

# Transthoracic Echocardiography Is Still Useful in the Initial Evaluation of Patients With Suspected Infective Endocarditis: Evaluation of a Large Cohort at a Tertiary Referral Center

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## Abstract

**Objectives:** To examine the sensitivity of contemporary transthoracic echocardiography (TTE) for the detection of vegetation, abscess cavity, or prosthetic valve dehiscence (Vg) in patients with suspected infective endocarditis (IE) and to identify whether a relatively normal initial TTE finding can be effectively used as a rule out test, obviating the need for transesophageal echocardiography (TEE).

**Patients and Methods:** We evaluated clinical, microbiological, and echocardiographic data for all patients with suspected IE referred for both TTE and TEE between January 1, 2005, and December 31, 2010. Patients were stratified into 3 groups by baseline TTE findings: negative TTE (native valves with less than or equal to mild regurgitation and no Vg), equivocal TTE (no Vg but prosthetic valve or greater than mild native valvular regurgitation), and positive TTE (Vg detected).

**Results:** We studied 622 consecutive patients (68% male; mean  $\pm$  SD age, 62 $\pm$ 17 years), including 256 with *Staphylococcus aureus* bacteremia (SAB). The presence of Vg was confirmed by TEE in 141 patients (23%). The TTE had low sensitivity for the detection of Vg (58%). A total of 271 patients (44%) had an initial negative TTE. Of these, TEE demonstrated Vg in only 8 patients (negative predictive value [NPV] of negative TTE, 97%). The negative TTE group included 132 patients with SAB, only 6 of whom had Vg (NPV, 95%). Of 265 patients with equivocal TTE, Vg was demonstrated in 51 (19%).

**Conclusion:** In a hospital population with clinically suspected IE, TTE had low sensitivity for the detection of Vg; however, a negative initial TTE was a common finding, with a high NPV, even in the setting of SAB. A TEE may be avoided in many patients with suspected IE.

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Infective endocarditis (IE) remains a lethal condition, with mortality of 15% to 20%.<sup>1,2</sup> Contemporary diagnosis is based on the modified Duke criteria,<sup>3,4</sup> requiring a combination of clinical, microbiological, and imaging information, with the demonstration of vegetation, abscess cavity, or prosthetic valve dehiscence (Vg) as a critical feature.

Echocardiography has been the cornerstone of imaging for Vg in patients with suspected IE since the 1980s. Most investigators have reported poor sensitivity of transthoracic echocardiography (TTE) in detecting Vg compared with transesophageal echocardiography (TEE),<sup>5-9</sup> although 2 recent studies have suggested significantly

improved sensitivity by using contemporary TTE acquisition and reporting technology.<sup>10,11</sup>

The current international guidelines reflect the suboptimal sensitivity and cost efficiency of TTE for the detection of Vg, recommending TEE in most patients with suspected IE<sup>12</sup> and as the initial imaging investigation in patients with *Staphylococcus aureus* bacteremia (SAB).<sup>13</sup>

A study of 134 patients from the mid-1990s suggested that those with no valvular abnormality on initial TTE were unlikely to have Vg, concluding that TEE could be avoided in "a substantial percentage" of patients.<sup>14</sup> The approach of using initial TTE as a rule out test has not been further studied.



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In this study, we aimed to evaluate the sensitivity of contemporary TTE for the detection of Vg in a large cohort of patients with suspected endocarditis and to define the negative predictive value (NPV) of a relatively normal TTE study in the overall population, including the subset with SAB.

## PATIENTS AND METHODS

### Study Population

Between January 1, 2005, and December 31, 2010, at Monash Health (a 2100-bed, university-affiliated tertiary hospital network in Victoria, Australia), 622 consecutive patients with suspected IE were referred for both TTE and TEE during the same hospital admission to evaluate for the presence or absence of Vg. We retrospectively evaluated all patients, irrespective of TTE image quality or the presence or absence of prosthetic intracardiac material.

### Clinical, Inflammatory, and Microbiological Information

The clinical characteristics (age and sex) of patients were recorded. Blood culture results from Monash Health were evaluated in all the patients, with the organism responsible for bacteremia and the number of positive culture results recorded. Each patient's maximum inpatient C-reactive protein (CRP) level was recorded.

### Transthoracic Echocardiography

All the TTE images were acquired using either Sonos 5500 or iE33 machines (Philips Ultrasound) or Vivid 7 transducers (GE Vingmed Ultrasound) with a 2.5-MHz phased array probe. All imaging was performed using harmonic imaging, and the images were stored digitally for review offline (Xcelera; Philips Ultrasound). Echocardiograms were reported by 1 of 5 experienced noninvasive imaging cardiologists, all of whom have completed dedicated echocardiography fellowships.

Echocardiographic evidence of Vg was defined as per the European Society of Cardiology guidelines as (1) vegetation/echodense mass attached to the valvular or mural endocardium or to implanted prosthetic material, which did not have the characteristics of valvular degeneration, Lambl excrescence, or fibroelastoma; (2) demonstration of abscesses or fistulas; or (3) a new dehiscence of a valve prosthesis.<sup>12</sup>

Doppler evaluation of cardiac valves and grading of valvular regurgitation was performed as per the American Society of Echocardiography criteria.<sup>15</sup>

### Transesophageal Echocardiography

Multiplane TEE was performed using Sonos 5500 or iE33 machines (Philips Ultrasound) with a 3.5-MHz probe using fundamental 2-dimensional imaging. Presence or absence of Vg and grading of regurgitation were defined as described for TTE.

### TTE-Based Patient Classification

Patients were categorized into 3 different groups based on their initial TTE examination findings: negative TTE, equivocal TTE, and positive TTE. The negative TTE group included patients with native valves with less than or equal to mild valvular thickening, less than or equal to mild valvular or annular calcification, and less than or equal to mild valvular regurgitation. The equivocal TTE group included patients with no visible Vg but abnormal TTE findings with either prosthetic intracardiac material (valves, devices) or those with native valves with more than mild thickening, calcification, or valvular regurgitation. Patients with extremely poor or nondiagnostic views were also included in this group. The positive TTE group included those with visible Vg on TTE.

### Statistics

The echocardiographically defined subgroups were compared by 1-way analysis of variance and multinomial logistic regression. Statistical calculations were performed using SPSS software version 19 (SPSS Inc), and significance was accepted at  $P \leq .05$ . The NPV, positive predictive value (PPV), and sensitivity were calculated using usual methods. All the results are presented as mean  $\pm$  SD.

## RESULTS

There were 622 patients (mean  $\pm$  SD age, 62 $\pm$ 17 years; 32% female) with suspected endocarditis who underwent TTE and TEE in the same hospital admission during the study.

### Rate and Location of Vg

The Vg was confirmed by TEE in 141 patients (23%), including 91 (65%) with native valve endocarditis and 50 (35%) with prosthetic

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