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PRESSURE OF END TIDAL CO 2 VERSUS CLINICAL DIFFERENTIATION OF CARDIAC CAUSES OF DYSPNEA

Dr. Ifra Saeed*[1], Dr. Muhammad Shaher Yar Khan[2] and Dr. Anwar UL Shakoor Awan[3]

[1]PMDC # 76404-P.
[2]PMDC # 93234-P.
[3]PMDC #: 77018-P

***Corresponding Author: Dr. Ifra Saeed**
PMDC # 76404-P.

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ABSTRACT

Introduction: Acute dyspnea is a common presentation in the Emergency Department and critical care setting. Early differentiation of cardiac causes of dyspnea from pulmonary related causes is of great significance. Clinical data including history and clinical examination may sometimes fail to differentiate the cause of dyspnea. Point of care pressure end tidal CO2 may add more diagnostic accuracy. *Objectives:* Our study compared the diagnostic accuracy of clinical criteria for diagnosis of heart failure related acute dyspnea as calculated with modified Boston criteria to pressure of end tidal CO_2 and to b lines on lung ultrasound. *Methods:* We conducted a prospective study. Mayo Hospital between December 2015 to February 2017, 250 patients with acute dyspnea were recruited, of whom 25 patients were excluded. 225 patients were subdivided based on final hospital diagnosis into heart failure related acute dyspnea group (n= 118) and pulmonary (asthma/COPD) related acute dyspnea group (n=107). History, clinical examination, standard laboratory tests, chest X-ray, and pressure end tidal Co2 level were collected. *Results:* Clinical evaluation using modified Boston criteria had sensitivity 85% and specificity of 83% and AUROC 0.96. The pressure of end tidal CO_2 had sensitivity 79% and specificity of 79% and AUROC 0.94. *Conclusions:* Structured clinical criteria gives accurate differentiation between cardiac related acute dyspnea from pulmonary related acute dyspnea.

KEYWORDS: Acute dyspnea, pulmonary.

INTRODUCTION

ACUTE congestive heart failure related dyspnea is one of the commonest causes of acute dyspnea faced in the intensive care units and is associated with high morbidity and mortality.[1-3]

The early and accurate differentiation of the cause of dyspnea presents an important clinical challenge and is of primary importance, as misdiagnoses are common and may result in adverse consequences.[4-6] The clinical differentiation of congestive heart failure related dyspnea can be enhanced using systemic review of characteristic symptoms as in Modified Boston Criteria.[7]

Patients with cardiac dysfunction had an abnormally low pressure of end tidal CO_2 at rest and during exercise compared with normal subjects.[10] $PETCO_2$ was correlated with cardiac output during exercise, and the sensitivity and specificity of $PETCO_2$ regarding decreased cardiac output were good. $PETCO_2$ was also correlated with the slope of the relationship between minute ventilation and CO_2 output, and the ratio of physiologic dead space to the tidal volume.[11]

Our study aimed to test the diagnostic accuracy of bedside end tidal CO_2 compared to clinical assessment in differentiating Heart Failure (HF)- related acute dyspnea from pulmonary (COPD/ asthma)-related acute dyspnea in the critical care setting.

PATIENTS AND METHODS

Over a period of one year starting from December 2015 to January 2017, 250 consecutive patients (131 males and 119 females) who presented to the Emergency Department of Kasr El-Ainy Teaching, Hospitals and Critical Care Units belonging to Critical Care Department of Cairo Medical School with acute dyspnea as the primary complaint were involved.

This is prospective cohort study in which patients are managed in Mayo Hospital by the intensive care units belonging to Critical Care Department and furtherly managed and investigated in the hospital setting for definite diagnosis and management.

Inclusion criterion for the study was shortness of breath as the primary complaint. This is defined as either sudden onset of dyspnea without history of chronic dyspnea or an increase in the severity of chronic dyspnea.

In our study we excluded age < 18 years, history of renal insufficiency, trauma, severe coronary ischemia (unless patient's predominant presentation was dyspnea) and other causes of dyspnea: Carcinoma, pneumothorax, pleural effusion, intoxications (drugs), anaphylactic reactions, upper airway obstruction, bronchial stenosis, and gastroesophageal reflux disorder, psychic disorders presenting with dyspnea; like generalized anxiety disorder.

All patients upon admission were subjected to Demographic data collection including age and gender, symptoms of nocturnal dyspnea orthopnea cough, clinical examination for fever, rales wheezes, mean pulse rate, jugular venous distension, lower extremity edema, ECG medical histories for Asthma/COPD medications, HF medications Troponin I level in serum on admission and Boston criteria for diagnosing heart failure.

Category I: History.

Criterion	**Point value**
Category I: History: • Rest dyspnea	4
• Orthopnea	4
• Paroxysmal nocturnal dyspnea	3
• Dyspnea while walking on level area	2
• Dyspnea while climbing.	1
Category II: Physical examination	
Criterion	**Point value**
Physical examination: • Heart rate abnormality (1 point if 91 to 110 beats per minute; 2 points if more than 110 beats per minute).	1 or 2
• Jugular venous elevation (2 points if greater than 6cm H_2O; 3 points if greater than 6cm H_2O plus hepatomegaly or edema).	2 or 3
• Lung crackles (1 point if basilar; 2 points if more than basilar).	1 or 2
• Wheezing.	3
• Third heart sound.	3

Category III: Chest radiography.

Criterion	**Point value**
Category III: Chest radiography: • Alveolar pulmonary edema.	4
• Interstitial pulmonary edema.	3
• Bilateral pleural effusion.	3
• Cardiothoracic ratio greater than 0.50.	3
• Upper zone flow redistribution.	2

No more than 4 points are allowed from each of three categories; hence the composite score (the sum of the subtotal from each category) has a possible maximum of 12 points. The diagnosis of heart failure is classified as "definite" at a score of 8 to 12 points, "possible" at a score of 5 to 7 points, and "unlikely" at a score of 4 points or less.

We measured the $PetCO_2$ values for identifying acute HF were 35mmHg or less.

Statistical methods

Data were statistically described in terms of mean and standard deviation for quantitative data and frequencies (number of cases) and relative frequencies (percentages) for qualitative data. Comparison of quantitative variables was done using unpaired *t*-test. For comparing categorical data, Chi square (X^2) test was performed. Exact test was used instead when the expected frequency is less than 5. Logistic regression was done to identify models for detecting cardiac disease as a cause of dyspnea using ultrasound, modified Boston criteria and pet CO_2. Predicted values by different models were calculated and compared with actual state using Receiver Operator Characteristic (ROC) curves. Area-Under-the Curve (AUC) and 95% confidence interval were used to determine model accuracy. Sensitivity, specificity, Negative Predictive Value (NPV), Positive Predictive Value (PPV), positive Likelihood Ratio (LR+) and negative Likelihood Ratio (LR–) were estimated in every model. ROC curves and Area-Under-the Curve (AUC) analysis were used to get the best cutoff values for detecting cause of dyspnea in numerical data. Odds Ratios (ORs) and 95% Confidence Interval (CIs) were calculated to examine the risk of cardiac cause of dyspnea. A probability value (*p*-value) less than 0.05 was considered statistically significant. All statistical calculations were done using SPSS (Statistical Package for the Social Science; SPSS Inc., Chicago, IL, USA) version 21.

RESULTS

During the period of the study, 250 consecutive patients presented with acute dyspnea were included. Those patients were managed in Emergency Department and the Intensive Care Unit. 118 patients were diagnosed with HF-related acute dyspnea. 107 patients were diagnosed with pulmonary-related acute dyspnea. Twenty five patients met the exclusion criteria from the study. Next figure is a flow diagram illustrating recruitment, exclusion and subsequent grouping of all patients in the study.

Table 1: Clinical and demographic characteristics of patients.

Clinical finding	Group I N=118		Group II N=107		*p*- value
Age. Gender M/F.	61.±8.5 69/49		59.±7.8 62/45		0.9 0.9
Nocturnal dyspnea.	56	47.5%	8	7.5%	<0.001
Orthopnea.	43	36.4%	7	6.5%	<0.001
Cough.	34	28.8%	44	41.1%	0.053
Sputum production.	7	5.9%	30	28.0%	<0.001
Asthma/COPD medications.	9	7.6%	68	63.6%	<0.001
HF medications.	97	82.2%	36	33.6%	<0.001
Previous CHF.	71	60.2%	17	15.9%	<0.001
Previous asthma/COPD.	25	21.2%	12	11.2%	0.044
Previous arrhythmia.	31	26.3%	8	7.5%	<0.001
Fever.	8	6.8%	29	27.1%	<0.001
Mean SaO_2, %.	69	7±	70	6±	0.150
Murmur.	27	23.1%	9	8.4%	0.003
Rales.	100	84.7%	10	9.3%	<0.001
Mean pulse rate.	98	±7	100	±8	0.085
Wheezes.	63	53.4%	85	79.4%	<0.001
Jugular venous distension.	33	28.0%	15	14.0%	0.011
Lower extremity edema.	56	47.5%	15	14.0%	<0.001
normal sinus rhythm.	95	80.5%	80	74.8%	0.301
Endotracheal tube insertion.	10	8.5%	12	11.2%	0.49
Troponin T >0.03ng/mL.	27	22.9%	3	2.8%	<0.001

So the study patients were divided according to final hospital diagnosis into Group I: Heart failure-related acute dyspnea and Group II: Pulmonary-related acute dyspnea.

Table 2: Evaluation of the diagnostic accuracy of end tidal CO2 and lung.

Clinical finding	Group I N=118	Group II N=107	*p*-value
$PetCo_2$	26.5±4.7	50.±14.1	<0.001
Boston criteria	10.1±1.5	4.3±0.7	<0.001

Total number of patients with acute dyspnea
n=225

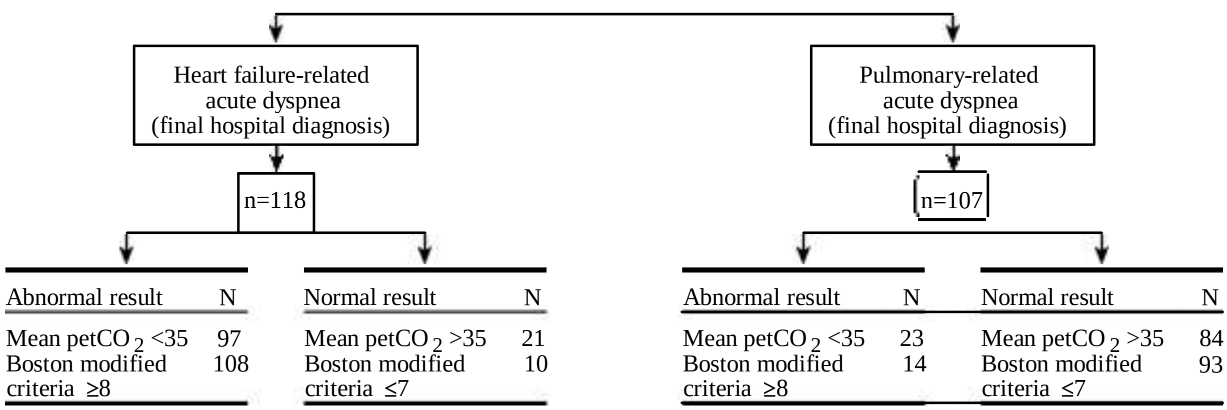

Table 3: Comparison between the diagnostic performance of end tidal CO2 and Boston criteria.

	PET CO_2	Boston criteria
• Sensitivity	78.8% (95% CI:	84.75% (95% CI:
	72.20% to 87.22%)	76.97% to 90.70%)
• Specificity	78.5% (95% CI:	83.18% (95% CI:
	69.51% to 85.86%)	74.72% to 89.71%)
• PPV	80.5% (95% CI:	84.75% (95% CI:
	72.20% to 87.22%)	76.97% to 90.70%)
• NPV	78.5% (95% CI:	83.18% (95% CI:
	69.51% to 85.86%)	74.72% to 89.71%)
• Positive	3.75 (95% CI:	5.04 (95% CI:
likelihood ratio	2.58 to 5.44)	3.28 to 7.73)
• Negative	0.25 (95% CI:	0.18 (95% CI:
likelihood ratio	0.17 to 0.36)	0.12 to 0.28)
No	n=25	Excl uded from the study

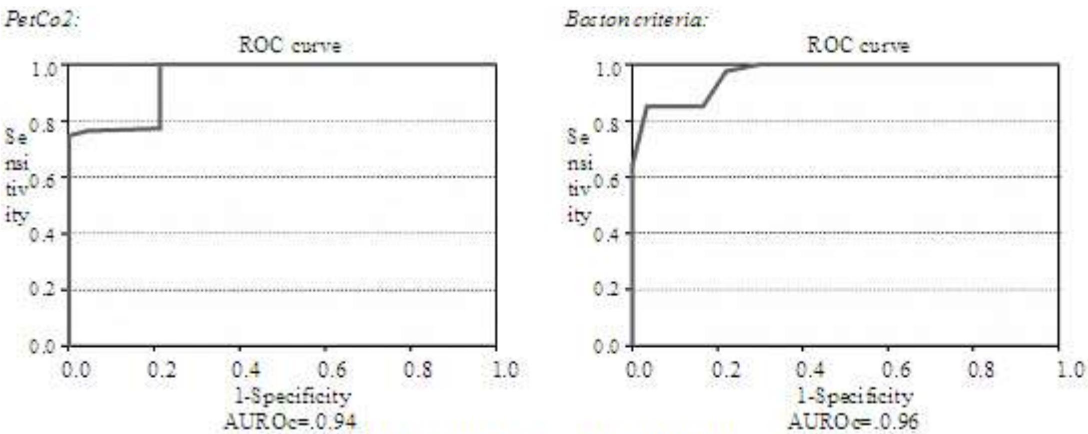

Fig. 2: Overall diagnostic accuracy using AUROC for each test.

DISCUSSION

The main result of our study shows that clinical characteristics of dyspnea have the better diagnostic performance in differentiating heart failure related acute dyspnea from pulmonary related acute dyspnea. This diagnostic accuracy of Boston criteria reached 84.75% sensitivity and 83.1% specificity for diagnosing cardiogenic pulmonary edema. Boston criteria, the structured clinical criteria for pulmonary edema, show the largest Area Under ROC (AUROC). So lung ultrasound had a significantly better diagnostic accuracy. Major advantages of clinical differentiation include readily availability, the lack of need for special logistics at the bedside and high reproducibility and cost efficiency.

The diagnostic performance of PetCO $_2$ was less, showing sensitivity of 78.8% and specificity of 78.5%. The area under ROC was less with Boston criteria and ever much less with PetCO $_2$.

The area under ROC was 0.97 for lung ultrasound versus 0.94 for pressure and tidal Co $_2$ and 0.96 for modified Boston criteria.

Brown et al., have studied pressure end tidal Co_2 to differentiate between cardiogenic dyspnea from obstructive lung disease related acute dyspnea.[12] They have found that $PETCO_2$ levels for pulmonary edema/CHF patients differ significantly from those of asthma/COPD patients. The ETCO $_2$ levels for pulmonary edema/Congestive Heart Failure (CHF) patients (27.1 ±7.8mmHg) vs. those of non cardiac patients (33.4 ±9.6mmHg); (p= 0.0375). Our study have found that $ETCO_2$ levels for pulmonary edema/CHF patients was 26.5 ±4.5 mmHg versus 50±4mmHg (p=0.001). This difference in Co_2 level may be explained partly by the more prevalence of COPD or chronic bronchitis patients in our study group.

Prosen et al., have found that using modified Boston criteria has sensitivity of 85% (95% CI 79 to 89) and specificity of 86% (95% CI 82 to 90). In accordance with our data the modified Boston criteria had showed comparable sensitivity and specificity.[13]

Further, this method can be used by the emergency service providers as showed by Brooke et al.,[20] Brooke et al., stated that the theoretical concept that paramedic-initiated prehospital assessment may be of benefit in the management of critically ill patients is not without logical conceptual reason. Studies to date have demonstrated that with the right education and mentorship.

CONCLUSION

The diagnosis of the exact etiology of acute dyspnea is sometimes challenging. The misdiagnosis of acute dyspnea can affect the outcome. The use of structured historical and clinical clues can minimize the misdiagnoses. The PetCO $_2$ is less accurate than history and clinical examination in differentiating the cause of acute dyspnea. The combined use of structured history and clinical examination in can furtherly maximize a bed side correct diagnosis of the cause of dyspnea.

REFERENCES

1. RAY P., DELERME S., JOURDAIN P. and CHENEVIERGOBEAUX C.: Differential diagnosis of acute dyspnea: The value of B natriuretic peptides in the emergency department. Q.J.M., 2008; 101: 831-43.
2. KLEMEN P., GOLUB M. and GRMEC S.: Combination of quantitative capnometry, N-terminal pro-brain natri- uretic peptide, and clinical assessment in differentiating acute heart filure from pulmonary disease as cause of acute dyspnea in prehospital emergency setting: Study of diagnostic accuracy. Croat. Med. J., 2009; 50: 133-42.
3. STEINHART B., THORPE K.E., BAYOUMI A.M., MOE G., JANUZZI J.L. Jr. and MAZER C.D.: Improving the diagnosis heart failure using a validated prediction model. J. Am. Coll. Cardiol., 2009; 54: 1515-21.
4. MICHOTA F.A. Jr. and AMIN A.: Bridging the gap between evidence and practice in acute decompensated heart failure management. J. Hosp. Med., 2008; 3(6 Suppl): S7-S15.
5. MOSESSO V.N. Jr., DUNFORD J., BLACKWELL T. and GRISWELL J.K.: Prehospital therapy for acute congestive heart failure: State of the rat. Pre. Hosp. Emerg. Care, 2003; 7: 13-23.
6. REMES J., MIETTINEN H., REUNANEN A. and PYÖRÄLÄ K.: Validity of clinical diagnosis of heart failure in primary health care. Eur. Heart J., 1991; 12: 315-21.
7. REMES J., MIETTINEN H., REUNANEN A. and PYOR-ALA K.: Validity of clinical diagnosis of heart failure in primary health care. Eur. Heart J., Mar., 1991; 12(3): 315-21.
8. CARDINALE L., VOLPICELLI G., BINELLO F., GAROFALO G., PRIOLA S.M., VELTRI A. and FAVA C.: Clinical application on lung ultrasound in patients with acute dyspnea: Differential diagnosis between cardiogenic and pulmonary causes. Radiol. Med., 2009; 114: 1053-64.
9. ARENA R., GUAZZI M. and MYERS J.: Prognostic value of end-tidal carbon dioxide during exercise testing in heart failure. Int. J. Cardiol., 2007; 117(1): 103-8.
10. MATSUMOTO A., et al.: End-tidal CO 2 pressure decreases during exercise in cardiac patients: Association with severity of heart failure and cardiac output reserve. J. Am. Coll. Cardiol., Jul., 2000; 36(1): 242-9.
11. BROWN L.H., GOUGH J.E. and SEIM R.H.: Can quantitative capnometry differentiate between cardiac and obstructive causes of respiratory distress? Chest., 1998; 113: 323-6. Medline: 9498946 Doi: 10. 1378/ chest. 113.2.323.
12. GREGOR PROSEN, et al.: Combination of lung ultrasound (a comet-tail sign) and N-terminal pro-brain natriuretic peptide in differentiating acute heart failure from chronic obstructive pulmonary disease and asthma as cause of acute dyspnea in prehospital emergency setting Critical Care, 2011; 15: R1 14.
13. LICHTENSTEIN D.A. and MEZIÈRE G.A.: Relevance of lung ultrasound in the diagnosis of acute respiratory failure: The BLUE protocol. Chest, 2008; 134: 117-25.
14. CARDINALE L., VOLPICELLI G., BINELLO F., GAROFALO G., PRIOLA S.M., VELTRI A. and FAVA C.: Clinical application on lung ultrasound in patients with acute dyspnea: Differential diagnosis between cardiogenic and pulmonary causes. Radiol. Med., 2009; 114: 1053-64.
15. VOLPICELLI G., MUSSA A., GAROFALO G., CARDINALE L., CASOLI G., PEROTTO F., FAVA C. and FRANCISCO M.: Bedside lung ultrasound in the assessment of alveolarinterstitial syndrome. Am. J. Emerg. Med., 2006; 24: 689-96.
16. AGRICOLA E., BOVE T., OPPIZZI M., MARINO G., ZANGRILLO A., MARGONATO A. and PICANO E.: "Ultrasound comet-tail images": A marker of pulmonary edema: A marker of pulmonary edema: A comparative study with wedge pressure and extravascular lung water. Chest., 2005; 127: 1690-5.
17. LITEPLO A.S., MARILL K.A., VILLEN T., MILLER R.M., MURRAY A.F., CROFT P.E., CAPP R. and NOBLE V.E.: Emergency Thoracic Ultrasound in the Differentiation of the Etiology of shortness of Breath (ETUDES): Sonographic B-lines and Nterminal Pro-brain-type Natriuretic Peptide in Diagnosing Congestive Heart Failure. Acad. Emerg. Med., 2009; 16: 201-10.
18. ZECHNER P.M., AICHINGER G., RIGAUD M., WILDNER G. and PRAUSE G.: Prehospital lung ultrasound in the distinction between pulmonary edema and exacerbation of chronic obstructive pulmonary disease. Am. J. Emerg. Med., 2010; 28: 3 89. E1 -3 89.E2.
19. BROOKE M., WALTON J. and SCUTT D.: Paramedic application of ultrasound in the management of patients in the prehospital setting: A review of the literature. Emerg. Med. J., 2010; 27: 702-7.