

Point-of-Care Screening Echocardiograms and their Potential Utility in the Acute Inpatient Medical Setting

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Abstract

Demands on echocardiography services are increasing annually. This Quality Improvement Project aimed to see whether a point of care screening echocardiography (SE) service in the acute inpatient medical setting might help reduce demand on full trans-thoracic echocardiography services (FE). The indication and results of all FE requests on the admission ward were analysed over a three-month period. Following this, it was considered whether a theoretical SE occurring prior, would have changed the on-going utilisation of FE resources. Of the 67 requests analysed, 57 underwent FE. 25% revealed no abnormality. In 47%, a SE prior may have changed the future use of FE resources. This small retrospective review highlights the potential benefits of a SE service and further work is required.

Keywords

Point-of-Care Ultrasound, Echocardiography, Screening Echocardiography, Acute Medicine.

Key Points

- Referrals for trans-thoracic echocardiograms are increasing annually.
- There is no literature on the utility of a screening echocardiography (SE) service in the acute medical setting, and how this might change the utilisation of full trans-thoracic echocardiography (FE) services following a SE.
- This project found that a SE potentially could change future FE use. This included no requirement for a FE following an SE, a need for a more urgent FE or a change in setting of the FE (outpatient rather than inpatient).
- Further work is needed to evaluate the potential future role of SE in the acute medical setting.

Introduction

Referrals for echocardiograms in the United Kingdom are increasing annually leading to lengthening waits for procedures¹. Additionally, a report by the British Society of Echocardiography (BSE) highlighted significant expected shortages of trained cardiac physiologists in 2018–2019. This, combined with the necessity to provide seven-day echocardiography services and 24 hour emergency echocardiography services, will have significant cost implications². There is no literature on the utility of a screening echocardiography (SE) service in the acute inpatient medical setting.

SE is a non-invasive test that can be rapidly performed by accredited individuals to assess the structure and function of the heart by the bedside. SE is a focussed assessment related to an individual's clinical history or examination and aims to answer a specific question. It should also determine whether a full transthoracic echocardiogram (FE) is required. It is not designed to replace full transthoracic echocardiograms. A SE collects basic echocardiography information. The British Society of Echocardiography (BSE) Level 1 certification

involves assessment of left ventricular size and function, right ventricular size and function, aortic and mitral valve structure and function, aortic root size, inferior vena cava size and collapsibility, and the presence of pericardial or pleural fluid.³

Given increasing demand and no previous work regarding this topic, a quality improvement project was conducted to assess what benefits the instigation of a SE service may bring. A small, retrospective review of all the formal echocardiograms requested whilst patients were admitted on the acute medical ward was conducted to see what potential benefits a SE performed in the acute inpatient medical setting may bring. In particular this looked at whether a FE would have been required at all, whether the setting (inpatient [IP] or outpatient [OP]) for the requested formal study could be changed, or if the results of a SE could result in more targeted clinical management.

Method

All patients that had a FE requested during their inpatient admission on the Acute Admissions Ward at St Thomas' hospital over a three-month period were identified and retrospectively reviewed.

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The process of how these scans were reviewed is shown in Figure 1. Firstly, the echocardiography report was reviewed to see whether the scan was completed. Two individuals with screening echocardiography experience reviewed the findings of the completed FE. The two reviewers knowing the results of the FE, then decided if a theoretical SE (carried out by a certified individual) prior to the FE could have changed on-going use of echocardiography resources (namely whether a FE was needed at all, or whether it could be done as an OP) or whether medical management might be changed as a result of SE.

No ethical approval was required; however, it was registered with the Quality Improvement Team.

Results

Data was collected retrospectively from the 1st January 2017 until the 31st March 2017.

67 FE requests were made whilst an inpatient on the admissions ward. 85% (n=57) had their scan completed as either an inpatient or an outpatient. There was no documentation to identify why the remaining 10 scans were not completed; this could be due to never receiving an appointment or failure to attend a given appointment.

The results are summarised in Figure 1.

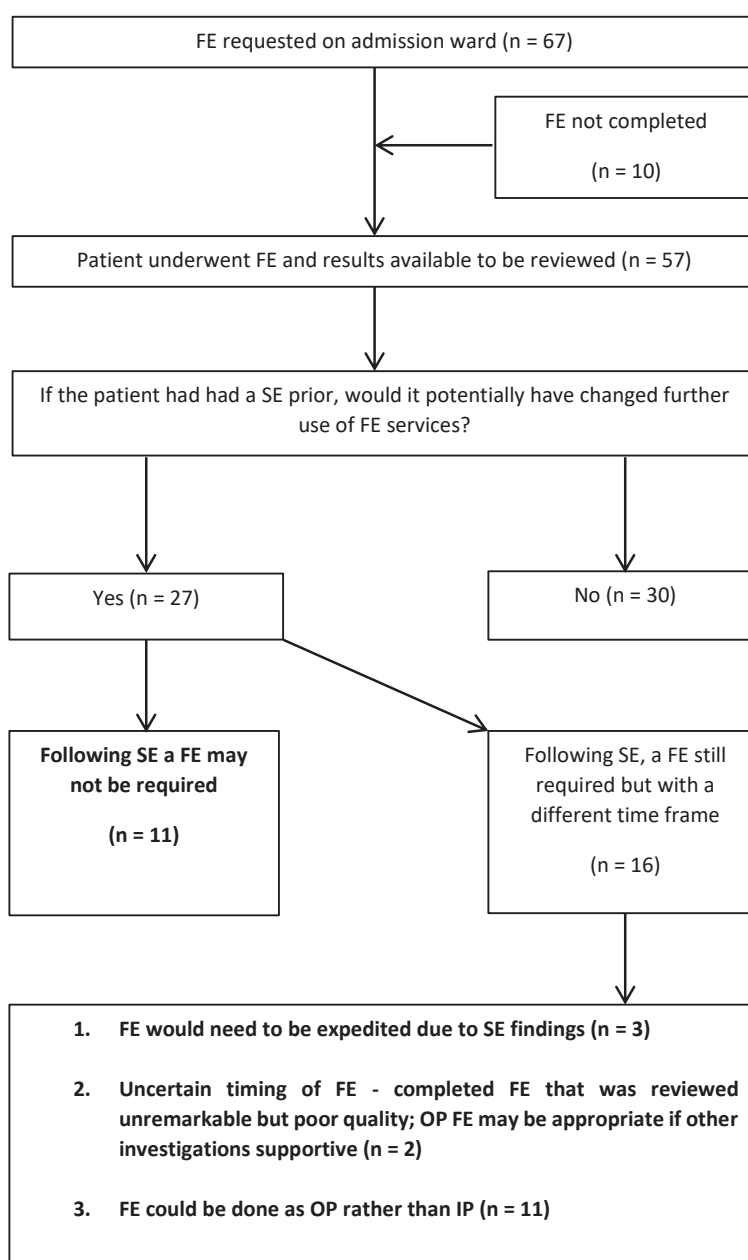


Figure 1. Showing how Screening Echocardiography (SE) could reduce demand on Formal Echocardiography (FE) services

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How might a SE change timeframe and need for FE?

Of those 57 scans completed:

- 25% (n=14) were normal
- In 47% (n=27) a SE could have potentially changed need or timeframe for a FE (see table 1)
 - In 28% (n=16) could have needed a FE with a different time frame:
 - 5% (n = 3) would have resulted in earlier scans being requested (see table 2).
 - 19% (n = 11) could have had an outpatient (OP) rather than inpatient (IP) echocardiogram.
 - In 19% (n=11) a SE would be sufficient, and a FE may not have been needed at all.
- 4% (n = 2) the optimal timing of FE is uncertain as the formal scan result was unremarkable, however the FE done was noted to be poor quality therefore it is unlikely that a SE would have got better image quality. Due to this resultant uncertainty, a FE should be requested. However, whether this was as an IP or OP would likely depend on the clinical course and results of other investigations. Given the indications, it is likely an OP scan would suffice in these cases.

Table 1. Showing how SE could change need and timeframe for a formal echocardiogram.

Indication Given on FE Request	Echocardiogram Findings	How does a SE change further investigation?
Shortness of breath, COPD exacerbation, BNP 4400	Normal LV size. EF 50%. N RV size and systolic function. Mild MR and PR.	Inpatient (IP) to Outpatient (OP) request
BNP 1042	Normal study	IP to OP request
Fall with uncertain loss of consciousness. Increasing ankle swelling and paroxysmal nocturnal dyspnoea	Normal LV size and function. RV dilated at base but preserved function. Mild to moderate AS (AVA 1.5cm ² , PG33mmHg)	IP to OP request
BNP 2500	Normal LV size and function. Mild LVH. Normal RV size and function. Mild to moderate AR. RVSP 47mmHg + RAP	IP to OP request
BNP 1084	Normal study except borderline LVH	IP to OP request
Sickle Cell and known pulmonary hypertension. Increasing shortness of breath and oedema on chest X-Ray	N LV size and function. Mildly dilated RV but normal function. PASP 45 + RAP	IP to OP request
New diagnosis of systemic lupus erythematosus with cardiomegaly and shortness of breath.	Normal study	IP to OP request
2 weeks chest pain. Prior pericarditis and prior PE.	LV function normal (EF 60%), wall thickness at upper limit of normal. Mild to moderate TR with mildly elevated PASP.	IP to OP request (if still needed after other investigations)
Raised JVP and pulmonary oedema.	Normal LV size and function. Normal RV size and function. Mild MR. Moderate TR with PASP 47 + 5mmHg.	IP to OP request
New atrial fibrillation, right bundle branch block, fluid overload	Normal study	IP to OP request

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Indication Given on FE Request	Echocardiogram Findings	How does a SE change further investigation?
Ejection systolic murmur, postural drop.	Normal LV size and function, normal RV size and function. Mild AS PG 23mmHg, Trivial MR	IP to OP request
Chest pain, troponin 15, leg swelling. Previous PE	Poor quality, normal valves. No evidence RV strain	Poor quality study so SE may not be sufficient and likely FE request – the timeframe of which likely to be dictated by other investigations (for example CTPA / D-dimer)
Chest Pain and T-wave inversion.	Poor quality but normal study	Poor quality study so SE may not be sufficient and likely FE request – the timeframe of which likely to be dictated by other investigations (for example troponin and prior ECG results)
Known ischemic heart disease with angina with normal troponin, ejection systolic murmur with echo 1 year prior	Normal LV and RV. Aortic PG 14mmHg, AVA 2.0cm ² . Aortic sclerosis.	SE sufficient and no formal study required
Segmental PE	Normal study	SE sufficient and no formal study required
Recurrent syncopal episodes	Normal study	SE sufficient and no formal study required
Chest Pain, increased JVP and peripheral oedema	Normal study	SE sufficient and no formal study required
BNP 435	Normal study except mild LVH	SE sufficient and no formal study required
Saddle embolus	Normal study	SE sufficient and no formal study required
Shortness of breath, known EF of 30%.	Non-dilated LV with EF 60%, Normal RV function. PASP 29 + RAP	SE sufficient and no formal study required (outside already arranged follow up)
Sarcoid, low voltage complexes on ECG Any evidence of pericardial effusion?	Small effusion otherwise normal study	SE sufficient and no formal study required
Palpitations and chest pain	Normal Study	SE sufficient and no formal study required
Chest pain, short of breath on exertion, LVH	Normal Study	SE sufficient and no formal study required
Syncope	Normal Study	SE sufficient and no formal study required

Key: BNP – Brain Natriuretic Peptide. LV – Left Ventricle. RV – Right Ventricle. LVH – Left Ventricular Hypertrophy. AS – Aortic Stenosis, MR – Mitral Regurgitation, TR – Tricuspid Regurgitation, PR – Pulmonary Regurgitation, EF – Ejection Fraction, PASP – Pulmonary Artery Systolic Pressure, RAP – Right Atrial Pressure, PG – Pressure Gradient, AVA – Aortic Valve Area, ECG – electrocardiogram, PE – Pulmonary Embolism, JVP – Jugular Venous Pressure, COPD – Chronic Obstructive Pulmonary Disease CTPA – Computerised Tomography Pulmonary Angiogram

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Table 2. Showing patients who may have benefited from an earlier echocardiogram

Indication	Echocardiogram Findings	Time to formal echocardiogram	Clinical implications
Chest Pain, ejection systolic murmur	Severe aortic stenosis, maximum PG 56mmHg, AVA 1.0cm ² , mild LVH and mildly reduced LV EF.	5 weeks	Could have expedited TAVI / surgical repair given LV dysfunction
Chest Pain	Normal LV systolic function with normal EF. RWMA noted. Dilated RV with normal systolic function. PASP 31–36mmHg.	7 weeks	If RWMA noted on screening scan, then more urgent formal echo or discussion with cardiology leading to potential earlier imaging of coronary arteries
Shortness of breath on exertion and cardiomegaly	Severely dilated LV and EF 26%	6 weeks	Earlier referral to heart failure clinic

Key: LV – Left Ventricle, RV – Right Ventricle, LVH – Left Ventricular Hypertrophy, EF – Ejection Fraction, RWMA – Regional Wall Motion Abnormality, PG – Pressure Gradient, AVA – Aortic Valve Area, TAVI – Transcatheter Aortic Valve Implantation, PASP – Pulmonary Artery Systolic Pressure

How might medical management change following SE?

- 5 patients presenting with a raised BNP had normal ventricular systolic function (see Table 3). Following a SE, medical staff could make sure that the patient is on optimal treatment for potential diastolic dysfunction or heart failure with a preserved ejection fraction (HFpEF) and then had a FE as an outpatient.
- 1 patient presented as a known heart failure and increasing shortness of breath. The echocardiogram showed severe RV dilation but preserved LV size and systolic function. A FE would still have been needed, but the SE could have resulted in the instigation of investigations and management of isolated right heart failure.

Discussion

Echocardiography is a complex skill, but multiple training programmes have been proposed to

facilitate the training and use of echocardiography by non-cardiologists. Studies have shown basic measurements obtained by a variety of non-expert medical practitioners are statistically similar to those obtained by formal echocardiography in a variety of measurements. These include left ventricular function,^{4–10} pericardial effusion,¹¹ evidence of hypertrophic obstructive cardiomyopathy, left ventricular cavity measurements^{12,13} and evidence of rheumatic heart disease.¹⁴

From this small review it would seem that provision of a SE service by appropriately trained professionals may have multiple benefits.

This project shows that potentially up to 47% of all scans requested on the acute medical ward could safely be performed as an OP (rather than IP) or have no need for a FE, if a SE had been carried out prior. This could have significant cost implications. The 2018/2019 NHS Tariff has different prices for an outpatient echocardiogram compared to one completed on the non-elective tariff¹⁵. Thus, if a SE results in a FE being performed as an

Table 3. Showing BNP and echocardiogram findings.

BNP	Echocardiogram findings
4400	Normal LV function, EF 50%. Normal RV size and function
1042	Normal LV and RV function
1000	Normal LV size and function, RV dilated but preserved function
2500	Normal LV size and function. Normal RV. Mild – Mod AR
1084	Normal LV and RV

Key: BNP – Brain Natriuretic Peptide, LV – Left Ventricle, EF – Ejection Fraction, RV – Right Ventricle, AR – Aortic Regurgitation

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outpatient or not at all, then this has the potential to save money. This could be progressively more important especially, with the increasing demand for echocardiograms¹. There has been a 43% increase in echocardiograms over the last six years, with the potential for further growth as the United Kingdom's usage of echocardiography is still 20% lower than other countries.²

Furthermore, patient experience may be improved if a further attendance to hospital is prevented by the use of a SE. For example, where a clinical question is proposed that could be answered by a SE, if a normal SE is completed on the admission ward this may result in no need for further investigation. Without the SE, then an OP FE may have been requested, requiring repeat hospital attendance. In our review, 25% of FE reports were normal. This is not a new finding; high rates of normal scans have previously been documented. One large UK review looking at over 4,500 echocardiograms found 44.8% of the echocardiograms that were asked to assess left ventricular function were normal¹⁶.

Aside from the cost and patient experience, it could be argued that with increasing use and availability of SE, patient care and safety is improved. Of 103 consecutive patients admitted to a general medical unit, 70% did not have a clinical indication for a FE, however within this cohort of patients they found that 17% had an important cardiac abnormality, including 10% with unsuspected left ventricular systolic dysfunction.¹⁷ There are other published studies and case reports where echocardiograms have revealed serious, unexpected findings.^{18,19} This is not a critique of FE requests made on the Acute Medical ward, nor is it an argument for routinely scanning patients without indication, as the principle of an SE is to answer a specific clinical question. However, the discovery of unexpected, and clinically relevant findings when conducting a SE could then lead to more directed patient care. A comparison could be "incidentalomas" that are found on computerised tomography scans. The rationale for improved patient safety is if a SE is easily available in the acute medical unit, then one could assume more patients will receive a SE and thus any unexpected findings, which can often be missed by physical exam,²⁰ can be identified and managed earlier. Of the 57 echocardiograms reviewed, 3 patients had important clinical findings that if seen on a SE, would have facilitated an earlier FE and subsequent treatment or further investigations as needed.

A further benefit of SE is that it could better guide appropriate investigation and management of certain patient cohorts. For example, in the patient where isolated right heart failure was identified, where biventricular dysfunction was expected, then further investigation of isolated right heart failure can be

instigated. The use of the FICE protocol in ICU has been shown to provide new diagnostic information that changed clinical management.²¹

A valid criticism of routine SE in acute medicine is that of cost and quality control. It is rightly argued that inexperienced operators may miss important diagnoses resulting in suboptimal patient care.²² However, the final part of a SE is to decide if a formal study is required; thus, if views are poor or the operator unsure, then patient safety should not be compromised, as a FE will be requested.

Naturally it would be expected that all SE operators maintain certain standards. As with any technical skill, it has been shown that only short breaks in scanning experience leads to decay in echocardiographic assessment and knowledge.²³ The BSE have different requirements for re-accreditation depending on the numbers of scans completed per annum.²⁴ These guidelines for re-accreditation should mean quality control is becoming easier to monitor.

There would be costs in providing a SE service, namely training and equipment. The British Cardiovascular Society (BCS) suggests that the BCS and Royal College of Physicians, working with the BSE and College for Acute Medicine [sic] should "agree (or develop) standards for point of care cardiac ultrasound".²⁵ Other countries have embraced ultrasound specifically in internal medicine. Canada has a point of care ultrasound curriculum for internal medicine trainees²⁶ and there are calls for standards for point of care ultrasound to be set in Europe.²⁷ It has been proposed that the FAMUS (Focused Acute Medicine Ultrasound) should be considered for integration into the acute internal medicine curriculum.²⁸ An agreement regarding what level of scan would be best suited to the acute medical ward will need to be made by all parties involved. This would ideally be within the umbrella of a supportive and collaborative cardiology department. BSE Level 1 includes basic valvular assessment. This would require more training and expense but would potentially yield more relevant information for the larger proportion of clinically stable patients on the acute medical ward. For example, the identification of mitral regurgitation as a cause of an acute dyspnoea presentation. There would be numerous logistical considerations as to how best incorporate SE training into acute medical training, especially if it was a mandated skill. Issues include access to training time, supervisors, equipment and the implementation of an appropriate clinical governance structure. These are by no means small challenges to overcome.

If availability and opportunity increases, then certified physicians would be able to scan regularly increasing their experience and reliability.

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Emergency physicians with more than 250 point of care echocardiograms were more able to pick up complex abnormalities.⁸ This would increase the clinical utility of the SE.

One major weakness of this study is the subjectivity that is unavoidably encountered. The two reviewers were looking at results of a formal scan and then theoretically and retrospectively deciding whether a SE would have changed subsequent use of echocardiography services or medical management. This could be improved with more reviewers making a collective decision. In addition, trained cardiac physiologists carried out the echocardiograms that have been reviewed. As a result, some findings may not have been seen on a SE or some scans may have been technically challenging and even though the FE result was unremarkable, a less experienced scanner doing a screening scan may have requested a FE due to uncertainty. These issues may reduce the benefits discussed above. Furthermore, this is only a small retrospective study with no statistical analysis. We advocate the need for further prospective work with significantly larger numbers to look at the use of SE and to see if the benefits alluded to above can be extrapolated and statistically show the aforementioned potential benefits of SE in the acute medical setting. One area not considered is whether a SE could result in earlier discharge and subsequent

cost savings. Further work looking at how many discharges are dependent on the results of a FE and whether the results of a SE provided in a timely manner would facilitate an earlier discharge. Finally, a formal cost analysis would need to be carried out looking at the cost of providing and maintaining a SE service versus those potential cost savings already discussed.

Conclusion

From this small review it seems that if good quality, screening echocardiograms are available, and are requested appropriately within a suitable clinical governance structure, then this can have multiple benefits to both diagnosis and management of individual patients and the larger healthcare organisation with regards to cost savings, and utilisation of formal cardiac echocardiography resources. Larger studies will need to be carried out to confirm this.

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Conflicts of Interest

Both authors declare they have no conflict of interests.

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