention. Firstly, the size of the study population was large but was from a single center. Secondly, all enrolled CKD patients underwent only one ABPM and we could not rule out subsequent changes in ABPM. Thirdly, some patients with non-severe proteinuria or renal damage might have been excluded, leading to bias. Finally, we cannot infer a cause–effect relationship based on our cross-sectional data.

Conclusion

In conclusion, we have provided the first evidence that higher 24h, daytime, nighttime SBP, better than clinic SBP, were significantly associated with greater prevalence of TOD in CKD patients with primary glomerular disease, after adjustment for demographics and clinical characteristics. Thus, ABPM should be considered optimal and preferred measurement for estimating cardiovascular risk in these patients.

Abbreviations

BP, Blood pressure; ABPM, Ambulatory blood pressure monitoring; TOD, Target organ damage; CKD: Chronic kidney disease; CKD-EPI: CKD Epidemiology Collaboration; ESRD: End stage renal disease; LVMI, Left ventricular mass index; LVH, Left ventricular hypertrophy; eGFR, Estimated glomerular filtration rate; ACR, Albumin-to-creatinine ratio; cIMT, Carotid intima-media thickness; ROC, Receiver operating characteristic.

Declarations

Ethics approval and consent to participate

Ethical approval was granted by the Ethics Committee of the Fifth Hospital of Sun Yat-Sen University (Guangdong, China). Participants were required to provide written consent to participate. Written informed consent for participation in the study was obtained where participants are children (under 16 years old) from their parent or guardian.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare no conflict of interests. The results presented in this paper have not been published previously in whole or part, except in abstract format.

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Authors' contributions

Study concept and design:RWW, XQC CW. Acquisition, analysis, and interpretation of data: RWW, XQC, YZ, JT K, YD. Drafting of the manuscript: RWW, XQC. Critical revision of the manuscript for important intellectual content: RWW, XQC. Statistical analysis:.RWW, XQC.All authors read and approved the final manuscript.

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Tables

Table 1. Demographic characteristics and clinical parameters of study population

Parameters	Value
No. of Patients	1178
Age(years)	38.8±14.0
Male[n(%)]	633(53.7)
BMI($kg.m^{-2}$)	22.9±3.5
Smoker[n(%)]	218(18.5)
Drinker[n(%)]	101(8.6)
Primary Glomerular Diseases	
IgA[n(%)]	354(30.1)
MsPGN[n(%)]	17(1.4)
MCD[n(%)]	38(3.2)
MN[n(%)]	162(13.8)
FSGS[n(%)]	36(3.1)
MPGN[n(%)]	9(0.8)
Others[n(%)]	562(47.7)
Medication	
ACEI or ARB[n(%)]	576(48.9)
β-blocker[n(%)]	179(15.2)
CCB[n(%)]	362(30.6)
α-blocker[n(%)]	71(6.0)
Statin[n(%)]	200(17.0)
Antihypertensive medication use	
0[n(%)]	347(29.5)
1[n(%)]	570(48.4)
2[n(%)]	172(14.6)
3[n(%)]	78(6.6)
4[n(%)]	11(0.9)
Laboratories	
Hemoglobin[g/L]	124.8±27.6
Albumin[g/L]	34.5±9.0
Total cholesterol[mmol/L]	5.3(4.3,6.9)
LDL cholesterol[mmol/L]	3.2(2.4,4.4)

HDL cholesterol[mmol/L]	1.2(1.0,1.5)
Triglycerides[mmol/L]	1.5(1.0,2.3)
Calcium[mg/dL]	8.8±0.8
Phosphate [mg/dL]	3.7±0.4
Calcium* Phosphate[mg^2/dL^2]	35.3±9.9
iPTH[pmol/L]	4.9(3.4,8.5)
Uric acid [μmol/L]	434.0(346.3,522.9)
Creatinine [μmol/L]	97.0(68.3,200.0)
CKD Stages	
Stage 1[n(%)]	489(42.4)
Stage 2[n(%)]	231(19.6)
Stage 3[n(%)]	165(14.0)
Stage 4[n(%)]	96(8.1)
Stage 5[n(%)]	197(16.7)
eGFR-EPI(ml/min/1.73m^2)	78.0(30.0,108.0)
eGFR<60 ml/min/1.73m^2 [n(%)]	458(38.9)
ACR [mg/g]	302.4(85.6,851.2)
ACR≥30mg/g[n(%)]	1031(87.5)
cIMT-left[mm]	0.7±0.2
cIMT-right[mm]	0.7±0.2
cIMT≥0.9mm or plaque[n(%)]	251(21.3)
Left ventricular mass index[g/m^2]	92.1±24.4
Left ventricular hypertrophy [n(%)]	116(9.8)

Numbers are mean±SD, median (25-75th interquartile range) or number (percentage). MsPGN, mesangial proliferative glomerulonephritis; MCD, minimal change disease; MN, membranous nephropathy; FSGS, focal segmental glomerulosclerosis; MPGN, membranoproliferative glomerulonephritis; ACEI, angiotensin-converting enzyme inhibitor;ARB, angiotensin receptor blocker; CCB, calcium channel blocker; LDL, low-density lipoprotein; HDL, high-density lipoprotein; iPTH, intact parathyroid hormone. ACR, albumin-to-creatinine ratio; cIMT, carotid intima-media thickness.

Table 2. Clinic and ambulatory blood pressure characteristics in study population

Parameters	Value
Clinic SBP(mmHg)	135.9±23.1
Clinic DBP(mmHg)	85.8±14.4
24h SBP(mmHg)	126.3±16.7
24h DBP(mmHg)	78.9±11.3
Daytime SBP(mmHg)	127.8±16.7
Daytime DBP(mmHg)	80.3±11.4
Nighttime SBP(mmHg)	119.6±18.4
Nighttime DBP(mmHg)	73.7±12.7
Nighttime hypertension[n(%)]	733(62.2)
Isolated nighttime hypertension[n(%)]	272(23.1)
Circadian patterns	
Reverse dipper[n(%)]	197（16.7）
Non dipper[n(%)]	609（51.7）
Dipper[n(%)]	341（28.9）
Extreme dipper[n(%)]	31（2.6）
Clinic-ambulatory BP status	
Normotension[n(%)]	446（37.9）
White-coat HBP[n(%)]	129（10.9）
Masked HBP[n(%)]	175（14.9）
Sustained HBP[n(%)]	428（36.3）

Table 3. Diagnostic performance of different BP indexes for TOD

	TOD assessments			
	LVH	eGFR＜60ml//min/1.73 m^2	ACR≥30mg/g	cIMT≥0.9mm or plaque
AUC （95%CI）				
Clinic SBP	0.721（0.667, 0.774）	0.725（0.695, 0.755）	0.629（0.586, 0.671）	0.694（0.645, 0.743）
24h SBP	0.770（0.722, 0.819）	0.762（0.734, 0.790）	0.654（0.610, 0.698）	0.681（0.632, 0.729）
Daytime SBP	0.760（0.711, 0.810）	0.756（0.728, 0.784）	0.647（0.603, 0.691）	0.676（0.627, 0.725）
Nighttime SBP	0.779（0.733, 0.824）	0.756（0.728, 0.784）	0.671（0.627, 0.715）	0.680（0.632, 0.728）
P value, Z value				
24h vs. Clinic SBP	**0.048, 1.977**	**0.007, 2.686**	0.204, 1.272	0.570, 0.568
Daytime vs. Clinic SBP	0.115, 1.578	**0.026, 2.221**	0.368, 0.900	0.441, 0.771
Nighttime vs. Clinic SBP	**0.028, 2.197**	**0.037, 2.083**	**0.045, 2.008**	0.587, 0.543

Table 4. Univariate and multivariate logistic regression analysis of different BP indexes for TOD

	Odds ratio (95% CI), *P* value			
	Clinic SBP	24h SBP	Daytime SBP	Nighttime SBP
LVH				
Unadjusted	1.033(1.025, 1.041), <0.001	1.063(1.050, 1.076), <0.001	1.061(1.046, 1.074), <0.001	1.056(1.045, 1.067), <0.001
Model 1（M1）	1.012(1.002, 1.022), 0.018	1.028(1.012, 1.045), <0.001	1.036(1.010, 1.042), 0.001	1.027(1.013, 1.041), <0.001
Model 2 (M1+Clinic SBP)	—	1.025(1.007, 1.043), 0.006	1.022(1.004, 1.040), 0.015	1.024(1.009, 1.039), 0.001
Model 3 (M1+Nighttime SBP)	1.006(0.995, 1.017), 0.290	—	—	—
eGFR<60ml//min per 1.73 m^2				
Unadjusted	1.041(1.035, 1.048), <0.001	1.068(1.058, 1.078), <0.001	1.066(1.056, 1.076), <0.001	1.059(1.050, 1.068), <0.001
Model 4（M4）	1.015(1.005, 1.025), 0.002	1.032(1.018, 1.047), <0.001	1.031(1.017, 1.045), <0.001	1.028(1.016, 1.040), <0.001
Model 5 (M4+Clinic SBP)	—	1.029(1.013, 1.045), <0.001	1.027(1.012, 1.043), 0.001	1.024(1.011, 1.038), <0.001
Model 6 (M4+Nighttime SBP)	1.008(0.997, 1.018), 0.160	—	—	—
ACR≥30mg/g				
Unadjusted	1.023(1.014, 1.032), <0.001	1.036(1.024, 1.049), <0.001	1.034(1.022, 1.047), <0.001	1.038(1.026, 1.050), <0.001
Model 7（M7）	1.015(1.003, 1.027), 0.011	1.026(1.011, 1.042), 0.001	1.025(1.009, 1.040), 0.002	1.030(1.015, 1.045), <0.001
Model 8(M7+Clinic SBP)	—	1.022(1.004, 1.040), 0.018	1.020(1.002, 1.038), 0.031	1.027(1.011, 1.043), 0.001
Model 9(M7+Nighttime SBP)	1.006(0.994, 1.019), 0.323	—	—	—
cIMT≥0.9mm or plaque				
Unadjusted	1.030(1.021, 1.039), <0.001	1.038(1.026, 1.050), <0.001	1.038(1.026, 1.050), <0.001	1.030(1.020, 1.041), <0.001
Model 10（M10）	1.004(0.995, 1.012), 0.389	1.003(0.991, 1.015), 0.669	1.003(0.991, 1.015), 0.663	1.004(0.993, 1.014), 0.482
Model 11 (M10+Clinic SBP)	—	1.000(0.987, 1.014), 0.981	1.000(0.987, 1.014), 0.981	1.002(0.991, 1.014), 0.681
Model12(M10+NighttimeSBP)	1.003(0.994, 1.012), 0.519	—	—	—

M1, M4, M7, M10 were short for Model 1, Model 4, Model 7 and Model 10, respectively. Model 1 included adjustment for age, sex, BMI, smoking, alcohol consumption status, hemoglobin. albumin, eGFR, number of BP medications and type of glomerular disease. Model 4 included adjustment for age, sex, BMI, smoking, alcohol consumption status. hemoglobin. albumin, ACR, iPTH, uric acid, calcium* phosphate product, number of BP medications and type of glomerular disease. Model 7 included adjustment for age, sex, BMI, smoking, alcohol consumption status, hemoglobin, albumin, uric acid, number of BP medications and type of glomerular disease. Model 10 included adjustment for age, sex, BMI, smoking, alcohol consumption status, eGFR, LDL-C, statin use, number of BP medications and type of glomerular disease. Model 2,5,8,11 included adjustment for the variables in Model 1,4,7,10 respectively and additional adjustment for clinic SBP when examining 24h/daytime/nighttime SBP as the independent variable. Model 3,6,9,12 included adjustment for the variables in Model 1,4,7,10 respectively and additional adjustment for nighttime SBP when examining clinic SBP as the independent variable. Odds ratios in the table above present 1 mm Hg increase in SBP.

Figures

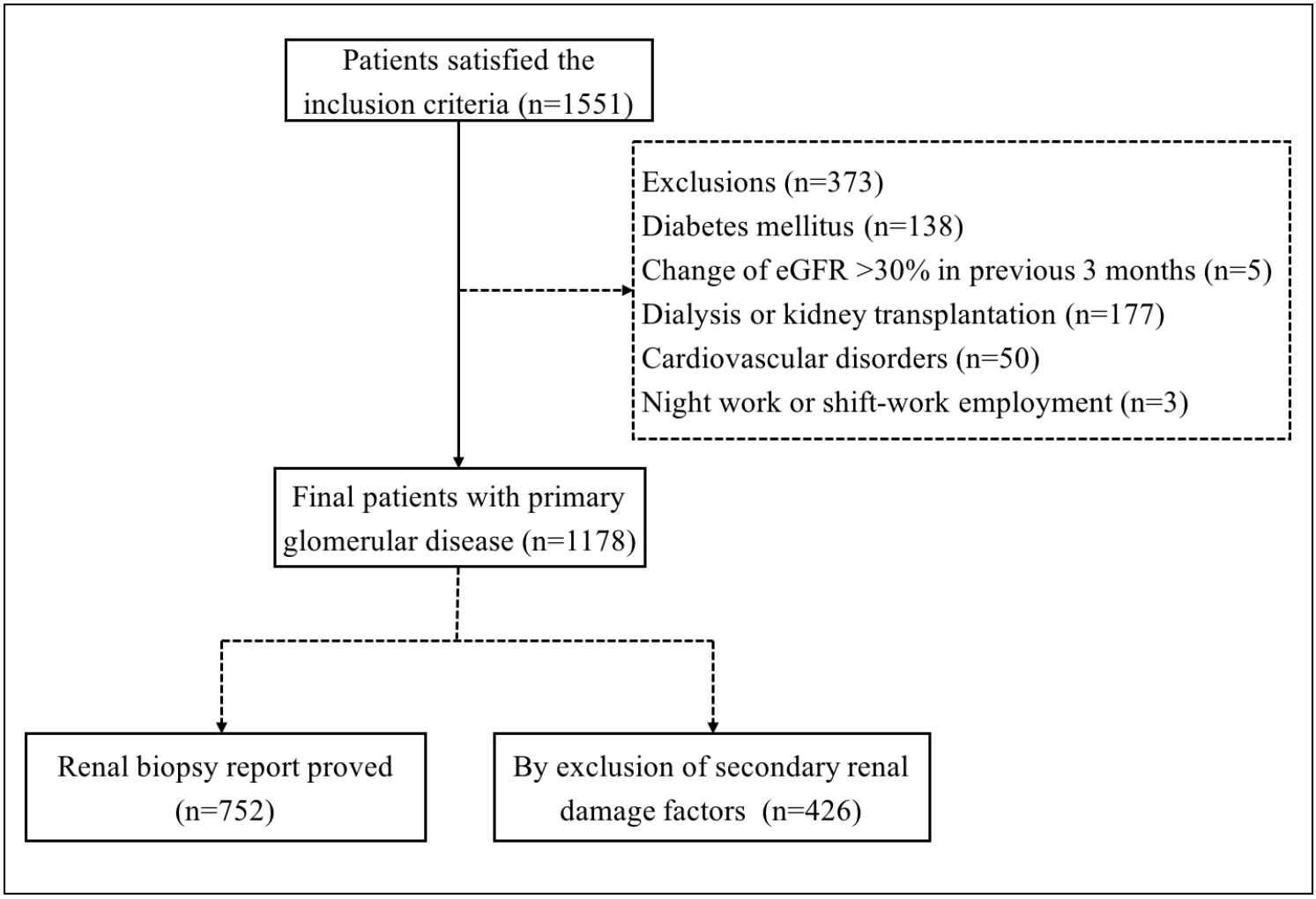

Figure 1

Shows the flowchart of included patients.

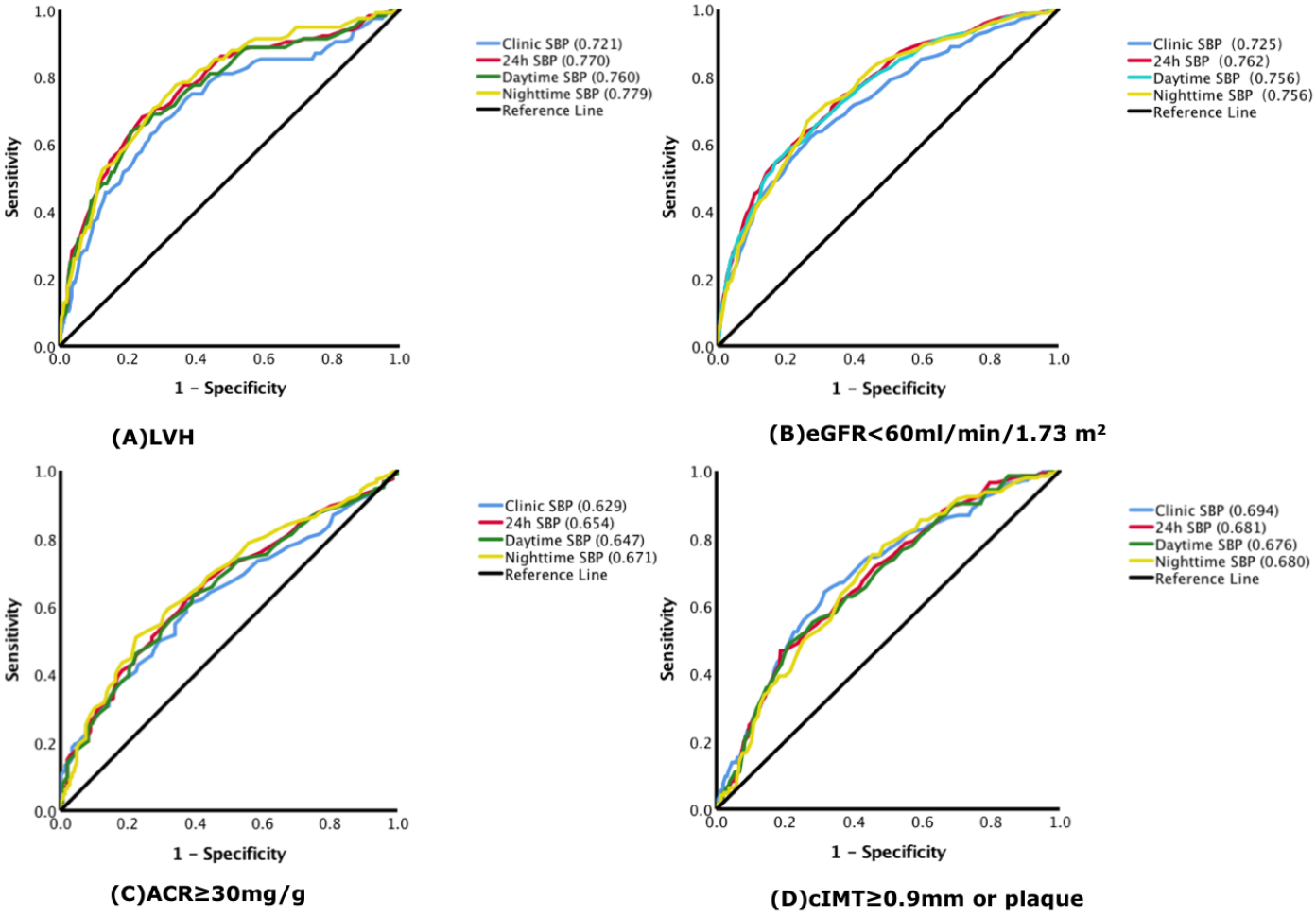

Figure 2

Shows receiver operating characteristic(ROC) curves of different BP indexes for TOD in four conditions: (A) left ventricular hypertrophy (LVH): LVMI ≥125 g/m2 (man) or ≥120 g/ m2 (woman), (B) eGFR<60ml/min per 1.73 m2, (C) ACR≥30mg/g, (D) cIMT≥0.9mm or carotid plaque. Value in the bracket is the area under the curve of each line.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementarySTROBEchecklistcrosssectional.doc
- Supplementarytable1.docx