Association of Transthoracic Echocardiography Findings and Long-Term Outcomes in Patients Undergoing Workup of Stroke

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Background: Transthoracic echocardiography (TTE) has become routine as part of initial stroke workup to assess for sources of emboli. Few studies have looked at other TTE findings such as ejection fraction, wall motion abnormalities, valve disease, pulmonary hypertension and left ventricular hypertrophy and their association with various subtypes of stroke, long-term outcomes of recurrent stroke, and all-cause mortality. *Methods and Results:* Computed tomography and magnetic resonance imaging brain imaging and TTE reports were reviewed for 2464 consecutive patients referred for TTE as part of a workup for acute stroke between 1/1/01 and 9/30/07. Study patients were 67 ± 15 years, 60% female, 75% minorities and had hypertension (76%), diabetes (41%), chronic kidney disease (27%) and atrial fibrillation (18%). On TTE, a mass, thrombus, or vegetation was identified in only 4 cases (0.2%), whereas a clinically significant abnormality (ejection fraction < 50%, left ventricle or right ventricle wall motion abnormalities, severe valve disease, pulmonary hypertension, or left ventricular hypertrophy) was identified in 16%. Those with an abnormal TTE had increased risk for death at 10 years (hazard ratio [HR] 1.8; 95% confidence interval [CI]: 1.6, 2.0; $P < .01$), although risk for readmission with stroke was not increased. Abnormal TTE remained associated with increased risk of death at 10 years after adjustment for age, sex, race, and cardiovascular risk factors (HR 1.4; 95% CI: 1.2, 1.7; $P < .01$). *Conclusions:* TTE performed as part of an initial workup for stroke had minimal yield for identifying sources of embolism. Clinically important abnormalities found on TTE were independently associated with increased long-term mortality, but not recurrent stroke.

Key Words: Stroke—transthoracic echocardiography—long-term outcomes—mortality

Introduction

Approximately 795,000 people experience a new or recurrent stroke each year. Stroke is the fifth leading cause of death and the most common etiology of long-term disability in the United States.[1] It is estimated that between 15% and 30% of ischemic strokes are due to a cardioembolic source.[2,3] Thus, transthoracic echocardiography (TTE) has become a routine investigation to assess for

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Received March 28, 2018; revision received May 31, 2018; accepted June 17, 2018.

Grant Support: None

Financial Disclosure: The authors declare that they have no relevant financial interests.

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1052-3057/$ - see front matter

https://doi.org/10.1016/j.jstrokecerebrovasdis.2018.06.023

cardiac lesions such as thrombi, masses, vegetations, or shunts, which may be potential sources of embolism.[3]

The use of TTE in the management of stroke is not without controversy.[2,4-6] This may be due to inconsistencies in studies regarding the use of TTE in stroke management. Many studies have illustrated a low diagnostic yield for sources of emboli on TTE, ranging from 3%-10%.[7,8] When considering other forms of heart disease, the yield for TTE can increase up to 37%.[2] In addition, the cost-effectiveness of TTE as part of an initial stroke workup has been questioned.[6] In clinical practice, however, the use of TTE in management of acute stroke is prevalent.[5]

While TTE is utilized to evaluate for possible cardiac sources of embolism in the acute setting, its use in the prediction of future neurological events in this population has not been well studied. TTE provides a wealth of information about cardiac disease that often is not part of acute stroke management. While certain cardiac abnormalities found on TTE such as atrial fibrillation and reduced ejection fraction (EF) are known to increase risk for stroke, other findings and their association with long-term outcomes of recurrent stroke and mortality have been incompletely studied. Patients with a first-time stroke are most likely to die from stroke within the first year, but in subsequent years the most common cause of death is cardiac disease.[9] Identifying sources of cardiac disease in this population may be crucial for risk factor management and reducing long-term morbidity and mortality. Therefore, we sought to determine whether certain TTE findings in this high-risk population were associated with long-term outcomes of recurrent stroke and all-cause mortality.

Materials and Methods

We retrospectively reviewed 4032 consecutive TTEs referred for evaluation of acute stroke performed from January 2001 through September 2007 at Montefiore Medical Center, an urban academic medical center located in Bronx, NY. All patients included initially presented to the Montefiore emergency department with neurological deficits necessitating further workup for a possible acute stroke. The decision to pursue TTE was at the discretion of the patient's primary team based on the suspicion for a possible cardioembolic source of the patient's neurological deficit and diagnosis related to cerebral ischemia (stroke or transient ischemic attack) as part of evaluation of stroke mechanism, rather than for prognostication purposes. Radiographic evidence of cerebral infarction on computed tomography (CT) or magnetic resonance imaging (MRI) brain imaging was not required for TTE imaging. After excluding patients aged < 18 and those with either no available brain imaging or brain imaging that occurred greater than 60 days from the time of TTE, we identified a total of 2464 patients.

In addition to investigating possible direct sources of embolism, we examined echocardiographic findings without known risk of embolism that may still have clinical significance and implications on patient management. Specifically, each TTE report was reviewed for EF, left ventricular (LV) and right ventricular (RV) wall motion abnormalities (WMA), severe valvular disease, severe pulmonary hypertension, severe left ventricular hypertrophy (LVH), atrial septal aneurysms, intracardiac masses, thrombi, valvular vegetations, and interatrial or interventricular shunting. All TTEs were read by eight National Board of Echocardiography certified echocardiographers, 95% of which were read by those with advanced level III training. Criteria for specific measurements including EF, severity of valve disease, pulmonary hypertension, and LVH were up to the discretion of the echocardiographer. Visual assessment for these measurements was often utilized as was the common practice at the time when the TTEs were performed.

Brain imaging was reviewed for each of the 2464 patients who underwent TTE for presumed stroke. If MRI imaging of the brain was not available, head CT imaging with the same time-frame parameters was reviewed. Each brain imaging report was assessed for whether an acute and/or chronic infarct was present. An identified infarct was then classified by subtype based on radiographic evidence as per the TOAST criteria.[10,11] An infarct was deemed to be consistent with large artery atherosclerosis or cardiac embolism (LAA/CE) if there was evidence of multiple concurrent regions of infarction consistent with emboli, a cortical, cerebellar, or brain stem infarct, or a subcortical infarct > 1.5 cm. If the radiologist determined there to be a lacunar infarct or if there was radiographic evidence of a subcortical or brain-stem infarct < 1.5 cm, the stroke subtype was characterized as a lacunar stroke. Hemorrhagic stroke and infarcts with other etiologies (i.e. global cerebral hypoperfusion or watershed infarcts) were also classified based on brain imaging reports.

Additional clinical data were acquired using the hospital's proprietary electronic patient information database, (clinical looking glass, Emerging Health Information Technology: Yonkers, NY). This database integrates clinical data from all inpatient visits at three facilities and outpatient encounters at 20 ambulatory sites, home care, and community service programs within the Montefiore system. Information extracted included comorbidities, sex, race, and ethnicity.

Primary outcome was defined as death of any cause or readmission for stroke or transient ischemic attack. Patient mortality and readmission data were also obtained from clinical looking glass, which captures all dates of death from the National Death Index and from the hospital's inpatient record. Vital status was determined as of November 2011 for survival analysis. This study was approved by the Montefiore Medical Center Institutional Review Board. All authors had access to the