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Faraz Pathan, MBBS, Ricardo Fonseca, MBBS, Thomas H. Marwick, MBBS, PhD, MPH

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Usefulness of Hand Held Ultrasonography as a Gatekeeper to Standard Echocardiography for "Rarely Appropriate" Echocardiography Requests

Faraz Pathan MBBS[a]*; Ricardo Fonseca MBBS[a]*; Thomas H. Marwick MBBS, PhD, MPH[a,b].

Menzies Institute for Medical Research[a], Hobart and Baker-IDI Heart and Diabetes Institute[b], Melbourne, Australia

***The authors wish it to be known that, the first two authors should be regarded as joint First Authors.**

Corresponding Author

Dr Thomas H. Marwick

Tel/ +61 38532 1550, Fax/ +61 38532 1160

E-mail: tom.marwick@bakeridi.edu.au

Baker-IDI Heart and Diabetes Institute,

75 Commercial Road, Melbourne, Vic 3004, Australia

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Abstract

Adoption of Appropriate Use Criteria (AUC) has not had a major impact on the frequency of "rarely appropriate" tests, with the rarely appropriate tests rate remaining at ~20% in most institutions. We sought weather access to Hand-Held Ultrasound (HHU) could be an alternative means of reducing rarely appropriate requests. We compared two approaches to rarely appropriate requests; "standard echocardiography" (SE) as requested (control) and HHU as a gate keeper (HHU). Patients were followed up for 6 months and assessed for endpoints including: time until scan, repeat echocardiography/ cost of either strategy, new major pathology and change in management. The most common rarely appropriate requests in both groups were assessment of infective endocarditis without positive blood cultures and precordial murmur evaluation in absence of any other signs or symptoms of cardiovascular disease. The groups had comparable age, gender, requesting physician, and inpatient vs outpatient distribution. HHU led to a 59% reduction in rarely appropriate requests requiring SE. HHU significantly reduced time to decision for inpatients (0 [IQR: 0,1] vs 2 days [IQR: 1,4], $p<0.001$) and total cost of echocardiography ($109±86 vs 181±37, $p<0.001$). New major pathology was identified in 29% and 23% of HHU and SE respectively. There was no difference with respect to change in management. In conclusion, HHU can be an effective gate-keeper to SE for rarely appropriate echocardiograms, reducing time to echocardiography and cost while satisfying the referring physician and avoiding repeat requests for SE. HHU provides a safety net which identifies potential important findings in rarely appropriate requests.

Keywords: Handheld ultrasonography, Appropriate Use

Introduction

The overutilization of echocardiography has been a significant contributor to the 4-fold growth of Medicare reimbursements to cardiologists between 2000 and 2006 [1]. The Appropriate Use Criteria (AUC) and other educational initiatives have been components of efforts to curb inappropriate use[2,3]. Despite a decrease in reimbursements by 33% for echocardiography between 2006-2010[4], there is limited evidence to suggest there is a decline in the rate of inappropriate echocardiography [5]. Indeed, interventions targeting education and the use of point of order applications have been applied with varying degrees of success [6,7]. A problem with the AUC process is that restriction of tests may be contrary to the guidelines[8] and risks missing important pathology. New, important transthoracic echocardiography (TTE) abnormalities have been demonstrated in 17% of inappropriate studies [9]; 22% of rarely appropriate tests resulted in an active change in management[10]. In the context of these observations, it is difficult to enforce an overarching prohibition on rarely appropriate requests. Although previously unconnected, hand-held ultrasonography (HHU) has developed over a similar timeline to the AUC. Validation studies against standard TTE (SE), show high levels of agreement for morphology, functional and valvular assessment[11]. Comparisons of HHU to physical examination have demonstrated superiority of the former and its cost effectiveness [12]. We hypothesised that HHU could be applied as a gatekeeper to SE for rarely appropriate examinations and that such a strategy would: Reduce numbers of SE performed and cost, identify important pathology which would have been missed if the rarely appropriate tests were cancelled and facilitate decision making and patient management.

Methods

This was a case control study designed to compare a HHU based approach to rarely appropriate tests to the current SE based system. It was performed across 2 hospitals and included both inpatients and outpatients. Rarely appropriate requests were identified using the AUC[3]. If the clinical history was inadequate to ascertain appropriateness, medical records were consulted. The process of cancelling rarely appropriate requests is not systematic, and is dependent on inpatient and outpatient waiting lists. We performed HHU on requests which were destined to be cancelled.

The study was performed between March 2015 and December 2015. All rarely appropriate requests during this time period were assessed for eligibility. Requests were excluded from analysis if deemed appropriate following review of medical records or if tests were mandated by guidelines. Requests beyond the scope of HHU were also excluded. The resulting cohort of HHU cases was case matched 2:1 to a cohort of rarely appropriate requests which had undergone SE between 2013 and 2015.

Eligible patients with rarely appropriate requests received a cardiology consultation and HHU examination performed by a cardiologist (Figure 1). If the consult suggested the request was appropriate, then a SE was performed and these patients were excluded. The study was approved by the Tasmanian Human Research Ethics committee.

HHU was performed using the GE Vscan V1.2 hand held device (GE Health Care, Milwaukee, WI). The HHU study protocol involved 2D greyscale and color Doppler images across all standard echocardiographic views (Figure 2). Linear or area measurements were made as appropriate. Spectral Doppler data was not obtained as this feature is not available on the HHU. Severity of disease was approximated using 2D signs of severity (eg. leaflet excursion, chamber dilatation) and size and duration of the color jet/ proximal convergence zone. All HHU examinations were limited to <10 minutes' duration. Results of the HHU study were communicated to the treating team, documented in clinical notes or provided as a short report for outpatients.

Eligible patients went on to have a formal SE if the HHU suggested a full study was warranted, if HHU was non-diagnostic, if there was any HHU abnormality in a patient without a previous echocardiogram or any new changes in patients with a previous examination.

The HHU cohort was case-matched to a cohort of patients with rarely appropriate tests, who underwent a SE. The SE examination was performed on 3 machines: GE Vivid 9 (GE Health Care, Milwaukee, WI), Phillips IE33 (Philips Medical Systems, Andover, Massachusetts) and Acuson SC2000 (Siemens, Erlangen, Germany). All SE were performed over 45- 60 minutes by an experienced sonographer and interpreted by a cardiologist.

Patients in both HHU and SE arms were followed up for 6 months and evaluated for the endpoints of: repeat TTE, cost of care, time to scan, length of stay (inpatients), new major TTE abnormality/ incidental findings and change in management. The cost of additional scans was incorporated into each arm. The cost of SE was $230, in accordance with standard reimbursement[13]. The cost of the hand-held device is $6000 USD - assuming a depreciation of $750/ year and its use in 100 rarely appropriate requests per year, the cost per scan of the device would be $7.50 per rarely appropriate scan. We added to this the cost of storage of images, 15 minutes' time for cardiologist to perform consultation, echocardiography and generate report to arrive at an estimate cost of $38 USD per scan. This approach is consistent with previous attempts to itemise a cost for HHU accounting for geographical variations (Table 1)[11,12,14-20].

Major pathology[9] was defined as: moderate or greater left ventricular dysfunction, valvular regurgitation/ stenosis, pulmonary hypertension, diastolic dysfunction), a regional wall motion abnormality, right ventricular dysfunction and moderate or greater pericardial effusion, thrombus or vegetation.

Changes in management[10] were characterized as: active change in care, including medication changes, subspecialty consultation, surgery or invasive procedures, diagnostic testing, change in level of care, cancellation of initially planned procedure or intervention.

Continuation of care was defined as no escalation or de-escalation of current care, following direct communication about TTE results and documentation by providers in the medical record.

No change in care was defined as; no change in therapy or documentation of reassurance about the findings after a TTE was performed, documentation of the next step in management being in place before the TTE result, or when results were not accessed, acknowledged or noted in further correspondence or discharge summaries.

The statistical analysis was performed using R version 3.2.2 software.[21] Baseline characteristics and outcomes were compared for the HHU and SE groups. Categorical variables and outcomes were compared using a chi-squared test and continuous variables using the Student's t-test with a $p<0.05$ considered statistically significant.

Results

A total of 872 echocardiography requests were audited for appropriateness. Based on the AUC, 93 (10.6%) requests were deemed inappropriate. Routine follow up of pulmonary hypertension which is mandated by guidelines was responsible for 37 of these requests, which were then excluded. Of the remaining 56 requests, 15 were excluded due to: inability to answer the clinical question with HHU (3 requests), designation as appropriate testing following cardiology consultation (2) and inability to attend for echocardiography appointment (10). The 41 remaining cases included in the analysis were case matched 2: 1 with a retrospective cohort.

A total of 123 (41 HHU, 82 SE) patients in whom rarely appropriate tests were requested, were included in this study. There were no significant differences in the clinical or the request characteristics of the two groups (Table 2). A cardiologist was the requesting physician in 24% of the HHU and 32% of SE examinations (p=0.53). The remaining requests in each arm were ordered by a combination of medical and surgical physicians. Rarely appropriate endocarditis studies, routine heart failure follow-up and evaluation of a precordial murmur or ventricular function in the absence of cardiovascular signs and symptoms were the most common requests in both arms.

Table 3 outlines the result of all endpoints. The time to scan and subsequent decision for inpatients was significantly shorter in the HHU arm (0 vs 2 days, p<0.001). There was no significant difference in relation to duration of inpatient stay between HHU and SE (14 vs 9 days, p=0.35). There was no significant difference between time to scan for outpatients between the HHU and SE (32 vs 35 days, p= 0.54).

As expected, many patients in the HHU arm (41%) required follow up SE study, which were mandated due to results of HHU and our safety protocol [new major pathology (12 cases), minor pathology (3) and non-diagnostic HHU (2)]. In the SE arm, only 11% required follow-up echocardiography, however 5 of these were due to new clinically appropriate indications over the course of 6 months' follow-up and these costs were not included into the SE costing assessment. The

mean cost of the HHU strategy was significantly less than the SE arm ($109 vs 181 USD, p<0.001), resulting in a saving of $72 per study.

During 6 months follow up of the 123 cases (HHU and SE) 31/123 (25%) of all rarely appropriate requests had new major pathology. There was no significant difference (p=0.15) between HHU arm and the SE arm with respect to major pathology. Only 1 patient in the HHU arm and 0 patients in the SE arm had a documented incidental finding - a liver mass requiring abdominal US.

Of 123 requests which were deemed rarely appropriate, 15% of results led to an active change in management using either HHU or SE. Furthermore 64% of results led to continuation of care. Thus only 21% of investigations resulted in absolutely no change in management. There were no significant differences between the two groups with regards to change in management (p=0.27).

Discussion

The results of this study show that despite being classified as rarely appropriate, 25% of total requests had new major TTE abnormalities which would have been missed if these tests were cancelled. The use of HHU to screen rarely appropriate requests led to a 59% reduction in SE studies, without any compromise in outcomes related to management. To our knowledge this is the first study which specifically provides an alternative imaging strategy to the performance or cancellation of rarely appropriate tests.

The current rate of "rarely appropriate" echocardiography remains at 10-20% [5,22]. Various strategies have been proposed to enforce the AUC, including education and point of order radiology benefit management software [23]. Ongoing rarely appropriate requests reflect the concern that these echocardiograms may still be clinically useful and influence management [9,10,24]A HHU based approach would enable application of the AUC and reduce the performance of inappropriate echocardiograms whilst simultaneously creating a safety net to identify important findings. Indeed, a HHU-backed approach to the AUC was a cost-saving strategy, with a saving of $72 per study.

All inpatient referrals were non-cardiology admissions and the longer duration of stay was unexpectedly higher than the expected 4 day length of stay [25]. The use of a HHU strategy in

inpatients did not influence length of stay, reflecting the complex patient phenotype where duration of stay is related to clinical factors.

Although not specifically devoted to use of HHU in rarely appropriate tests, previous work supports the use of HHU in common situations associated with rarely appropriate tests. In a study of HHU and repeat TTE in 105 adult patients undergoing follow-up echocardiography, HHU showed good to excellent correlation with TTE[20]. In addition, a HHU protocol could save between $41-64 per study. Twelve percent of these patients were deemed rarely appropriate, but a subgroup analysis was not performed.

Our study was not a direct comparison of HHU vs SE, and cannot address the question of echocardiographic false negative scans, although the validation of HHU has been previously explored in great detail [11,20]. A consensus statement published by the American Society of Echocardiography found that LV enlargement, LV hypertrophy, LV systolic function, LA enlargement, RV enlargement, RV systolic function, pericardial effusion and IVC size have all been accurately detected [26].

This is a case control study; despite the patients in both arms being well matched, the lack of a randomised controlled trial may have resulted in potential selection bias. A randomized study should be considered, with head-to-head comparison of HHU with SE. From a practical standpoint, a cardiologist may not always be able to provide a consultation. Finally, the categorisation of “change in management” is a difficult task. In using the criteria proposed by Matuleviscius et al we recognise the limitations of relying on medical documentation and correspondence to differentiate between “No change in Management” and “Continuation of Care”.

1. Shaw LJ, Marwick TH, Zoghbi WA, Hundley WG, Kramer CM, Achenbach S, Dilsizian V, Kern MJ, Chandrashekhar Y, Narula J. Why all the focus on cardiac imaging? *JACC Cardiovasc Imaging* 2010;3:789-794.

2. Cassel CK, Guest JA. Choosing wisely: helping physicians and patients make smart decisions about their care. *Jama* 2012;307:1801-1802.

3. Douglas PS, Garcia MJ, Haines DE, Lai WW, Manning WJ, Patel AR, Picard MH, Polk DM, Ragosta M, Ward RP, Weiner RB. ACCF/ASE/AHA/ASNC/HFSA/HRS/SCAI/SCCM/SCCT/SCMR 2011 Appropriate Use Criteria for Echocardiography. A Report of the American College of Cardiology Foundation Appropriate Use Criteria Task Force, American Society of Echocardiography, American Heart Association, American Society of Nuclear Cardiology, Heart Failure Society of America, Heart Rhythm Society, Society for Cardiovascular Angiography and Interventions, Society of Critical Care Medicine, Society of Cardiovascular Computed Tomography, and Society for Cardiovascular Magnetic Resonance Endorsed by the American College of Chest Physicians. *J Am Coll Cardiol* 2011;57:1126-1166.

4. Bhatia RS, Alabousi M, Dudzinski DM, Weiner RB. Appropriate use criteria: a review of need, development and applications. *Expert Rev Cardiovasc Ther* 2016;14:281-290.

5. Fonseca R, Negishi K, Otahal P, Marwick TH. Temporal changes in appropriateness of cardiac imaging. *J Am Coll Cardiol* 2015;65:763-773.

6. Bhatia RS, Milford CE, Picard MH, Weiner RB. An educational intervention reduces the rate of inappropriate echocardiograms on an inpatient medical service. *JACC Cardiovasc Imaging* 2013;6:545-555.

7. Goldzweig CL, Orshansky G, Paige NM, Miake-Lye IM, Beroes JM, Ewing BA, Shekelle PG. Electronic Health Record–Based Interventions for Improving Appropriate Diagnostic ImagingA Systematic Review and Meta-analysisEHR-Based Interventions for Improving Appropriate Diagnostic Imaging. *Ann Inter Med* 2015;162:557-565.

8. Fonseca R, Negishi K, Marwick TH. What is the evidence status of Appropriate Use Criteria (AUC)? Insight from a matching exercise with the guidelines for echocardiography. *Intern Med J* 2015;45:864-869.

9. Ward RP, Mansour IN, Lemieux N, Gera N, Mehta R, Lang RM. Prospective evaluation of the clinical application of the American College of Cardiology Foundation/American Society of Echocardiography Appropriateness Criteria for transthoracic echocardiography. *JACC Cardiovasc Imaging* 2008;1:663-671.

10. Matulevicius SA, Rohatgi A, Das SR, Price AL, DeLuna A, Reimold SC. Appropriate use and clinical impact of transthoracic echocardiography. *JAMA internal medicine* 2013;173:1600-1607.

11. Khan HA, Wineinger NE, Uddin PQ, Mehta HS, Rubenson DS, Topol EJ. Can hospital rounds with pocket ultrasound by cardiologists reduce standard echocardiography? *Am J Med* 2014;127:669 e661-667.

12. Mehta M, Jacobson T, Peters D, Le E, Chadderdon S, Allen AJ, Caughey AB, Kaul S. Handheld ultrasound versus physical examination in patients referred for transthoracic echocardiography for a suspected cardiac condition. *JACC Cardiovasc Imaging* 2014;7:983-990.

13. Australian Government Department of Health. *Medicare Benefits Schedule Book Category 5. Operating from 01 November 2013* http://www.health.gov.au/internet/mbsonline/publishing.nsf/Content/384D46598C2B03FBCA257BFA002418A2/$File/201311-Cat5.pdf . (accessed September 2014).

14. Vourvouri EC, Koroleva LY, Ten Cate FJ, Poldermans D, Schinkel AF, van Domburg RT, Vletter WB, Roelandt JR. Clinical utility and cost effectiveness of a personal ultrasound imager for cardiac evaluation during consultation rounds in patients with suspected cardiac disease. *Heart* 2003;89:727-730.

15. Greaves K, Jeetley P, Hickman M, Dwivedi G, Sabharwal N, Lim T, Janardhanan R, Senior R. The use of hand-carried ultrasound in the hospital setting--a cost-effective analysis. *J Am Soc Echocardiogr* 2005;18:620-625.

16. Galasko GI, Barnes SC, Collinson P, Lahiri A, Senior R. What is the most cost-effective strategy to screen for left ventricular systolic dysfunction: natriuretic peptides, the electrocardiogram, hand-held echocardiography, traditional echocardiography, or their combination? *Eur Heart J* 2006;27:193-200.

17. Trambaiolo P, Papetti F, Posteraro A, Amici E, Piccoli M, Cerquetani E, Pastena G, Gambelli G, Salustri A. A hand-carried cardiac ultrasound device in the outpatient cardiology clinic reduces the need for standard echocardiography. *Heart* 2007;93:470-475.

18. Gianstefani S, Catibog N, Whittaker AR, Ioannidis AG, Vecchio F, Wathen PT, Douiri A, Reiken J, Monaghan MJ. Pocket-size imaging device: effectiveness for ward-based transthoracic studies. *Eur Heart J Cardiovasc Imaging* 2013;14:1132-1139.

19. Kitada R, Fukuda S, Watanabe H, Oe H, Abe Y, Yoshiyama M, Song JM, Sitges M, Shiota T, Ito H, Yoshikawa J. Diagnostic accuracy and cost-effectiveness of a pocket-sized transthoracic echocardiographic imaging device. *Clin Cardiol* 2013;36:603-610.

20. Kini V, Mehta N, Mazurek JA, Ferrari VA, Epstein AJ, Groeneveld PW, Kirkpatrick JN. Focused Cardiac Ultrasound in Place of Repeat Echocardiography: Reliability and Cost Implications. *J Am Soc Echocardiogr* 2015;28:1053-1059.

21. R Development Core Team. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0. 2008. URL http://www.R-project.org.

22. Gurzun M-M, Ionescu A. Appropriateness of use criteria for transthoracic echocardiography: are they relevant outside the USA? *European Heart Journal - Cardiovascular Imaging* 2014;15:450-455.

23. Hendel RC. Utilization management of cardiovascular imaging pre-certification and appropriateness. *JACC Cardiovasc Imaging* 2008;1:241-248.

24. Ward RP. The role of appropriateness criteria in the clinical practice of echocardiography. *Curr Cardiovasc Imaging Rep* 2009;2:319-324.

25. Prevention CCfDCa. Number, rate, and average length of stay for discharges from short-stay hospitals, by age, region, and sex: United States. *http://wwwcdcgov/nchs/data/nhds/1general/2010gen1_agesexalospdf* 2010.

26. Spencer KT, Kimura BJ, Korcarz CE, Pellikka PA, Rahko PS, Siegel RJ. Focused cardiac ultrasound: recommendations from the American Society of Echocardiography. *J Am Soc Echocardiogr* 2013;26:567-581.

Figure Legends

Figure 1 Study Design

AUC= Appropriate Use Criteria, RA= Rarely Appropriate, SE= Standard Echocardiographic examination

Figure 2 HHU Protocol

1,2) Parasternal long and short axis views including short axis sweep for left ventricular function and regional wall motion assessment. 3,4,5) Apical views as illustrated and 5 chamber for aortic valve assessment. 6) Subcostal- long axis and inferior vena cava views 7) Aortic Arch view. Color Doppler applied to all views**.**

Table 1.

Cost benefit studies of hand held ultrasonography vs standard echocardiography.[a]

Author	Year	Country	Device	HHU Cost	Operator Cost	Total HHU Cost (Device+Operator)	Total StdE Cost
Vourvouri	2003	Netherlands	SonoHeart	$5	$116[b]	$121	$213
Greaves	2005	UK	OptiGo	NR	NR	$8	$128
Galasko	2006	UK	OptiGo	NR	NR	$65- $50	$258
Trambaiolo	2007	Italy	OptiGo	$14	$26	$40	$122
Gianstefani	2013	UK	VScan	$1	$33[c]	$34	$137
Kitada	2013	Japan	VScan	$2	NR	$2	$88
Khan	2014	USA	VScan	NR	NR	NR	$800
Mehta	2014	USA	VScan	$8	$11	$19	$1511[d]
Kini	2015	USA	VScan	$9	$0- 23	$9- 32	$73
Pathan	**2016**	**Australia**	**VScan**	**$8**	**$30**	**$38**	**$173**

NR= Not Reported

a.) All costs converted to US dollars based on conversion rate at time of publication, b.) Including Cardiology Consult, c.) £25 + 8 (Operator + Hospital costs), d.) $162 (Professional charge) + $1349 (Facility charge)

Table 2.

Patient and Request Characteristics at Baseline

Patient Characteristics	**HHU (n= 41)**	**SE (n= 82)**	**p**
Age (median [IQR]) (years)	62 [52, 73]	61 [48, 72]	0.60
Male	23 (56%)	40 (49%)	0.57
Hypertension	21 (51%)	38 (46%)	0.75
Diabetes mellitus	6 (15%)	11 (13%)	1.00
Valvular heart disease	6 (15%)	15 (18%)	0.80
Atrial fibrillation	4 (10%)	12 (15%)	0.58
Ischemic heart disease	12 (29%)	15 (18%)	0.25
Heart failure	7 (17%)	12 (15%)	0.93
Lung disease	4 (10%)	14 (17%)	0.42
Renal disease	4 (10%)	8 (10%)	1.00
Liver disease	2 (5%)	10 (12%)	0.33
Systemic disease	4 (10%)	8 (10%)	1.00
Requested by Cardiologist	10 (24%)	26 (32%)	0.53
Setting Ambulatory care/Outpatient	20 (49%)	48 (58%)	0.41

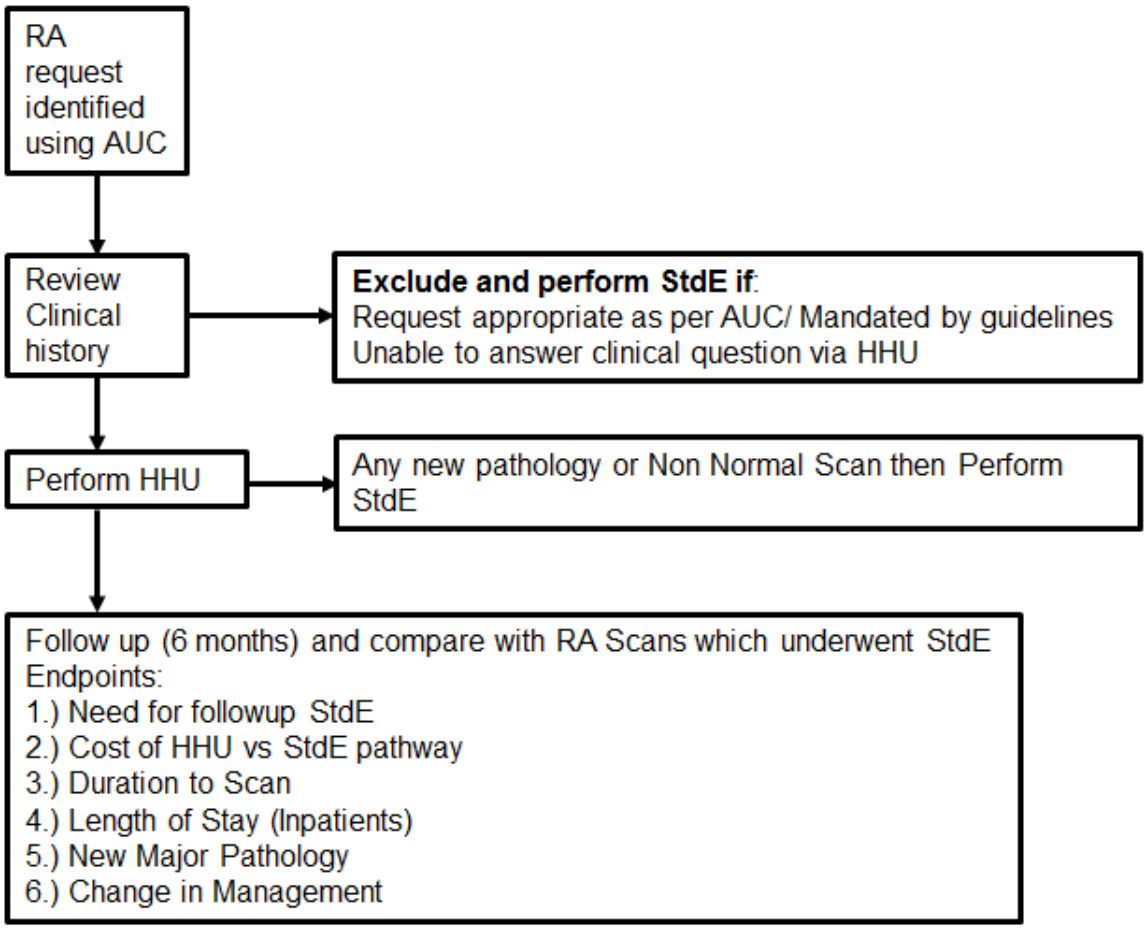
IQR= interquartile range, HHU= Hand held Ultrasound (Echocardiography), SE= Standard transthoracic echocardiography

Table 3.

Endpoints

Endpoints	**HHU (n= 41)**	**SE (n= 82)**	**p**
Time to scan days Inpatients, (median [IQR])	0 [0, 1]	2 [1, 4]	**<0.001**
LOS days Inpatients, (median [IQR])	14 [7, 28]	9 [5, 21]	0.35
Time to scan days Outpatients, (median [IQR])	31 [31, 32]	35 [21, 108]	0.54
Follow up SE within 6 months n (%)	17 (41%)	9 (11%)	**<0.001**
Average cost USD, (mean (sd))	109 (86)	181 (37)	**<0.001**
New Major Pathology	12 (29%)	19 (23%)	0.15
Change in management			0.27
No Change	8 (19%)	18 (22%)	
Continuation of Care	24 (58%)	55 (67%)	
Active change in management	9 (22%)	9 (11%)	0.18
Change in Management or Continuation of Care	33 (80%)	64 (78%)	0.94

USD= US Dollar (Costs were calculated in Australian dollars and converted to US dollars. 1 Australian dollar=0.75 USD), HHU= Hand Held Ultrasound, IQR= interquartile range, LOS= length of stay, sd= Standard Deviation, SE= Standard transthoracic echocardiography


RA request identified using AUC
Review Clinical history
Exclude and perform StdE if:
Request appropriate as per AUC/ Mandated by guidelines
Unable to answer clinical question via HHU
Perform HHU
Any new pathology or Non Normal Scan then Perform StdE
Follow up (6 months) and compare with RA Scans which underwent StdE
Endpoints:
1.) Need for followup StdE
2.) Cost of HHU vs StdE pathway
3.) Duration to Scan
4.) Length of Stay (Inpatients)
5.) New Major Pathology
6.) Change in Management