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Evaluation of Compatibility Between Emergency Physicians and Cardiologists in Measuring Pulmonary Artery Pressure: A Prospective, Observational Study

Murat Duyan[1], Serhat Günlü[2], Ali Sarıdaş[3], Elif Ertaş[4], Başar Cander[5]

[1]University of Health Sciences Turkey, Antalya Training and Research Hospital, Clinic of Emergency Medicine, Antalya, Turkey
[2]Dağkapı State Hospital, Clinic of Cardiology, Diyarbakır, Turkey
[3]University of Health Sciences Turkey, İstanbul Prof. Dr. Cemil Taşcıoğlu City Hospital, Clinic of Emergency Medicine, İstanbul, Turkey
[4]Mersin University Faculty of Medicine, Department of Biostatistics, Mersin, Turkey
[5]University of Health Sciences Turkey, Kanuni Sultan Süleyman Training and Research Hospital, Clinic of Emergency Medicine, İstanbul, Turkey

Abstract

Aim: To evaluate the degree of agreement between emergency physicians (EPs) and cardiologists in measuring pulmonary arterial pressure (PAP) (measurement with simplified Bernoulli equation).

Materials and Methods: This prospective observational study was conducted between January 2020 and January 2022 in the University of Health Sciences Turkey, Antalya Training and Research Hospital, Clinic of Emergency Medicine, a tertiary hospital. Sample size calculation: According to the kappa (2 raters) - Hypothesis testing method: Assuming minimum acceptable kappa 0.6 and Expected kappa 0.85, significance level 0.05, and Power 90%, including the Expected dropout rate of 10% in the study, 117 patients were included in the study. Demographic findings, personal history, laboratory tests, and PAP values of the patients calculated by the EPs and cardiologists were recorded.

Results: The study included 117 patients who attended the emergency department with shortness of breath or chest pain complaints. While 72.6% of them are female, 27.4% are male patients. The age of the patients included in the study was a minimum of 33 and a maximum of 80. Their mean age and deviation were 59.6±10.6. A near-perfect agreement was found between the measurements of the cardiologist and the EP according to the criteria for PAP measurement ≤20 and >20 (Cohen's kappa coefficient 0.86; <0.0001).

Conclusion: We found near-perfect agreement between cardiologists and emergency room physicians trained in focused cardiac ultrasound (FoCUS) in detecting normal or increased PAP.

Keywords: Pulmonary artery pressure, chest pain, dyspnea, focused cardiac ultrasound, emergency medicine

Introduction

Patients who applied to emergency department (ED) clinics with shortness of breath and chest pain are important among all applications (1). In addition to a detailed examination, laboratory tests, and imaging techniques, ultrasound is used to correct these patients. Focused cardiac ultrasound (FoCUS) is a rapid and reliable point-of-care ultrasonography (USG) protocol recommended to evaluate symptomatic patients in ED clinics (2). FoCUS can provide a quick prediction of cardiac activity, cardiac contractility, central venous pressure and volume status, pericardial effusion or tamponade, and cardiac arrest. Additionally, the left ventricular ejection fraction (LVEF) can be determined; also, volume overload and right-sided cardiac pressure can be estimated by the caval index (3-5). One of the most important causes of high pulmonary artery pressure (PAP) is pulmonary embolism (PE), and it is a condition that should be taken care of ED clinics. Many methods are used to measure PAP (6,7). The Bernouilli equation, a technique used to measure PAP in ED clinics, is a very practical method (8).

Corresponding Author: Murat Duyan MD, University of Health Sciences Turkey, Antalya Training and Research Hospital, Clinic of Emergency Medicine, Antalya, Turkey
Phone: +90 242 249 44 00 **E-mail:** drmuratduyan@gmail.com **ORCID ID:** orcid.org/0000-0002-6420-3259

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The aim of this study was to determine whether PAP measurements with the simplified Bernoulli equation by the emergency physicians are compatible with the PAP measurement calculated in the echocardiography performed by the cardiologist.

Materials and Methods

Study Design and Settings

This study is a prospective observational study conducted between January 2020 and January 2022 in the Clinic of Emergency Department, University of Health Sciences Turkey, Antalya Training and Research Hospital, a tertiary hospital. The study was approved by the Ethics Committee of University of Health Sciences Turkey, Antalya Training and Research Hospital (no: 2019-392 - decision number: 27/23, date: 26th December 2019). This study was conducted in line with the Declaration of Helsinki.

Pre-study Power Analysis

Sample size calculation: According to the kappa (2 raters) - hypothesis testing method: Assuming minimum acceptable kappa 0.6 and Expected kappa 0.85, significance level 0.05, and Power 90%, and considering the Expected dropout rate of 10% in the study, 117 patients were included in the study.

Selection of Participants

Patients over the age of 18 who gave written informed consent, applied to the ED with shortness of breath or chest pain, and performed echocardiography by the emergency physician and the cardiologist were included in the study. Pregnant patients who had chest trauma in the last three weeks and had ST-elevation acute coronary syndrome were transferred to the ED with pneumothorax, known severe tricuspid stenosis, and pulmonary hypertension (HT) excluded from the study's diagnosis.

Study Protocol

Patients who met the inclusion criteria among patients who applied to the ED with shortness of breath or chest pain were included in the study. Demographic findings, histories, and laboratory tests of the patients were recorded. PAP measurements were recorded by emergency physicians who had at least two years of experience as an emergency physician, attended an accredited ultrasound course, and achieved success. Before the study, emergency medicine physicians received two hours of didactic and two hours of practical training. In the preliminary research, it was observed that she made accurate measurements at least 20 times. Ultrasound images were transferred to a computer environment and interpreted by an experienced and independent cardiologist. Images with inaccurate measurements and poor image quality were excluded from further analysis and the study.

Imaging 2

The emergency physician performed an FoCUS examination. In imaging, tricuspid regurgitation velocity (TR V_{max}) was measured from the apical four-chamber window, and the diameter of the inferior vena cava (IVC) was measured from the subcostal window. It was evaluated whether it collapsed with respiration. The guidelines for echocardiographic evaluation of the right heart in adults were used as the basis for cardiac images (9). FoCUS were examined with a cardiac probe in a Mindray brand USG device (Model DC-T6). Pulmonary arterial pressure calculated by the cardiologist was accepted as the reference. The systolic PAP (sPAP) was measured echocardiographically, and peak tricuspid regurgitation flow velocity (CRAD m/s) was first measured by color Doppler examination from the apical 4-chamber window. In patients without pulmonary valve stenosis, right ventricular systolic pressure was assumed to be equal to sPAP, and sPAP was calculated from TR V_{max} using Bernoulli's equation and adding the estimated right atrial pressure (RAP). RAP was calculated echocardiographically based on the diameter of the IVC and the variation in diameter during respiration (Figure 1, 2).

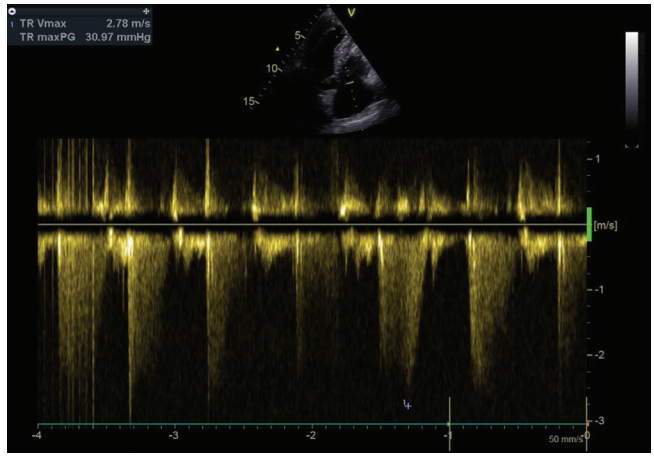

Figure 1. Peak tricuspid regurgitation flow velocity

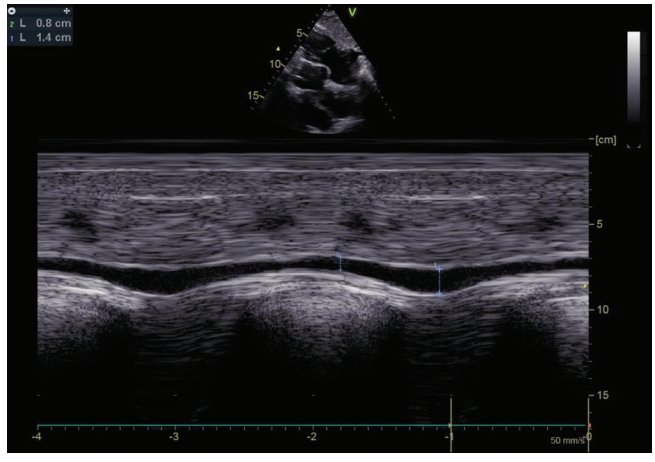

Figure 2. VCI inspiration and expiration image

In the joint guidelines of the European Society of Cardiology and Respiratory and recommended by other authors, PH was defined as the upper limit of the normal value, with mean PAP (oPAP) above 20 mmHg (10-13).

Outcome

PAP was measured by the consultant echocardiography (cardiologist) using the Bernoulli equation of the emergency physician.

Statistical Analysis

In the analysis of the data, the mean and standard deviation, minimum and maximum values of the features: Frequency, and percentage values were used to define categorical variables. The compatibility of different doctors' nominal level measurement results was evaluated with Cohen's kappa. The statistical significance level of the data was taken as $p<0.05$. www.e-picos.com New York software and MedCalc statistics for the data evaluation package program was used.

Results

The study included 117 patients who visited the ED with shortness of breath or chest pain complaints. The flow chart of the clinical study is shown in Figure 3.

The patients' socio-demographic and disease history characteristics are shown in Table 1. While 72.6% of them are female, 27.4% are male patients. The age of the patients included in the study was a minimum of 33 and a maximum of 80. Their mean age and deviation were 59.6±10.6. When their distribution according to chronic disease states is examined, 29.9% of them are HT, 28.2% are diabetes mellitus, 11% are coronary artery disease, 20.5% are chronic obstructive pulmonary diseases, 8.5% have congestive heart failure (Table 1).

In Table 2, the mean values of vital signs and laboratory parameters and minimum-maximum measurements of the patients included in the study are given, respectively (Table 2).

In Table 3, physician compliance statistics between emergency doctors and cardiologists according to PAP measurement.

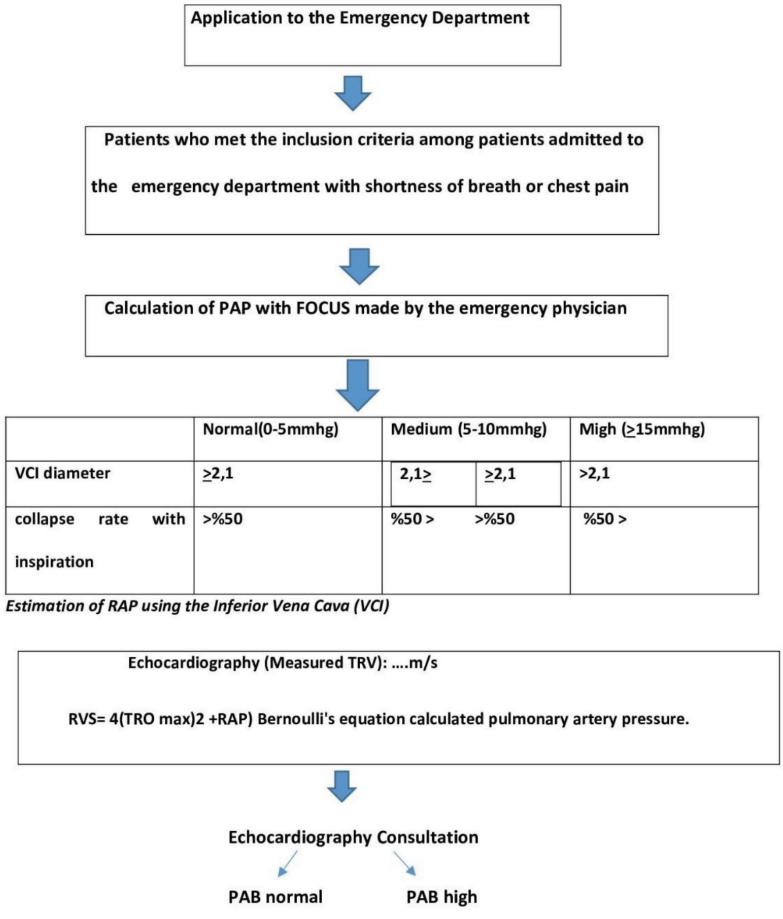

Figure 3. Patient flow in the study

RVS: Right ventricular strain, PAP: Pulmonary arterial pressure

As seen in Table 3: According to the criteria for PAP measurements of ≤20 and >20, a significant and almost perfect agreement was found between the measurements of cardiologists and emergency doctors (Cohen's kappa coefficient 0.86; <0.0001) (Table 3).

Discussion

This study suggests that emergency medicine physicians who are successful in accredited USG training can successfully detect the PAP increase with short-term training.

In many cases, emergency physicians quickly decide with targeted examination and imaging. They provide significant benefits to patients with early treatment by detecting the pathological condition that causes the disease early. The use of USG in ED clinics is increasing day by day. Many fatal diseases can be diagnosed or excluded by USG (14-17). In a consensus statement made by the American Society of Echocardiography and the American College of Emergency Physicians in 2010, a cardiac ultrasound performed by emergency physicians (EPs) is a "basic ultrasound" was accepted as a "tool" (18).

FoCUS provides important information in diagnosing and differential diagnoses of patients who applied to EDs with chest pain and shortness of breath. In addition to providing information about direct cardiac functions, it provides important information in pathologies that rapidly increase PAP, such as PE. By detecting PAP elevation and early treatment for pathology causing it, mortality or morbidity that may develop is prevented.

Table 1. Socio-demographical and disease history distribution

N=117	$\bar{X}$±SD	Min.-Max.
Age	59.6±10.6	33-80
	n	%
Gender		
Sex		
Female	85	72.6
Male	32	27.4
HT		
No	82	70.1
Yes	35	29.9
DM		
No	84	71.8
Yes	33	28.2
CHD		
No	117	100
Yes	-	-
CAH		
No	104	88,9
Yes	13	11.1
COPD		
No	93	79.5
Yes	24	20.5
CHF		
No	107	91.5
Yes	10	8.5

Values are reported as n (%) for categorical variables.
HT: Hypertension, DM: Diabetes mellitus, CVD: Cerebrovascular disease, CHD: Coronary heart disease, COPD: Chronic obstructive pulmonary disease, CHF: Congestive heart failure, SD: Standard deviation, Min.: Minimum, Max.: Maximum, CAH: Congenital adrenal hyperplasia

Table 2. Distribution of vital findings and laboratory measurements

N=117	$\bar{X}$±SD	Min.-Max.
Systolic blood pressure (mmHg)	140.51±12.24	110-180
Diastolic blood pressure (mmHg)	85.94±8.98	60-110
Pulse (beat/min.)	99.1±21.49	55-120
Respiration rate (per min.)	22.3±2.9	16-30
O_2 saturation (%)	95.4±3.6	65-99
Glucose (mg/dL)	151.38±60.62	72-400
Creatinine (mg/dL)	0.91±0.2	0.56-1.78
Na (mmol/L)	139.27±3.38	124-147
K (mmol/L)	4.17±0.39	3.04-5
HGB (g/dL)	14.43±1.41	9.2-17.11
HCT (%)	42.96±4.08	30.1-51.71
AST (U/L)	27.92±18.88	10-114
ALT (U/L)	20.79±16.44	5-147
WBC ($10^3/mm^3$)	12.68±3.85	6.05-25.41
PLT ($10^3/mm^3$)	275.48±67.03	149-577.1
INR	1.17±0.08	0.98-1.45
Troponin T (ng\L)	36.16±34.5	3-110

Values are reported as mean±SD for continuous variables.
Na: Sodium, K: Potassium, HGB: Hemoglobin, HTC: Hematocrit, ALT: Alanine aminotransferase, AST: Aspartate aminotransferase, WBC: White blood cells, PLT: Platelets, INR: International normalized ratio, SD: Standard deviation, Min.: Minimum, Max.: Maximum

Table 3. Inter-physician compliance evaluation according to PAP measurement

n=117		Cardiology			
PAB		**≤20**	**>20**	**Cohen's kappa**	**p value**
Emergency physicians	≤20	78	4	0.86	<0.0001
	>20	3	32		
	Total	81	36		

*Significant at the p<0.05 level (Cohen's kappa coefficient).
PAP: Pulmonary artery pressure

Right heart catheterization should be performed to diagnose increased PAP (19). Right heart catheterization cannot always be performed under emergency conditions. For this reason, it can be used briefly and practically in echocardiography to measure the effect of excessive pressure overload on the right ventricle to detect the increase in PAP. We investigated FoCUS-trained emergency physicians whether there was an acceptable agreement between cardiologists and PAP measurements according to the simplified Bernouilli equation.

According to the results of our study, significant and almost perfect compatibility was found between the measurements of Cardiologists and Emergency Doctors, according to the criteria of ≤20 and >20 in PAP measurement with the simplified Bernouilli equation (Cohen's kappa coefficient 0.86; <0.0001).

There are many studies in which a concordance was found between emergency physicians who received FoCUS training and cardiology specialists in the literature. Randazzo et al. (20) evaluated the LVEF and central venous pressure of USG-trained emergency physicians similar to cardiologists using echocardiography. Echocardiography interpretations from a clinical study compared with a cardiologist for right ventricular strain (RVS) showed excellent agreement with kappa values between 0.89 and 0.96 (21). In another study for RVS, a moderate agreement (k=0.44) was found with limited echocardiography performed by emergency physicians compared with consultation echocardiography (22). In a study comparing emergency physicians and cardiologists in terms of LVEF evaluation, a significant correlation ($r=0.73$, $p<0.001$) was found (23). Rasooli et al. (24) found that the echocardiography results of the emergency physician to be equivalent to the results of cardiologists in their patients with acute coronary syndrome. In the meta-analysis of Albaroudi et al. (25), it was found that there was a concordance in the evaluation of echocardiography use between emergency physicians and cardiologists with USG training.

Emergency physicians who received USG training in PAP measurement significantly contributed to the literature by determining measurements compatible with cardiologists. We think this will be beneficial to the clinical decisions of emergency physicians.

Study Limitations

Our study had some limitations. Since the study aimed to evaluate the ability of the emergency physician to measure PAP, the exact diagnoses of the patients were not followed. Laboratory values increased in PE, such as D-dimer, were excluded from the evaluation because all patients did not demand them. FoCUS could not be performed in cases suspected or diagnosed with coronavirus diseases-2019 (COVID-19) infection during the COVID-19 pandemic period. Therefore, some patients could not be included in the study. Our current findings may provide insight into larger clinical studies in the future.

Conclusion

We found near-perfect agreement between cardiologists and emergency room physicians trained in FoCUS in detecting normal or increased PAP. We believe this will benefit the emergency physician in clinical decision-making for patients presenting to ED clinics with shortness of breath or chest pain complaints.

Ethics

Ethics Committee Approval: The study was approved by the Ethics Committee of University of Health Sciences Turkey, Antalya Training and Research Hospital (no: 2019-392, decision number: 27/23, date: 26th December 2019). This study was conducted in line with the Declaration of Helsinki.

Informed Consent: Informed consent was obtained.

Peer-review: Externally and internally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: M.D., Concept: M.D., Design: M.D., Data Collection and Processing: M.D., S.G., A.S., E.E., B.C., Analysis and Interpretation: M.D., S.G., A.S., E.E., B.C., Literature Search: M.D., S.G., A.S., E.E., B.C., Writing: M.D., S.G., A.S., E.E., B.C.

Conflict of Interest: No conflicts of interest was declared by the authors.

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