

Focused cardiac ultrasound screening for rheumatic heart disease by briefly trained health workers: a study of diagnostic accuracy

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Summary

Background Echocardiographic screening for rheumatic heart disease (RHD) can identify individuals with subclinical disease who could benefit from antibiotic prophylaxis. However, most settings have inadequate resources to implement conventional echocardiography and require a feasible, accurate screening method. We aimed to investigate the accuracy of screening by non-expert operators using focused cardiac ultrasound (FoCUS).

Methods In this prospective study of diagnostic accuracy, we recruited schoolchildren aged 5 to 15 years in Fiji to undergo two blinded tests. The index test was a FoCUS assessment of mitral and aortic regurgitation, performed by nurses after an 8-week training programme. The reference standard was the diagnosis of RHD by a paediatric cardiologist, based on a standard echocardiogram performed by a skilled echocardiographer. The primary outcome was the accuracy of the index test with use of the most sensitive criteria (any regurgitation).

Findings We included 2004 children in the study. The index tests were done between September, 2012, and September, 2013, by seven nurses in eight schools in Fiji. The diagnostic accuracy of the screening test (area under receiver operator characteristic curve) was 0·89 (95% CI 0·83–0·94). When the primary cut-off point (any regurgitation) was used for analysis, sensitivity was 84·2% (72·1–92·5) and specificity was 85·6% (83·9–87·1). The sensitivity of individual nurses ranged from 66·7% to 100% and specificity 74·0% to 93·7%.

Interpretation Screening by briefly trained nurses using FoCUS was accurate for the diagnosis of RHD. Refinements to training and screening test methods should be studied in a range of settings, and in parallel with investigations of the long-term clinical and cost-effectiveness of screening for RHD.

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Introduction

Rheumatic heart disease (RHD) is an important cause of global morbidity and mortality.¹ Patients typically present late in the illness, and there is a high risk of death in the first years after diagnosis.^{2,3} Screening can detect people who might benefit from secondary antibiotic prophylaxis, and is recommended by WHO in high-prevalence areas;⁴ however, there is a lack of evidence to inform implementation.^{5,6}

Population screening requires a test that is safe, accurate, and readily available.⁷ Echocardiography is safe and much more accurate for diagnosing RHD than is clinical evaluation.^{8–10} However, the shortage of echocardiographers and cardiologists to perform and interpret echocardiograms is a major barrier to their use and hampers scale-up of screening to the population level.¹¹ Task shifting screening to non-expert health workers could overcome the human resource constraints.^{12,13} In this approach, nurses who have completed a short training course use focused cardiac ultrasound (FoCUS) to screen for valvular regurgitation, and refer positive cases for diagnostic assessment, including standard echocardiography.

In Fiji, there are too few physicians to perform echocardiographic screening, but the country does have a capable nursing workforce and a nurse-led school health programme. Therefore, we sought to assess whether task shifting FoCUS to existing school-health nurses is a feasible strategy for implementation of population screening for RHD. We have shown in a pilot study¹⁴ that the training of nurses in ultrasound-based RHD screening was feasible. We have also reported in another study,¹⁵ that nurses who had undertaken an 8-week training course could acquire FoCUS images of appropriate quality and accurately measure regurgitation. Here, we aimed to investigate the accuracy of FoCUS screening tests done by non-experts, using a range of cut-off criteria.

Methods

Study design and setting

In this prospective investigation of the accuracy of a new test,¹⁶ the index test was FoCUS for RHD, performed by nurses who had completed a defined training programme, using a simplified protocol and portable

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Research in context

Evidence before this study

A search of PubMed and Embase between Jan 1, 1990, and Dec 31, 2011, using search terms “non-expert”, “nurse”, “community health worker”, “education”, “echocardiography”, “ultrasound”, and “rheumatic heart disease”, and discussion with colleagues yielded no relevant publications. We repeated the search in December, 2015. We found two studies: both trained and assessed two nurses who used hand-held ultrasound for screening. Three additional feasibility studies were found.

Added value of this study

This study is large and is consistent with guidelines for studies of diagnostic accuracy. The design included training a large group of

health workers and unsupervised screening at eight sites over 12 months, which may be more representative of a real-world scenario than other studies. The training programme and test protocols were highly defined and could be replicated in other settings. Our results show that the screening test was accurate. Additionally, these data clarify the influence of various criteria and cut-off points on test sensitivity and specificity. Our results also highlight the issue of variation in accuracy between operators.

Implications of all available evidence

Screening by non-expert operators, using simplified imaging protocols, has been shown to be accurate across all studies. Further studies and refinements of test methods should be explored.

ultrasound machines. The reference standard was the diagnosis of RHD by a paediatric cardiologist, based on findings from a standard echocardiogram. This study took place in Fiji, a South Pacific nation with a population of about 900 000 people and a high prevalence of RHD.¹⁰

The study was approved by the Fiji National Health Research Committee and Menzies School of Health Research, Australia.

Procedures

In June and July, 2012, school-health nurses in Fiji, who had only a basic understanding of cardiac anatomy and physiology and no previous imaging experience, were trained to screen for RHD using FoCUS. Training included 1 week of classroom-based workshops and 7 weeks of practical training, as reported elsewhere.¹⁷

The evaluation of the screening test was conducted in eight primary schools in the Central, Northern, and Western administrative divisions of Fiji (figure 1). Children underwent two tests: a FoCUS performed by a nurse, and a standard echocardiogram by an echocardiographer. Tests were done in different rooms, so that the nurse and echocardiographer were not aware of the other's findings. We aimed to have both tests take place on the same day.

Nurses followed a simplified 12-step protocol, assessing the presence of mitral regurgitation or aortic regurgitation on colour Doppler imaging in the parasternal long axis, parasternal short axis, and apical views, and if present, measuring the longest visible jet (appendix). To attempt to avoid the measurement of benign closing volumes, we asked nurses to measure regurgitation only if it had been seen in two or more frames. Nurses made assessments at the time of examination and clinical information was not available to them. All images and loops were saved. Nurses used the M-Turbo portable ultrasound machine (SonoSite Inc, Bothell, WA, USA), chosen for acceptable colour Doppler imaging and relative affordability, therefore representing the type of machine that could be practical to procure and use in resource-limited and remote settings.

The echocardiographer was highly skilled in RHD imaging, and performed a directed echocardiogram, including parasternal long axis, parasternal short axis, and apical views on all children, and continued to an extended echocardiogram, including continuous-wave Doppler and M-mode imaging if any of the following abnormalities were seen: mitral regurgitation ≥ 1.5 cm; aortic regurgitation ≥ 0.5 cm; mitral or aortic stenosis; morphological features of RHD as described in the 2012 World Heart Federation (WHF) criteria;¹⁸ or any other pathology. The echocardiographer used a Vivid *e* ultrasound machine (GE Healthcare, Freiburg, Germany), which has been used in other screening studies.^{19,20}

Standard echocardiograms were reported by a paediatric cardiologist, who was unaware of the nurses' assessment or any clinical information. Diagnosis was in accordance with WHF criteria,¹⁸ with categories of normal, borderline RHD, definite RHD, and congenital abnormalities. The severity of RHD was based on a grading of valvular regurgitation and/or stenosis.^{21,22} If there was diagnostic uncertainty, a second cardiologist reported the echocardiogram. In the case of an inconsistent diagnosis between the first and second cardiologist, the report of a third cardiologist was used. We entered data into a REDCap electronic database hosted at the Murdoch Childrens Research Institute in Melbourne, Australia.²³ Children with abnormal echocardiograms were referred to specialist centres for diagnostic assessment and management.

Participants

Seven nurses participated: two from each of the three administrative Divisions and one additional nurse from Central Division in case of dropout. We included schools that would allow each nurse to screen within their local Division and do approximately equal numbers of tests (figure 1). Research staff explained study procedures to students, parents, and teachers at the participating schools and we provided information sheets in Fijian and

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