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Diagnostic Efficiency of BNP Levels in Patients Presenting to ER with Acute Heart Failure

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ABSTRACT

Background: Heart failure is a critical global health concern associated with significant morbidity and mortality. Timely diagnosis is essential, and B-type natriuretic peptide (BNP) has emerged as a potential biomarker for diagnosis of acute heart failure (AHF).
Objective: This study aimed to evaluate the diagnostic efficiency of BNP levels in patients presenting to the emergency room (ER) with clinical features suggestive of AHF.
Materials and Methods: Over the course of three months, a descriptive cross-sectional research was carried out, conducted in the emergency room of the cardiology department of MTI-LRH, Peshawar. There were 102 individuals in all who presented with signs and symptoms of acute cardiac failure. Serum BNP levels were measured alongside clinical evaluations. Chronic Kidney Disease and Cor-pulmonale were ruled out among these patients. Statistical analyses were performed to determine associations between variables.
Results: Elevated BNP levels (>350 pg/mL) were detected in 81.4% of patients, underscoring its diagnostic efficacy for AHF. The prevalence of CKD and cor-pulmonale was relatively low at 3.9% and 2.0% respectively. Although no statistically significant associations were identified, observed trends indicated potential complex relationships within the database.
Conclusion: BNP levels are an effective diagnostic tool for AHF, aiding early intervention and improving outcomes.Further research with larger, diverse cohorts is needed to validate and expand these findings.
Keywords: Acute heart failure, BNP, Chronic kidney disease, Cor-pulmonale, Diagnostic marker, Emergency room.

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INTRODUCTION

Heart failure is a critical health issue that affects over 20 million individuals worldwide and is a major source of morbidity and mortality. In the US, it results in almost a million hospital admissions per year. Congestive heart failure (CHF) remains a significant therapeutic problem even with enormous progress in our knowledge of the disease's biology, particularly in the field of diagnosis.[1] These medications have prolonged life and improved symptoms.[2] For the first time since the advent of echocardiography about 20 years ago, a straightforward blood test seems to be a substantial advancement in this field.[3]

The cardiac ventricle releases a neurohormone known as B-type natriuretic peptide (BNP) in response to pressure overload and volume expansion. The ability of BNP activation to diagnose left ventricular dysfunction in patients has generated a lot of attention. Despite studies indicating that levels associated with the severity and prognosis of HF4, BNP could not be used in active clinical settings until a rapid, inexpensive test was created. Current data such as article by Berger et al., in this issue of circulation, really showed that BNP has now cemented its position in this field.[5]

For diagnostic screening tests to be useful in acute treatment, they must not only detect individuals who have clinical symptoms in addition to dyspnea caused by CHF, but also have a strong negative predictive value. Davis et al. found that the acceptance plasma BNP concentration more precisely matched the final diagnosis compared with the ejection fraction or plasma concentration of atrial natriuretic peptide[6] in 52 patients who had their levels of the hormone measured upon presenting with acute dyspnea. The recently launched point-of-care fast assay was used to measure the BNP levels of 250 patients who were seen at the San Diego VA Health Care urgent care center, according to Duo et al. The non-CHF group (n = 139) had a mean BNP concentration of 38 plus or minus 4 pg/ml, while the CHF patients (n = 97) had a mean BNP concentration of 1076 plus or minus 1387. BNP was shown to be very sensitive and extremely specific for the diagnosis of CHF at a cut point of 80 pg/ml. BNP level continued to give important diagnostic information that was not accessible from other clinical criteria, according to multivariate analysis, even after the emergency department physician had considered all useful techniques for making the diagnosis.[8]

The distinction between cardiac and pulmonary causes of dyspnea may be made with the use of fast BNP testing, according to research by Morrison et al. Elevated BNP levels were linked to many pulmonary conditions, such as lung cancer, pulmonary embolism, and cor pulmonale, albeit often not to the same degree as in patients with acute LV dysfunction.[9] The recently completed multinational poorly (BNP) research was built on the basis of the aforementioned findings. The innovative large-scale research analysed 1568 people who experienced abrupt shortness of breath.

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It was shown that a single BNP result was more trustworthy than the "National Health and Nutrition Examination Score and Framingham", which are probably the two criteria most often used to diagnose CHF. BNP had a significant negative predictive value and was able to discriminate between causes of dyspnea caused by CHF and those caused by other conditions.[10] Because data from earlier international studies have shown conflicting results regarding "Diagnostic efficacy of BNP levels in acute heart failure patients" and because of variations in our population's genetic make-up, nutritional status, and environment, this study assist us in determining "Diagnostic efficacy of BNP levels in acute heart failure patients" in our local population of Khyber Pakhtunkhwa. Thus, this study helped us to perform further extensive studies which will help in creation of guidelines for the BNP level for the diagnosis of acute heart failure in the people of Khyber Pakhtunkhwa.

MATERIALS AND METHODS

This investigation followed a Descriptive Cross-Sectional study design and was conducted within the Emergency Room (ER) Department of Cardiology at MTI-LRH in Peshawar. The study extended over a period of three months from July 2024 to September 2024. A total of 102 individuals constituted the study's sample size, and we employed a Consecutive Non-probability sampling technique. The sample size of 102 individuals was calculated based on the prevalence of acute heart failure (AHF) in similar studies and available resources within the study period. Using a prevalence estimate of 1% for AHF and a confidence level of 95%, along with a margin of error of 5%, the sample size was determined using the formula:

$$n=Z^2 \cdot p \cdot (1-p)/ e^2$$

Where:

- n = required sample size
- Z = Z-score corresponding to the desired confidence level (1.96 for 95%)
- p = estimated prevalence of the condition
- e = margin of error

Given logistical constraints and the duration of data collection, the sample was finalized at 102 participants, ensuring the study's feasibility while maintaining statistical robustness.

The selection criteria included:

- Patients of any age groups
- Patients of both genders
- Patients reporting to the ER department of LRH Peshawar with symptoms and signs of Acute heart failure

And exclusion criteria of:

- Patients with history of Chronic Lung Disease, Sleep Apnea or recurrent pulmonary emboli and physical examination findings of elevated JVP, Peripheral edema, RV Heave, Cyanosis and clubbing and Loud P2 on auscultation underwent CXR, ECG, ABGs, and PFTs to rule out cor-Pulmonale.
- Patients with risk factors and physical findings of pallor and fluid overload underwent investigations such as RFTS, Urea and Electrolytes (sodium, potassium, calcium, phosphate), CBC, and Renal Ultrasound to assess kidneys size, structure and obstruction in order to rule out CKD.
- Pregnant women in female patient of child bearing age by urinary pregnancy test.

Operational Definitions

Acute Decompensated Heart Failure: determined by whether or not all of the following conditions are met.

- breathing difficulty during rest or after activity
- Oedema, rales, and/or congestion on a chest radiograph or features of congestion.[21]

Elevated BNP: "Brain natriuretic peptide (BNP) 350 pg/mL or N-terminal pro BNP (NT-proBNP) 1400 pg/mL (BNP 500 pg/mL or NT-proBNP 2000 pg/mL for those with atrial fibrillation)".[22]

Data Collection Procedure

Permission was obtained from the hospital's ethical and research committee of LRH, MTI , Peshawar (Approval number: 669/LRH/MTI Dated 23rd Feb. 2023). The study included every patient admitted to the hospital who satisfied the inclusion and exclusion criteria. A thorough history and complete physical examination were conducted. History focus was on identifying symptoms of acute heart failure, past medical conditions (e.g., hypertension, coronary artery disease), and medication use. Physical signs such as jugular venous distension, peripheral edema, and lung crackles were noted. Blood samples were collected for CBC to detect infection or anemia, kidney function to assess renal health, and serum BNP to diagnose acute heart failure. Chest radiographs identified pulmonary congestion, ECGs checked for arrhythmias, and echocardiograms assessed heart function and structural abnormalities. Abdominal ultrasounds were conducted to rule out chronic kidney disease. Blood samples were collected from patients during the management of acute heart failure and sent to the laboratory for serum BNP analysis. BNP levels were measured using the Siemens Immulite 2000 analyzer, which employs a chemiluminescent enzyme immunoassay (CLEIA) method. The analyzer has a detection range of 5-5000 pg/mL and a sensitivity of 5 pg/mL. Results were available within 30-45 minutes and documented on pre-designed structured forms attached to the study. All parameters, including patient names, ages, genders, addresses, and serum BNP levels, were recorded on a pre-designed structured form attached to this study.

Data Analysis

SPSS Version 22.0 was used to input and analyze the data. For quantitative information like age and serum BNP values, means and standard deviations were calculated Chi-square tests were used to assess the association between BNP levels and heart failure, age, and gender. Serum BNP level, age, and gender are examples of categorical variables for which frequencies and percentages were calculated. Serum BNP levels were stratified by age and gender for further analysis.

RESULTS

The information in table 01 shows the participants Age and Gender. There are 102 valid data points with no missing values for the variable "Age," and the mean age is approximately 59.91 years, with a standard deviation of 12.498. Regarding "Gender," there are 50 males, 52 females, and no information for "Other."

Table 01. Age and gender based distribution

Age	N	Valid	102
		Missing	0
	Mean		59.9118
	Std. Deviation		12.498
Gender	N	Male	50
		Female	52
		Other	0

Figure 01 presents information related to "SERUM_BNP_LEVEL," which likely represents serum B-type natriuretic peptide (BNP) levels. It shows that 83 out of 102 observations (81.4%) have BNP levels categorized as "RAISED (>350)," while the remaining 19 observations (18.6%) fall into the "NOT-RAISED (<350)" category. This breakdown provides insight into the distribution of BNP levels within the dataset, with the cumulative percentage indicating that all observations are accounted for.

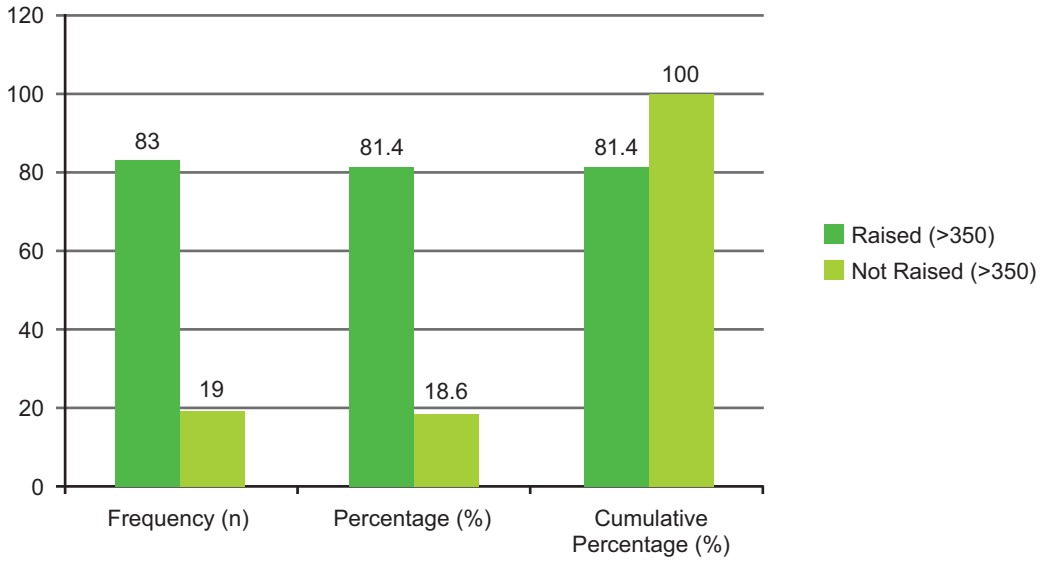


Figure 01. showing serum BNP

The Chi-Square Tests table reports the statistical analysis results for assessing the association between categorical variables. Specifically, it examines the relationship between variables using three different chi-square tests. P-values of 0.834, 0.714, and 0.493 are obtained for the “Pearson Chi-Square, Likelihood Ratio Chi-Square, and Linear-by-Linear Association tests”, respectively. According to these p-values, there is not a significant relationship between the variables being studied. Additionally, a note highlights that a substantial proportion of cells (98.8%) have expected counts below 5, which can impact the reliability of Chi-Square results, but the tests collectively suggest that no strong association exists in this dataset.

Table 02. Chi-Square Tests 1

Value		Df	Asymptotic Significance (2-sided)
Pearson Chi-Square	30.48a	39	.834
Likelihood Ratio	33.59	39	.714
Linear-by-Linear Association	.470	1	.493
N of Valid Cases	102		

a. Expected count for 79 cells (98.8%) is less than 5. The predicted count must be at least.19.

The Chi-Square Tests table 5 presents the statistical analysis results for evaluating associations between categorical variables. In particular, it displays three distinct Chi-Square tests. The Likelihood Ratio Chi-Square and the Pearson Chi-Square both provide high statistics, but their respective p-values of 0.380 and 1.000 show no statistically significant relationships between the variables studied. The Linear-by-Linear relationship test, on the other hand, stands out due to its substantial statistical significance (p .001), which indicates a significant linear relationship between the variables. The remark (b) further emphasises that every cell would have anticipated counts lower than 5, with the lowest predicted count being as low as 0.01, which may impact the reliability of the results but does not alter the significant linear trend detected by the Linear-by-Linear Association test.

Table 03. Chi-Square Tests 2

Value		Df	Asymptotic Significance (2-sided)
Pearson Chi-Square	3219-800[b]	3196	.380
Likelihood Ratio	651.801	3196	1.000
Linear-by-Linear Association	61.017	1	<.001
N of Valid Cases	102		

a.3325 cells (or 100 percent) have an anticipated count of less than 5. The least anticipated count is.01.

DISCUSSION

The objective of our research was to evaluate the diagnostic value of blood B-type natriuretic peptide (BNP) levels in patients who presented to the emergency room (ER) with acute heart failure. Our findings suggest that elevated BNP levels hold promise as a valuable diagnostic marker for this condition, with approximately 81.4% of patients in our study cohort exhibiting raised BNP levels exceeding 350pg/mL. This observation aligns with previous research, highlighting BNP as a reliable indicator of acute heart failure,[11] particularly when clinical symptoms and signs alone may not suffice for a definitive diagnosis. The high prevalence of elevated BNP levels within our study population underscores the importance of including BNP measurements as part of the diagnostic workup for patients presenting to the ER with symptoms suggestive of acute heart failure.[12] Such early detection can facilitate prompt intervention and potentially improve patient outcomes by reducing the time to appropriate treatment initiation.

Our study adds to the expanding body of data supporting the diagnostic value of blood BNP levels in the setting of acute heart failure presenting in the Emergency Room13, when compared to prior studies in the field. Our results are consistent with other studies, supporting the use of BNP as a marker for the early identification and diagnosis of acute heart failure, particularly when clinical symptoms alone may not provide a definitive diagnosis. However, it's noteworthy that our study's cohort exhibited a relatively higher prevalence of elevated BNP levels (81.4%) compared to some recent studies, which underscores the importance of considering the specific patient population and clinical context in interpreting BNP results.[14] Moreover, our study sheds light on the low prevalence of comorbid conditions like Chronic Kidney Disease and cor-pulmonale in this setting, offering valuable insights for clinicians in differentiating acute heart failure from other potential causes. While acknowledging the need for larger, multi-center studies to validate and generalize our findings, our research provides pertinent guidance on behalf of the frontline managing of acute heart failure in the Emergency Room.[15]

Additionally, our study assessed the prevalence of two conditions, Chronic Kidney Disease (CKD) and cor-pulmonale, in this patient population. The relatively low prevalence of CKD (3.9%) and cor-pulmonale (2.0%) within our cohort suggest that these conditions may not be major etiology of the elevated leve.[16] This insight can help guide clinicians in their differential diagnosis process, focusing on conditions that are more likely to be relevant in this specific setting. Furthermore, our statistical analysis explored potential associations between variables, and although no statistically

significant associations were found, the presence of a significant linear trend in some cases suggests complex relationships within our data. While our study did not establish causation, it underscores the need for further investigation into the interplay between various factors in the context of acute heart failure.[17]

Despite the useful information this research has provided, it is important to recognise its limits. The ability to be generalised of our findings18 may be constrained by the sample size's relative smallness and the application of data from just one centre. Our findings need to be confirmed and expanded upon by larger, multi-center investigations. Future research should also take into account the possible effects of missing information along with the need for strong statistical methods to handle predicted counts under 5 in certain analyses.[19] According to our research, measuring blood BNP levels might be a useful diagnostic technique for identifying sudden cardiac arrest in ER patients. The significance of early detection and care for acute heart failure in this particular situation is highlighted by the low incidence of CKD and cor-pulmonale in this group. This study offers helpful recommendations for medical practitioners in the diagnosis and treatment of acute heart failure patients in the Emergency Room, even if further research is required to examine possible links and corroborate our findings.[20]

Limitation

It is important to recognize the many limitations of the current study. The study was limited to a single site, which might limit the applicability of the results in other contexts. Second, the findings' statistical power and accuracy may be limited by the small sample size. Lastly, the study had a relatively short period of three months, which may have hindered the capacity to identify significant connections between variables. Furthermore, while it emphasizes the diagnostic value of serum BNP levels in the context of acute heart failure, it lacks a detailed examination of other diagnostic criteria. Further research is required to confirm and build upon these results, necessitating larger-scale investigations conducted across several centers with extended observation durations.

CONCLUSION

Our research suggests that increased BNP levels may be a useful diagnostic tool for acute heart failure in individuals receiving care in emergency rooms, with approximately 81.4% exhibiting raised BNP levels. Moreover, our findings suggest that chronic kidney disease and cor-pulmonale are relatively infrequent contributors to acute heart failure in this context. While statistical associations were not significant, the presence of a significant linear trend in some cases underscores the intricacies of our data. These insights offer guidance to healthcare professionals in diagnosing and managing acute heart failure, although larger, more diverse studies are needed to validate and expand upon our findings.

Ethical Consideration

This study was approved by Institutional Review Board of Lady Reading Hospital, Peshawar, Pakistan.

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Conflict of Interest

Authors declared no conflict of interest.

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DATA SHARING STATEMENT: The data that support the findings of this study are available on request from the corresponding author. The data is not publicly available due to privacy or ethical restrictions.

AUTHORS' CONTRIBUTION

The following authors fullfill authorship criteria as per ICMJE guidelines;

Adil M:	Substantial contribution to conception and design, drafting the manuscript, final approval, agreed to be accountable for all the work.
Ahmad B:	Substantial contribution to conception and design, data acquisition, drafting the manuscript, final approval, agreed to be accountable for all the work.
Hussain S:	Analysis and interpretation of data, drafting the manuscript, final approval, agreed to be accountable for all the work.

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