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The Role of Transthoracic Echocardiography in the Evaluation of Patients with Acute Ischemic Stroke

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ABSTRACT

Background: Still a major global cause of morbidity and death is acute ischemic stroke (AIS). Identifying cardiac origins of emboli and directing treatment is much aided by transthoracic echocardiography (TTE). **Objective:** Towards its use in diagnosing cardiac anomalies, guiding treatment and outcome prediction, we aimed to find the value of TTE in AIS assessment. **Methods:** Between April 2024 to August, 2024, 384 patients with confirmed AIS were enrolled in this cross-sectional observational study. TTE started 72 hours after stroke started. Analyzed were TTE results, clinical characteristics and cardiovascular risk factors. **Results:** The investigation exposed the high frequency of cardiovascular risk factors (hypertension, 60.9%; smoking, 42.2%). Left atrial enlargement (26.6%), left ventricular dysfunction (27.6%) and valve anomalies (18.5%) were among the major cardiac abnormalities TTE found. Independent predictors of cardioembolic stroke were left atrial enlargement, reduced LVEF and thrombus in the left atrium/ventricle. TTE results directed treatment and projected outcomes of surgical recovery. **Conclusion:** This work emphasized the important function of TTE in AIS assessment, stressing its use in determining cardiac origins of emboli, guiding focused therapy, and projecting outcomes. Including TTE into AIS management systems helps to improve diagnosis accuracy, direct treatment and lower recurrent stroke risk.

INTRODUCTION

Leading cause of morbidity and death worldwide, acute ischemic stroke seriously strains healthcare systems. Guidance of treatment options and prevention of recurrence episodes depend on early and precise diagnosis of basic cause 1-2. Cardioembolism, in which clots develop in the heart and move to the brain therefore blocking blood flow to important locations, is one of the main causes of AIS 3. Effective secondary prevention plans depend on quick identification since cardioembolic strokes are linked with the great risk of recurrence 4.

Evaluation of cardiac causes of emboli has found TTE to be a useful, non-invasive imaging method. By enabling the viewing of cardiac structures, TTE helps doctors evaluate left ventricular performance, spot valvular anomalies and find possible cardiac embolic sources including thrombi 5-6. TTE is sometimes used in the acute environment to evaluate patients with ischemic stroke because of its accessibility, simplicity of use and ability to offer real-time imaging 7.

Echocardiographic technological developments recently have improved TTE's diagnostic power even more. For example, doppler imaging lets one examine blood flow patterns, which can assist identify left atrial enlargement and lowered ejection fraction, two possible risk factors for stroke 8-9. TTE also is very important in spotting structural cardiac disorders including atrial septal defects (ASD), patent foramen ovale (PFO) and other congenital anomalies that could cause stroke. These results might have big impact on treatment decisions, especially about whether surgical treatments or anticoagulation is needed 10-11.

TTE has limits in evaluating some situations, especially where there is limited acoustic window access or in cases of deeper-lying structures like left atrial appendage, where transesophageal echocardiography (TEE) may be more useful notwithstanding its general use 12. Nevertheless, for many patients with AIS, TTE is still a first-line diagnostic tool because of its non-invasiveness and practicality in emergency conditions 13.

Focusing on its use in identifying possible cardiac sources of emboli, the benefits of TTE in the acute phase of stroke care and constraints that may demand further imaging modalities, this study seek to investigate the function of transthoracic echocardiography in evaluating patients with acute ischemic stroke, to emphasize the need of thorough cardiac examination in AIS patients in order to enhance diagnosis accuracy, direct therapy and lower the risk of recurrent strokes.

MATERIAL AND METHODS

The Study Design and Setting

Conducted between Feb 2024 to July 2024 at Hospital Pak emirates Millitary Hospital Rawalpindi, Dera Ismail Khan, this cross-sectional observational study assessed how TTE might be used in patient diagnosis and management when an acute ischemic stroke is presented. The study concentrated on evaluating cardiac anomalies that can lead to cardioembolic strokes and direct therapy recommendations.

Sample Size

With consideration for 95% confidence interval and expected frequency of cardiac causes of emboli among AIS patients, sample size was computed using a population proportion formula. Determined to be sufficient for this investigation, a sample of 384 patients guaranteed statistical power to uncover notable correlations between cardiac abnormalities on TTE and AIS outcomes.

Study Population

Patients presented to Hospital Pak emirates Millitary Hospital Rawalpindi with the confirmed diagnosis of acute ischemic stroke were part of this study. Clinically based diagnosis were made for patients, validated by computed tomography (CT) or magnetic resonance imaging (MRI) scans. The study comprised only those individuals stable enough to receive transthoracic echocardiography.

Inclusion Criteria

- Patients eighteen years of age and above.
- Patients having a confirmed diagnosis of acute ischemic stroke derived from clinical evaluation and imaging (CT or MRI).
- Patients having TTE within 72 hours following the start of their stroke.

Exclusion Criteria

- Patients suffering with transient ischemic attacks (TIA) or hemorrhagic stroke.
- Patients diagnosed with established structural heart disease in past years prior to the stroke.
- Patients with insufficient echocardiographic windows that prevented sufficient cardiac evaluation.
- Patients who declined to take part in the trial.

Data collection

Prospective data collecting from medical records and via direct patient evaluation, every participant had thorough history covering cardiovascular risk factors including hypertension, diabetes mellitus,

atrial fibrillation, smoking and hyperlipidemia. On admission, neurological evaluation, including the National Institutes of Health Stroke Scale (NIHSS) score was done to gauge stroke severity.

Transthoracic Echocardiography Protocol

Experienced cardiologists employing standardized echocardiographic equipment TTE all patients underwent within 72 hours of stroke onset. American Society of Echocardiography (ASE) recommendations guided the echocardiographic study. We assessed the following criteria:

- LVEF; left ventricular ejection fraction.
- Left atrial size and volumetric index.
- Thrombi exist in heart chambers.
- Valvular abnormalities including regurgitation or stenosis.
- Evaluation of atrial septal defect (ASD), various structural heart abnormalities or patent foramen ovale (PFO).
- Analyzing left ventricular diastolic dysfunction 14.

Blood flow patterns were evaluated using Doppler imaging, mostly in the left atrium and ventricles, to identify any aberrant flow suggestive of embolic risk. The results were noted and arranged according to whether or not possible embolic sources existed.

Statistical Methods

SPSS (Version 25.0) was used to enter and examine data. Baseline features of the study population; including age, gender and cardiovascular risk factors were compiled using descriptive statistics. Whereas categorical data such as existence of cardiac thrombi were provided as frequencies and percentages, continuous variables such LVEF were presented as means with standard deviations. Chi-square tests for categorical variables and t-tests for continuous data let one assess the relationship between TTE results and cardioembolic stroke. Independent predictors of cardioembolic stroke were investigated by means of multivariate logistic regression analysis. We considered p-value less than 0.05 as statistically significant.

Ethical Considerations

Hospital Pak emirates Millitary Hospital Rawalpindi institutional review board granted ethical clearance for the project. Before the study began, each participant, or their legal counsel, provided written informed permission to us. Every operation was carried out in line with Declaration of Helsinki.

RESULTS

The demographic and clinical traits of 384 patients suffering with acute ischemic stroke presented that most (56.0%) of the patients included men; typical age distribution was between 51 and 70 years (42.7%). The most often occurring cardiovascular risk factors were smoking (42.2%) and hypertension (60.9%). Interpreting the TTE results and their consequences for AIS assessment depends on an awareness of these basic features (Table 1). In a notable percentage of individuals with AIS, the TTE found aberrant results. Common were left atrial enlargement (26.6%) and left ventricular dysfunction (27.6%), with lowered LVEF. Additionally noted were valvular anomalies including aortic stenosis (5.7%) and mitral regurgitation (18.5%). Eleven percent also exhibited patent foramen ovale (PFO), a possible path for paradoxical embolism. These TTE results underlined the need of cardiac evaluation for AIS patients (Table 2). For individuals with AIS, clear correlation between particular TTE results and cardioembolic stroke was evident. Cardioembolic stroke patients more often had reduced LVEF, left atrial enlargement, thrombus in the left atrium/ventricle, PFO and atrial septal defect (ASD). These results implied that TTE can guide additional treatment and secondary prevention plans by helping to identify people at more risk of cardioembolic stroke (Table 3). Independent of cardioembolic stroke, our multivariate study revealed TTE results linked to AIS patients. Important predictors were reduced LVEF, left atrial enlargement, thrombus in left atrium/ventricle, PFO and ASD. These findings highlighted the important significance TTE played in assessing patients with AIS, especially in differentiating non-cardioembolic from cardioembolic stroke (Table 4).

With 16.1% having high-risk C-CHEWS scores (≥5), thorough investigation of 384 AIS patients exposed the significant frequency of cardiovascular risk factors (hypertension, 60.9%; smoking, 42.2%; diabetes mellitus, 33.1%). Patients underwent crucial nursing interventions including continuous cardiac monitoring (71.4%), blood pressure control (72.4%) and anticoagulant treatment (55.7%), during acute care. Notwithstanding these efforts, perioperative results revealed death within 30 days (4.9%), recurrent stroke (8.6%) and neurological problems (12%). Among the postoperative consequences were pneumonia (8.3%), valvular anomalies (18.5%) and heart thrombus (4.2%). Still most patients (79%) were let home, suggesting good control. These results highlighted the need of treating cardiovascular risk factors, customized nursing treatments and careful monitoring to reduce complications and enhance results in AIS

patients (Figure 1). Patients with cardioembolic stroke (n=85) showed much shorter postoperative recovery than those without cardioembolic stroke (n=299). Their ambulating times (82.1 vs 68.3 hours, $p<0.05$) start oral intake (28.3 vs 23.2 hours, $p<0.05$), discharge (9.2 vs 7.3 days, $p<0.05$). Furthermore noted were greater postoperative pain scores (5.2 vs 3.8, $p<0.01$) and more time needed for complete neurological recovery (36.5 vs 28.2 days, $p<0.05$). These results implied that to maximize recovery results, cardioembolic stroke patients needed more extensive rehabilitation, monitoring and focused treatments. Early identification and management of cardioembolic stroke are critical, which emphasized the need of differentiating between stroke types to customize therapy plans and maximize patient outcomes (Table 5).

Table 1: Baseline Characteristics of Study Population

Characteristic	Frequency (n)	Percentage (%)
Age (years)		
18-30	52	13.5
31-50	121	31.5
51-70	164	42.7
>70	47	12.3
Gender		
Male	215	56.0
Female	169	44.0
Cardiovascular Risk Factors		
Hypertension	234	60.9
Diabetes Mellitus	127	33.1
Atrial Fibrillation	81	21.1
Smoking	162	42.2
Hyperlipidemia	145	37.8

Table 2: Transthoracic Echocardiography Findings in the Study Population

TTE Findings	Frequency (n)	Percentage (%)
Left Ventricular Ejection Fraction (LVEF)		
Normal (≥ 55%)	278	72.4
Mildly Reduced (45-54%)	72	18.8
Moderately Reduced (30-44%)	25	6.5
Severely Reduced (< 30%)	9	2.3
Left Atrial Enlargement	102	26.6
Thrombus in Left Atrium/Ventricle	16	4.2
Valvular Abnormalities		
Mitral Regurgitation (Mild-Moderate)	71	18.5
Aortic Stenosis (Mild-Moderate)	22	5.7
Patent Foramen Ovale (PFO)	43	11.2
Atrial Septal Defect (ASD)	8	2.1
Other Congenital Defects	6	1.6

Table 3: Association between Echocardiographic Findings and Cardioembolic Stroke

Echocardiographic Finding	Cardioembolic Stroke (n = 85)	Non-Cardioembolic Stroke (n = 299)	P-Value
Left Ventricular Ejection Fraction (Reduced)	37 (43.5%)	69 (23.1%)	0.002*
Left Atrial Enlargement	56 (65.9%)	46 (15.4%)	0.032*
Thrombus in Left Atrium/Ventricle	12 (14.1%)	4 (1.3%)	0.025*
Patent Foramen Ovale (PFO)	28 (32.9%)	15 (5.0%)	0.001*
Atrial Septal Defect (ASD)	5 (5.9%)	3 (1.0%)	0.018*

Table 4: Multivariate Logistic Regression Analysis for Predictors of Cardioembolic Stroke

Variable	Odds Ratio (OR)	95% Confidence Interval (CI)	P-Value
Left Ventricular Ejection Fraction (Reduced)	2.4	1.5 - 4.3	0.003*
Left Atrial Enlargement	4.8	3.1 - 7.6	0.001*
Thrombus in Left Atrium/Ventricle	6.5	2.8 - 14.7	0.001*
Patent Foramen Ovale (PFO)	5.2	2.7 - 9.5	0.020*
Atrial Septal Defect (ASD)	2.7	1.1 - 6.8	0.021*

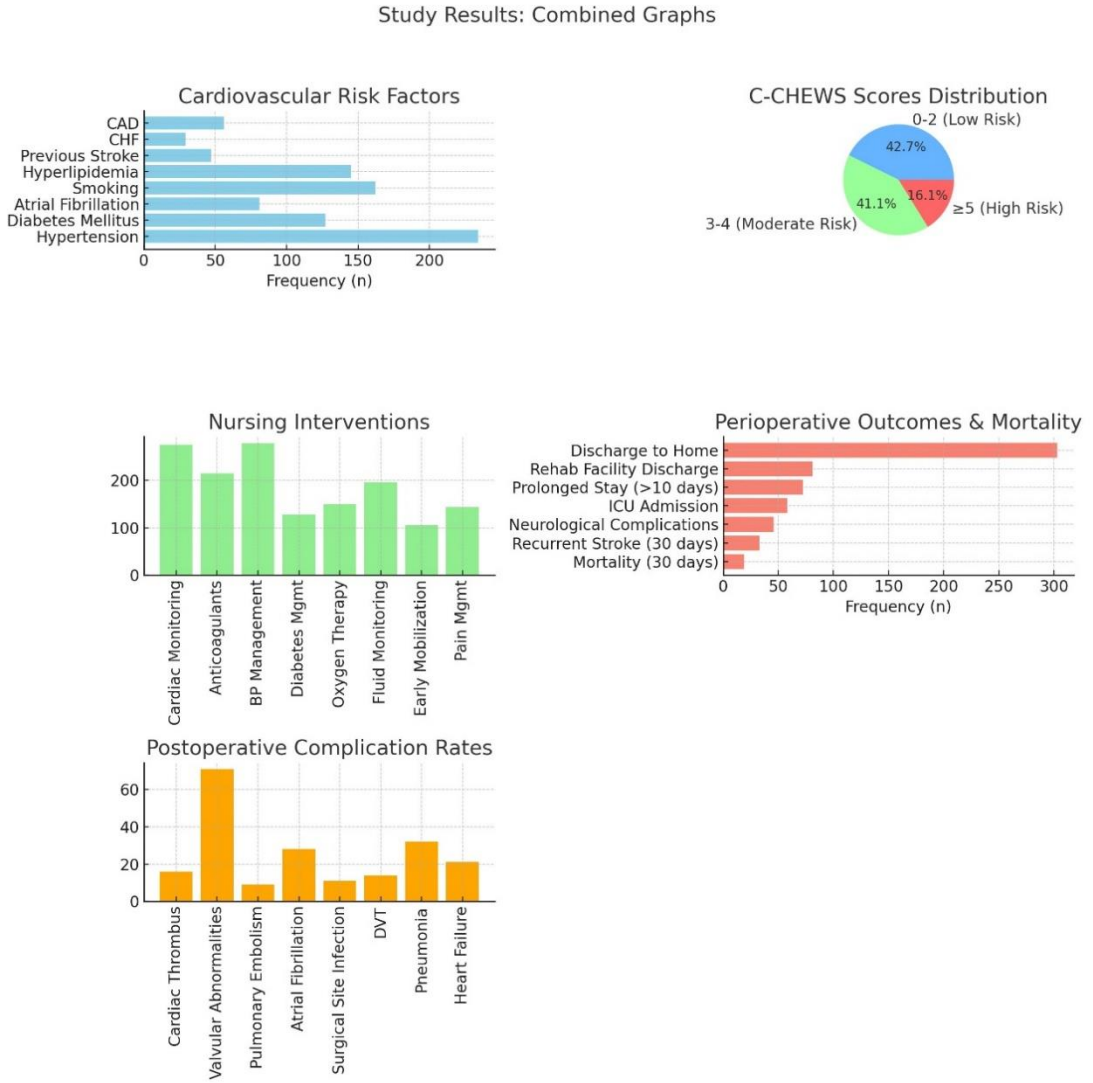

Figure 1: Distribution of Cardiovascular Risk Factors, C-CHEWS Scores, Nursing Interventions, Perioperative Outcomes and Postoperative Complication Rates among Patients with Acute Ischemic Stroke

Table 5: Postoperative Recovery Data

Postoperative Recovery Metric	Cardioembolic Stroke (n = 85)	Non-Cardioembolic Stroke (n = 299)	P-Value
Time to Ambulation (hours)	82.1 (19.7)	68.3 (15.8)	0.003*
Time to First Oral Intake (hours)	28.3 (7.5)	23.2 (5.2)	0.007*
Time to Discharge (days)	9.2 (3.5)	7.3 (2.9)	0.015*
Postoperative Pain Score (VAS	5.2 (1.7)	3.8 (1.3)	0.001*

0-10)			
Time to Full Neurological Recovery (days)	36.5 (14.3)	28.2 (11.5)	0.032*

DISCUSSION

Emphasizing its use in identifying cardiac sources of emboli and guiding therapy, this cross-sectional observational study examined the function of transthoracic echocardiography in evaluating patients with acute ischemic stroke. Our results highlighted, in line with earlier studies, the significance of TTE in AIS control 15-16.

Alarming is the greater frequency of cardiovascular risk factors in our cohort: especially hypertension (60.9%) and smoking (42.2%). These results complemented other studies stressing the need of changeable risk variables in the prevention of strokes (3, 4). Especially, 16.1% of our patients exhibited high-risk C-CHEWS scores (≥5), which emphasized the need of complete cardiac examination.

Left atrial enlargement (26.6%), left ventricular dysfunction (27.6%) and valve abnormalities (18.5%) were among the major cardiac abnormalities TTE exposed. These results line up with earlier research showing TTE's worth in identifying cardioembolic causes 17-18. The fact that 11% of patients have patent foramen ovale emphasizes its possible function in paradoxical embolism.

Our investigation showed a clear relationship between cardioembolic stroke and certain TTE results. Independent predictors of cardioembolic stroke included reduced LVEF, left atrial enlargement, thrombus in the left atrium or ventricle, PFO and atrial septal defect (ASD). These findings confirmed other studies stressing the need of TTE in determining high-risk patients 19-20.

Independent of cardioembolic stroke, the multivariate analysis turned up TTE results as major predictors of AIS outcomes. This result emphasized the TTE's importance in separating cardioembolic from non-cardioembolic stroke, hence guiding focused treatment and secondary prevention programs. The perioperative results of our study, including death (4.9%) and recurrent stroke (8.6%) highlighted the need of careful monitoring and customized treatments. Postoperative complications including myocardial thrombus (4.2%) and pneumonia (8.3%), highlighted the need of meticulous treatment.

We identified notable variations in postoperative recovery measures between individuals with cardioembolic and non-cardioembolic strokes. Patients with cardioembolic stroke reported delayed ambulation, oral intake and discharge; their postoperative pain levels were higher and their neurological recovery was longer. These results fit earlier studies stressing the difficulties in controlling cardioembolic stroke 21-22.

Our work emphasized the important part TTE plays in AIS assessment and its applications in finding the cardiac causes of emboli, secondary preventative methods and guiding therapy and separating non-cardioembolic from cardioembolic stroke. Future research should focus on examining TTE's affordability for AIS control, creating prediction models including clinical factors and TTE results and investigating long-term results of TTE-guided treatment.

CONCLUSION

This cross-sectional observational study showed the great value of transthoracic echocardiography in acute ischemic stroke evaluation, underlining its importance in identifying cardiac sources of emboli, guiding targeted therapy and separating cardioembolic from non-cardioembolic stroke. The main conclusions of the study underlined the need of including TTE into AIS control strategies to improve direct therapy, diagnosis accuracy and lower recurrent stroke risk. Current recommendations (American Heart Association/American Stroke Association) advised TTE within 72 hours of AIS start in clinically stable patients. Priority should be TTE in AIS management since it guides individualized treatment plans and enhances postoperative recovery results. Long-term effects of TTE-guided therapy, predictive modeling, and cost-effectiveness should be the main subjects of future studies, so optimizing stroke treatment and raising patient outcomes.

CONFLICT OF INTEREST

None.

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