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Troponin Improves the Yield of Transthoracic Echocardiography in Ischemic Stroke Patients of Determined Stroke Subtype

Shadi Yaghi, MD[1], **Andrew D. Chang, MS**[1], **Shawna Cutting, MD**[1], **Mahesh Jayaraman, MD**[1,2,3], **Ryan A. McTaggart, MD**[2], **Brittany A. Ricci, BS**[1], **Katarina Dakay, DO**[1], **Priya Narwal, MD**[1], **Brian Mac Grory, MD**[1], **Tina Burton, MD**[1], **Michael Reznik, MD**[1], **Brian Silver, MD**[4], **Ajay Gupta, MD**[5], **Christopher Song, MD**[6], **Emile Mehanna, MD**[6], **Matthew Siket, MD**[7], **Michael P. Lerario, MD**[8], **Daniel C. Saccetti, MD**[9], **Alexander E. Merkler, MD**[9], **Hooman Kamel, MD**[9], **Mitchell S. V. Elkind, MD, MS**[10,11], and **Karen Furie, MD, MPH**[1]

[1]Department of Neurology, the Warren Alpert Medical School of Brown University, Providence RI

[2]Department of Diagnostic Imaging, the Warren Alpert Medical School of Brown University, Providence RI

[3]Department of Neurosurgery, the Warren Alpert Medical School of Brown University, Providence RI

[4]Department of Neurology, University of Massachusetts, Worcester, MA

[5]Department of Radiology, Weill Cornell Medical College, New York, NY

[6]Department of Internal Medicine, Division of Cardiology, The Warren Alpert Medical School of Brown University, Providence, RI

Corresponding author: Shadi Yaghi, MD, The Warren Alpert Medical School of Brown University, 353 Eddy Street APC 530, Providence, Rhode Island, 02903, Tel: 401-444-2622, Fax: 401-444-8781.

Author contributions

Shadi Yaghi: Data collection, study concept and design, outcome adjudication, manuscript preparation
Andrew Chang: Data analysis
Brittany Ricci: Data collection
Shawna Cutting: outcome adjudication and data collection
Mahesh Jayaraman: Manuscript revision and data collection
Ryan McTaggart: Manuscript revision and data collection
Katarina Dakay: Manuscript revision
Priya Narwal: Manuscript revision
Brian MacGrory: Manuscript revision
Tina Burton: Manuscript revision
Michael Reznik: Manuscript revision
Matthew Siket: Manuscript revision
Brian Silver: Manuscript revision
Ajay Gupta: Study concept and manuscript revision
Christopher Song: Manuscript revision and preparation
Emile Mehanna: Manuscript revision
Michael P. Lerario: Manuscript revision
Daniel Sacchetti: Manuscript revision
Alexander Merkler: Manuscript revision, study concept and design
Hooman Kamel: Manuscript revision, study concept and design
Mitchell S.V. Elkind: Manuscript revision, study concept and design
Karen L. Furie: Manuscript revision, study concept and design

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[7]Department of Emergency Medicine, The Warren Alpert Medical School of Brown University, Providence, RI

[8]Departments of Neurology, New York Presbyterian Hospital Queens, New York, NY

[9]Departments of Neurology and Feil Family Brain and Mind Research Institute, Weill Cornell Medical College, New York, NY

[10]Department of Neurology, College of Physicians and Surgeons, Columbia University, New York, NY

[11]Department of Epidemiology, Mailman School of Public Health, Columbia University, New York, NY

Abstract

Background and Purpose—Transthoracic echocardiography (TTE) is widely used in the ischemic stroke setting. In this study, we aim to investigate the yield of TTE in patients with ischemic stroke and known subtype and whether the admission troponin level improves the yield of TTE.

Methods—Data was abstracted from a single center prospective ischemic stroke database over 18 months and included all patients with ischemic stroke whose etiologic subtype could be obtained without the need of TTE. Unadjusted and adjusted regression models were built to determine whether positive cardiac troponin levels (≥ 0.1 ng/mL) improve the yield of TTE, adjusting for demographic and clinical.

Results—We identified 578 patients who met the inclusion criteria. TTE changed clinical management in 64 patients (11.1%) but intracardiac thrombus was detected in only 4 patients (0.7%). In multivariable models, there was an association between TTE changing management and positive serum troponin level (adjusted OR 4.26; 95% CI 2.17–8.34; $p<0.001$).

Conclusion—In ischemic stroke patients, TTE might lead to a change in clinical management in nearly one out of ten patients with known stroke subtype prior to TTE but changed acute treatment decisions in less than one percent of patients. Serum troponin levels improved the yield of TTE in these patients.

Keywords

transthoracic echocardiography; yield; ischemic stroke; stroke subtype; cardioembolic stroke

Introduction

While stroke risk factor modification remains crucial for secondary stroke prevention, determining stroke mechanism is also an important step in improving stroke prevention strategies.[1, 2] After an ischemic stroke, patients undergo a diagnostic evaluation which typically includes brain imaging, intracranial and extracranial vascular imaging, electrocardiogram (ECG), inpatient cardiac telemetry, echocardiography, and prolonged outpatient cardiac monitoring if the stroke mechanism is not determined after the initial inpatient diagnostic evaluation.

While brain and vascular imaging are often obtained in the emergency department or early after admission for ischemic stroke, obtaining echocardiography in hospitalized patients may lead to prolongation of the inpatient hospital stay. European Stroke Organization and American Heart Association guidelines recommend obtaining an echocardiogram in select patients with ischemic stroke[3, 4] Nevertheless, inpatient echocardiography is performed on a large proportion of patients with ischemic stroke.[5]

In this study, we hypothesize that inpatient echocardiography will not lead to a change in the immediate clinical management in hospitalized patients with acute stroke in which the stroke etiologic subtype classification could be determined on the basis of brain, vascular imaging, and cardiac rhythm testing. In addition, we hypothesize that echocardiography is more likely to lead to a change in clinical management in patients with a positive admission troponin level.

Methods

Patient population

Data were retrieved from an inpatient quality improvement prospective registry REDCap (Vanderbilt University, Nashville, TN) database (not publicly available). We included consecutive patients admitted to our facility with a diagnosis of ischemic stroke over an 18-month period. Patients underwent a standard diagnostic evaluation that included laboratory testing, brain imaging, intracranial and extracranial vascular imaging, 12-lead electrocardiogram, cardiac telemetry throughout their hospital stay, and transthoracic echocardiography. The stroke subtype was determined prospectively by the treating vascular neurology attending based on the Embolic Stroke of Unknown Source (ESUS) consensus criteria.[6]

Since we aimed to investigate the yield of transthoracic echocardiography (TTE) in patients who received a TTE but whose stroke subtype was determined without the need of echocardiography, we only included patients with cardioembolic stroke in the setting of atrial fibrillation or atrial flutter, small vessel disease, large artery disease, or other determined mechanism. We excluded patients with cardioembolic stroke due to mechanisms detected on the inpatient TTE (low ejection fraction, severe valvular heart disease, cardiac thrombus, etc.), patients with ESUS where echocardiography was needed to exclude a cardioembolic source (patent foramen ovale, cardiac thrombus, etc.), and patients with a known mechanical or bioprosthetic valve where echocardiography may be needed to assess the function/integrity of the valve. The study was approved by the institutional review board and since this is a retrospective study, the need for informed consent was waived.

Primary predictor

The primary predictor was admission cardiac troponin level defined as negative (<0.1 ng/mL) and positive (≥0.1 ng/mL)

Outcome

TTE was performed using commercially available ultrasound machines (HD15, ie33, ie33 Matrix; Phillips. Vivid E9; GE Healthcare) and software (Centricity Cardio Workflow; GE Healthcare) with 2-dimensional and Doppler data recorded with a 1–5 MHz transducer. Images were acquired using the standard views: parasternal long and short axes, the apical 2-, 3-, and 4-chamber views, and subcostal views.

TTE was considered to have changed clinical management by: (i) detecting regional wall motion abnormalities in patients without a history of coronary heart disease or myocardial infarction or ECG evidence of previous MI, (ii) detecting low ejection fraction (EF ≤40%) in patients without a known history of congestive heart failure, (iii) detecting severe valvular heart disease in patients without history of valvular heart disease, or (iv) detecting a cardiac thrombus. Patients with regional wall abnormalities were referred to a cardiologist for an outpatient evaluation and potentially a cardiac stress test and those with a new diagnosis of congestive heart failure were referred to a cardiologist and started on an angiotensin-converting enzyme inhibitor or angiotensin II receptor blocker and a beta blocker. Patients with new severe valvular heart disease were referred to a cardiologist for surgical consideration. Patients in whom a cardiac thrombus was detected were started on anticoagulation therapy.

Statistical analysis

Patients were divided into two groups: those in whom TTE changed management and those in whom TTE did not change management. We compared clinical characteristics, laboratory values, ECG data, and functional outcomes between the two groups. Pre-specified multivariable logistic regression models (below) were used to estimate the association between positive troponin level and TTE findings that changed management. Analyses were performed using SPSS version 18.0 (Chicago, IL) and $p < 0.05$ was considered statistically significant.

Results

Baseline characteristics of the study sample

We identified 647 patients who met the inclusion criteria; 578 (89.3%) had a TTE. The baseline characteristics of patients with and without TTE were similar (Supplemental Table I). The mean age was 74.0 ± 13.7 years and 263 (45.5%) were women. The stroke subtypes were as follows: 315 (54.5%) cardioembolic, 150 (26.0%) large artery disease, 97 (16.8%) small vessel disease, and 16 (2.8%) other defined mechanism. Troponin level on admission was obtained in 545 patients (94.3%).

The yield of Transthoracic Echocardiography

TTE changed clinical management in 64 patients (11.1%):wall motion abnormalities in patients without known or ECG evidence of previous MI (37 patients, 6.4%), severe valvular heart disease in patients without known valvular heart disease (8 patients, 1.4%: five with severe aortic stenosis, one with severe aortic insufficiency, and two with severe mitral regurgitation), a low ejection fraction (EF ≤ 40%) in patients without known congestive

heart failure (23 patients, 4.0%), and intracardiac thrombus (4 patients, 0.7%). Of the 4 patients with intracardiac thrombus, two had a left atrial appendage thrombus in the setting of AF and two with large artery disease subtype had evidence of a left ventricular thrombus. Both patients with left ventricular thrombus had a positive serum troponin level.

Univariable and multivariable models for predictors of TTE changing management

Univariable analyses are shown in Supplemental Table II. A positive troponin was highly specific in predicting that TTE will change management but had low sensitivity (specificity = 0.906 and sensitivity = 0.339).

In a fully adjusted analysis, there was an association between a positive troponin and a change in management (OR 4.26; 95% CI 2.17–8.34; p<0.001) (Table). This association persisted in patients with non-cardioembolic stroke only (adjusted OR 9.21; 95% CI 1.46–57.98; p=0.018) (Table). In sensitivity analyses excluding patients with cardiac thrombus and adjusting for estimated glomerular filtration rate, the results remain unchanged.

Discussion

In this study, TTE in the setting of ischemic stroke identified covert cardiac disease and led to a change in clinical management, even in patients in whom the stroke subtype could be determined without the TTE. Patients whose TTE was more likely to lead to a change in clinical management were those with an elevated serum troponin level on admission, a biomarker of cardiac disease, with a high specificity but low sensitivity.

While a TTE may have potentially changed management in 11.1% of patients, in the study patient cohort it only changed acute treatment decisions in 0.7% of patients. Furthermore, the association between positive troponin and TTE changing management is not unexpected as troponin positivity may reflect underlying clinically covert cardiovascular disease.[5] Due to our small numbers and the retrospective nature of this study, larger studies or meta-analyses are needed to confirm our findings and to determine whether a negative serum troponin would help identify patients with non-cardioembolic stroke in whom the TTE was expected to be low yield for findings affecting acute management. In our study, a positive troponin level had very high specificity but low sensitivity. A high sensitivity troponin assay may improve the accuracy of predicting high yield echocardiograms in future studies.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table.

Multivariable models showing the association positive troponin with transthoracic echocardiogram findings that changed management

	Positive troponin (all patients) Odds Ratio, 195% Confidence Interval, p-value	Positive troponin (non-cardioembolic stroke patients) Odds Ratio, 95% Confidence Interval, p-value
Unadjusted	OR 4.92; 95% CI 2.67–9.04; p<0.001	OR 8.54; 95% CI 2.27–32.10; p=0.002
Model 1 *	OR 4.98; 95% CI 2.68–9.26; p<0.001	OR 10.95; 95% CI 2.68–44.64; p=0.001
Model 2 *	OR 4.26; 95% CI 2.17–8.34; p<0.001	OR 9.21; 95% CI 1.46–57.98; p=0.018

* Model 1: adjusted for age and sex

* Model 2: adjusted for age, sex, hypertension, hyperlipidemia, diabetes, smoking, prior stroke, coronary artery disease, congestive heart failure, admission NIHSS, atrial fibrillation, and positive troponin