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Correlation between Subclinical Heart Disease and Cardiovascular Risk Profiles in an Urban Emergency Department Population with Elevated Blood Pressures: A Pilot Study

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Abstract

Objective—Determine the point prevalence of left ventricular hypertrophy and diastolic dysfunction in an urban emergency department (ED) population with elevated blood pressures

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(EBP) and examine the correlation between subclinical disease and patient cardiovascular risk profiles.

Methods—A convenience sample of emergency department patients with elevated blood pressures (blood pressure 140/90 mm Hg on at least 2 measurements) with or without a history of hypertension were enrolled. Subjects had limited bedside echocardiograms performed by ED physicians with ultrasound training and baseline laboratory studies obtained. Patients were classified as having subclinical hypertensive heart disease if any of the following were identified using standard echocardiogram criterion: left ventricular hypertrophy, abnormal ejection fraction, or diastolic dysfunction.

Results—A total of 39 patients with EBP were enrolled. The mean age was 46 years (SD 10.9 years), 59 % (n=23) were women, 21% (n=8) were smokers, and 92% had a history of hypertension (n=33). The average BMI was 30.7 (SD=8.7). Racial/ethnicity included African Americans 67% (n=26), Latinos 23% (n=9), Caucasian 5% (n=2), Asian and Native Americans 3% (n=1 respectively). Subclinical hypertensive disease was found in 39% (n=15) with 31% (n=12) having left ventricular hypertrophy, 15% (n=6) having evidence of diastolic dysfunction and 8% (n=3) having abnormal ejection fraction. On bivariate analysis elevated diastolic blood pressure (p=0.039) and blood urea nitrogen (p=0.016) were correlated with the presence of subclinical heart disease. After adjusting for other covariates, receiving oral/intravenous antihypertensive medications in the ED (p= 0.005) was associated with subclinical heart disease in multivariate regression analysis.

Conclusions—We found a point prevalence of subclinical heart disease of 39% in this urban ED population with EBP screened using limited bedside echocardiograms performed by ED physicians. Identification of subclinical heart disease at early stages in real-time in the ED in conjunction with abnormal renal function can help ED physicians risk stratify and identify those patients in need of more aggressive therapy and urgent follow-up thus decreasing the likelihood of cardiovascular disease progression and complications such as heart failure and renal failure at later stages.

Introduction

Emergency departments serve a high-risk population with many patients utilizing the emergency department as part of their primary care access.^{1,2} Uncontrolled/untreated hypertension is a frequent condition among patients presenting to emergency departments (ED) and is a finding in up to 25% of ED patients.^{3,4} Up to half of the patients presenting with elevated BP to the ED are not presently under medical care making the ED visit their only point of contact with health care providers.⁵ Among known hypertensives, approximately 42% report medication non-adherence.⁶

Early identification of subclinical cardiac disease is an important component of cardiovascular disease prevention. Studies have estimated the prevalence of subclinical diastolic dysfunction can be as high as 48% among high-risk groups with cardiovascular risk factors.^{7,8} Levy et al. in a cohort of African American patients identified from an urban ED found a 90% point prevalence of subclinical hypertensive heart disease.⁹ Left ventricular hypertrophy (LVH) is one of the strongest predictors of adverse cardiovascular outcomes in

a hypertension population.^{10–12} Early recognition of left ventricular hypertrophy is important because it is reversible and antihypertensive medications can decrease the associated cardiovascular morbidity and mortality.^{13,14}

The study objective was 1) to determine the point prevalence of subclinical heart disease (left ventricular hypertrophy and diastolic dysfunction) in an urban ED population with elevated blood pressures using real-time bedside ED echocardiograms, 2) to examine the correlation between subclinical disease and patient cardiovascular risk profiles, and 3) identify the utility for risk assessment/stratification in this population.

Methods

A convenience sample of emergency department patients with elevated blood pressures (blood pressure $\geq 140/90$ mm Hg) with or without a history of hypertension were consented and enrolled from the University of Illinois Hospital and Health Sciences System Emergency Department. Patients were enrolled at various times of the days including early mornings, weekends and nights to obtain a representative sampling of patients. Subjects were identified based upon their triage blood pressure but only consented and enrolled if their discharge BP was $\geq 140/90$ mm Hg. ED physicians performing the echocardiograms were blinded to the patients history of hypertension if present.

Inclusion criteria

Adult ED patients with blood pressures $\geq 140/90$ (on 2 or more measurements in the emergency department) or a past medical history of hypertension.

Exclusion criteria

Patients presenting with hemodynamic instability, history of heart failure, renal failure, or an inability to provide consent were excluded from study participation.

Echocardiograms

Subjects had ED bedside echocardiograms performed by ED physicians with ultrasound training. Echocardiograms took approximately 7–10 minutes to complete per subject. All echocardiographic measurements were performed using a commercially available ultrasound system equipped with a harmonic 4.0 MHz variable-frequency phased –array transducer. Patients were classified as having subclinical hypertensive heart disease if any of the following were identified using standard echocardiogram criterion: left ventricular hypertrophy, abnormal ejection fraction, or diastolic dysfunction.

Determining diastolic function

Diastolic function was evaluated by estimating LA pressure using E/e' ratio. Diastolic dysfunction considered to be present if E/e' (septal) was greater than or equal to 15, if E/e' (lateral) was greater than or equal to 12, if septal e' was less than 8cm/sec, if lateral e' was less than 10cm/sec.¹⁵

Grading of diastolic dysfunction

Once diastolic dysfunction was determined, the E/A ratio was used to determine the grade of diastolic dysfunction. If E/A ratio was less than 0.8, then the patient was considered to have grade I diastolic dysfunction. If E/A was between 0.8–1.5, then the patient was considered to have grade II diastolic dysfunction. If E/A was greater than 1.5, the patient was considered to have grade III diastolic dysfunction.¹⁶

Bedside cardiac ultrasound measurements

Mitral flow velocities were recorded in the apical 4-chamber view. The Tissue Doppler imaging (TDI) of the septal and lateral mitral annulus was performed on all patients. Left ventricular free wall thickness was measured in the parasternal long view at end diastole. Left ventricular hypertrophy was reported as present or absent.¹⁷ Ejection fraction was noted as normal (≥ 55%) or abnormal (<55%).

Data Analysis

Descriptive characteristics of study participants including demographics, physical measures, medication use, medical history, and echocardiogram parameters were correlated with the presence or absence of subclinical heart disease. For continuous variables, t-tests or Wilcoxon two-sample tests were used to test significance of difference between the those subjects with and without subclinical heart disease as appropriate; for categorical variables, Pearson's chi-square test or Fisher's exact test were used as appropriate. Covariates were selected based upon the reviewed medical literature. Backward stepwise elimination logistic regression analysis was performed to examine the association of risk factors with subclinical heart disease.

The University of Illinois Institutional Review Board reviewed and approved this study.

Results

A total of 39 emergency department patients with evaluated blood pressures were enrolled. There was no predominance of cardiac symptoms among presenting chief complaints (multiple complaints 28%, musculoskeletal 26%, cardiac 21%, gastrointestinal 15%, ENT 2%, and pulmonary 2%). The mean age was 46 years (SD 10.9 years), 59 % (n=23) were women, 21% (n=8) were smokers, and 92% had a past medical history of hypertension (n=36). The average BMI was 30.7(SD=8.7). Race/ethnicity included African Americans 67% (n=26), Latinos 23% (n=9), Caucasian 5% (n=2), Asian and Native Americans 2% (n=1 respectively). Subclinical hypertensive disease was found in 39% (n=15) with 31% (n=12) having left ventricular hypertrophy, 15% (n=6) having evidence of diastolic dysfunction and 8% (n=3) having abnormal ejection fraction. Of those subjects demonstrating diastolic dysfunction, the majorities were at grade 2 (Grade I–33% n= 2, Grade 2- n=3, Grade 3- n=1). (Table 1)

ED echocardiograms were independently reviewed for classification accuracy by a board certified Cardiologist who was blinded to the echocardiogram classification by the ED physician (Interobserver agreement 82%; Cohen's kappa statistic 0.95).

Covariates associated with subclinical heart disease

Bivariate analyses were performed to first identify variables that are significantly associated with either having left ventricular hypertrophy, diastolic dysfunction or low ejection fraction. Based upon analysis, subjects with evidence of Stage II hypertension (DBP >100, $p < 0.039$), those receiving oral/IV antihypertensive medications in the ED ($p < 0.002$), or elevated blood urea nitrogen levels ($p < .016$) were statistically significantly more likely to have evidence of subclinical heart disease. (Table 1)

Based upon those results, variables were selected in order to narrow down the pool of variables to be included in the final regression model. In a multivariate analysis done via stepwise backward elimination logistic regression, seven covariates (SBP, DBP, BUN, Cr, history of hypertension, Beta Blockers, and BP treated in ED) were examined. After adjusting for other covariates, receiving oral/intravenous antihypertensive medications in the ED ($p = 0.005$) was associated with subclinical heart disease in multivariate regression analysis. (Table 2)

Discussion

We found a point prevalence of subclinical heart disease of 39% in this diverse urban ED population with elevated blood pressures with the majority having evidence of left ventricular hypertrophy (31%). This represents a higher proportion compared to population studies such as the Multi-Ethnic Study of Atherosclerosis (MESA), which found a 9.8% prevalence of left ventricular hypertrophy among study participants and 13.1 % prevalence among hypertensive participants.^{18,19} The MESA study is an ongoing longitudinal cohort study of men and women 45 to 84 years of age without evidence of clinical cardiovascular disease at enrollment.^{18,19} Our findings are not surprising given that hypertensive patients presenting to the ED are a particularly high-risk group for target organ damage (TOD) and its consequences with >50% having stage II or higher hypertension (SBP > 160 or DBP >100). In a separate study among an African American cohort conducted in an urban ED, Levy et al. found a 90% point prevalence of subclinical hypertensive heart disease; however the majority demonstrated evidence of diastolic dysfunction (89.7%) and more than half of the subjects had evidence of both left ventricular hypertrophy and diastolic dysfunction (57.3%) demonstrating more advanced progression of subclinical disease.⁹

For some of our most vulnerable populations, the ED visit may serve as the initial contact with health care providers and may represent an ideal setting for HTN risk assessment/stratification. Early identification of subclinical heart disease (such as diastolic dysfunction and left ventricular hypertrophy) is a critical component of secondary cardiovascular disease prevention.²⁰

One of the primary goals of antihypertensive therapy is to reduce cardiovascular events and data suggest that blood pressure management is the primary determinant of cardiovascular risk reduction.²¹ This is particularly important in the prevention of hypertension-related cardiovascular complications such as heart failure because studies have shown that left ventricular (LV) remodeling and the development of left ventricular hypertrophy (LVH) precedes the development of subclinical LV dysfunction (i.e. diastolic dysfunction) and

aggressive treatment of hypertension can greatly attenuate the initial development of LVH.^{12,13} We found that the majority of participants with abnormal bedside echocardiograms had left ventricular hypertrophy indicating an ideal window of opportunity for intervention. Studies have shown that in patients with established LVH, disease regression is possible hence providing an objective target for monitoring the effectiveness of clinical interventions.¹³

The relationship between hypertension and kidney dysfunction is well known.^{22,23} Recently, the significant relationship of LVH and diastolic function with cardiovascular and renal outcomes in African Americans with hypertension chronic kidney disease has been documented.²⁴ African Americans are disproportionately affected by hypertension, LVH, and chronic renal disease with disease progression leading to death, stroke, heart failure and end-stage renal disease.^{25,26} Recent studies suggest BUN levels can help in risk stratification as elevated levels appear correlated with increase burden of CAD on cardiac catheterization in unstable angina patients.²⁷ Our study cohort included a population at high risk for hypertensive cardiovascular complications (African-American 67%, and Latinos 23 %), and among risk factors examined found diastolic BP and BUN were correlated with the presence of subclinical heart disease.

Limitations

This study involved a very small convenience sample of emergency department patients from a single urban academic emergency department and may not accurately reflect the true extent of subclinical heart disease in an ED population with elevated blood pressures. In addition, although there was an attempt to include all racial/ethnic groups in the study cohort, certain racial groups remained underrepresented; however the demographics of the cohort were representative of the overall ethnic composition of the patient population at our medical center. Future studies should include multiple emergency departments in various geographic locations.

Conclusion

We demonstrated that patients with elevated blood pressures in the ED are at high risk for subclinical heart disease compared to the general population. Current published guidelines for the management of asymptomatic hypertension in the emergency department recommend future research related to the optimal screening for this patient population in the ED.²⁸ Real-time identification of subclinical heart disease at earlier stages in patients with elevated blood pressures in the ED can help risk stratify and identify those patients in need of more aggressive therapy and follow-up.

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Table 1
Demographics, Clinical Parameters, and Echocardiogram Data for Study Cohort

Demographics, clinical parameters, and echocardiogram findings for study cohort with and without evidence of subclinical heart disease.

Covariates	Overall N=39	Subclinical Heart Disease (N=15)	No Evidence of Subclinical Heart Disease (N=24)	P value,
Mean Age, y (SD)	45.6 (10.9)	46.6 (11.5)	44.9 (10.7)	0.651
Gender, N (%)				0.571
• Female	23 (59.0)	8 (53.3)	15 (62.5)	
Race/Ethnicity, N (%)				0.517
• African Americans	26 (66.7)	12 (80.0)	14 (58.3)	
• Latinos	9 (23.1)	3 (20.0)	6 (25.0)	
• Caucasian	2 (5.1)	0 (0.0)	2 (8.3)	
• Asians	1 (2.6)	0 (0.0)	1 (4.2)	
• Native American	1 (2.6)	0 (0.0)	1 (4.2)	
Mean Body Mass Index, kg/m ² (SD)	30.7 (8.7)	28.7 (5.3)	32.0 (10.3)	0.217
History of Hypertension, N (%)	36 (92.3)	14 (93.3)	20 (83.3)	0.364
Received Oral/IV Antihypertensive Medications in ED	10 (25.6)	8 (53.3)	2 (8.3)	0.002
• Oral antihypertensive medication (9)				
• IV antihypertensive medication (1)				
Taking antihypertensive medications, N (%)				
• ACEI or ARB	17 (43.6)	7 (46.7)	10 (41.7)	0.759
• Beta Blockers	12 (30.8)	5 (33.3)	7 (29.2)	0.089
• Calcium Channel Blockers (CCB)	6 (15.4)	2 (13.3)	4 (16.7)	0.779
• Diuretics	3 (7.7)	1 (6.7)	2 (8.3)	0.849
• Other	8 (20.5)	4 (26.7)	4 (16.7)	0.452
Tobacco Use	8 (20.5)	3 (20.0)	5 (20.8)	0.950
History of Diabetes, N (%)	8 (20.5)	8 (53.3)	8 (33.3)	0.217
Vital signs, mean (SD)				
• Systolic Blood Pressure	166.8 (24.3)	175.1 (25.7)	161.6 (22.4)	0.106
• Diastolic Blood Pressure	97.7 (13.7)	103.5 (13.1)	94.2 (13.1)	0.039

Covariates	Overall N=39	Subclinical Heart Disease (N=15)	No Evidence of Subclinical Heart Disease (N=24)	P value,
Renal Function, mean (SD)				
• Serum creatinine, g/dL	2.1 (4.0)	4.1 (6.1)	0.8 (0.2)	0.080
• Blood urea nitrogen, g/dL	15.5 (10.4)	21.4 (13.1)	11.5 (5.5)	0.016
Hemoglobin	12.2 (2.4)	11.7 (2.6)	12.6 (2.2)	0.315
Echocardiogram Findings				
• Diastolic Dysfunction (DD)				
▪ DD-Grade I		1 (6.7)		
▪ DD-Grade II		3 (20.0)		
▪ DD-Grade III		1 (6.7)		
• Left ventricular hypertrophy		12 (80.0)		
• Abnormal Ejection Fraction		3 (20.0)		

Table 2
Multivariate Logistic Regression for covariates and subclinical heart disease in an Urban ED population with Asymptomatic Hypertension

Results of multivariate logistic regression for covariates and subclinical heart disease in study cohort.

Effect	p-value	Odds Ratio Estimate	Odds Ratio 95% CI
Use of Beta Blockers	0.136	0.216	(0.029, 1.622)
Received Oral/IV Antihypertensive Medications in ED	0.005	0.033	(0.003, 0.355)