SUPPLEMENTAL MATERIAL

Training and assessment for non-expert practitioners participating in SPLASH echocardiography training for the *Pedrino* study

Recruitment to training

Non-expert practitioners were identified by partner organisations with links to communities where echocardiography screening took place in the Northern Territory of Australia and Timor-Leste. These organisations included Malal'a Health Services, Maningrida Health Centre, Hospital Nacional Guido Valadares and Maluk Timor. A total of 18 people were offered training, including six non-specialists doctors (pediatric registrars), one nurse and four community workers from Timor-Leste; three nurses and four Aboriginal community workers from Australia. All participants from Timor-Leste spoke Tetum as a first language. Three of the Aboriginal community workers spoke Burrara as their first language. All four nurses from Australia spoke English as their first language. Each of the doctors had scored 5.0 or greater on an International English Language Testing System (IELTS) assessment in Australia (37). No other participants completed any English language assessment prior to training, but all were deemed competent in conversational English.

Training methods

Participants were required to complete 10 modules of an online course in the echocardiographic diagnosis of rheumatic heart disease prior to face-to-face training. These modules were designed for nurses and other medical professionals and are available in English, Spanish and Portuguese (28). They cover basic principles of rheumatic fever, rheumatic heart disease (RHD) and echocardiography. They are not specific to the handheld devices (GE Vscan) used in the face-to-face training and screening study. Participants were

able to complete these modules in their own time, and with support from colleagues in their workplace. On average, the 10 modules take approximately 10 hours to complete.

Participants were then supported to attend a five-day face-to-face course of intensive training at Menzies School of Health Research and NT Cardiac in Darwin, Australia. Theory and practical sessions were interspersed throughout the five days, and assessments took place during the same period.

The course included nine hours of theory lectures and workshop sessions, covering the following topics: RHD and the rationale of screening; Cardiac anatomy and physiology; VScan basics; Echocardiography basics; Standard echocardiography views; VScan – pre and post scan instructions; Incidental findings; RHD pathophysiology; Optimising 2D images; Optimising color Doppler imaging; RHD findings on echocardiography – case examples.

Practical training was focussed on completing supervised studies using the single parasternal long axis view including 2D and color Doppler with a 'sweep' through both mitral and aortic valves (SPLASH echocardiography). Supervision was provided by a faculty including one pediatric cardiologist, three general pediatricians with echocardiography skills, and three cardiac sonographers, all with extensive experience in the diagnosis of RHD. Training was focused on teaching participants how to detect aortic and mitral regurgitation, and how to correctly measure any mitral regurgitation jet identified.

Each participant completed a minimum of 30 supervised SPLASH echocardiography studies, which were documented in a logbook. These were performed on volunteers, some of whom had normal cardiac anatomy, and others with established RHD.

A brief refresher course (four hours) was provided prior to commencement of screening. This included workshop style discussion of theoretical and practical aspects of SPLASH echocardiography screening for RHD, and study procedures for data collection.

Assessment methods

A mid-course, formative theory assessment was conducted on day three of the intensive training course to get an indication of participants' knowledge. This involved nine written questions (in English) requiring short-answers or labelling of diagrams.

A summative theory assessment consisting of 18 written questions (in English) was conducted on the final day of the intensive training course. This included questions on cardiac anatomy, use of the GE VScan, and valvular pathology. The assessment was conducted without a time-limit, but no access to written or online learning materials was permitted during the assessment. Participants could ask for clarification of English words that they did not understand. A score of 80% or greater was required to pass the assessment.

For the final practical assessment, each candidate was asked to perform a SPLASH echocardiography study on two subjects, one with normal cardiac anatomy and one with mitral regurgitation secondary to RHD. The participants were blinded to the diagnosis and were only informed that they would have to complete two scans. In order to pass the assessment, participants were required to correctly identify if there was mitral or aortic regurgitation and to correctly measure any regurgitant jet for both scans.

A single re-sit of either the final theory assessment or the final practical assessment was allowed for any who did not pass either assessment on the first attempt.

Assessment results

Assessments were completed by 17/18 participants. One nurse from Australia did not complete the assessments.

For the mid-course theory assessment, 14/17 scored 80% or greater, with a mean score of 88%; 15/17 scored 80% or greater on the final theory assessment, with a mean score of 91%. For the practical assessment, 14/17 passed on the first attempt.

One candidate (an Aboriginal community worker from Australia) who passed the practical assessment but failed the first attempt at the theory assessment, passed the theory assessment on a re-sit examination. One candidate (an Aboriginal community worker from Australia) who passed the theory assessment but failed the practical assessment on the first attempt, passed the practical assessment on a re-sit examination.

One candidate who passed the theory assessment but failed the practical assessment on the first attempt, also failed the re-sit practical assessment. One candidate failed both practical and theory assessments and did not re-sit. Both unsuccessful candidates were community workers from Timor-Leste, without formal health qualifications who had not completed any formal English language assessments.

In total, 15/18 non-expert practitioners (6/6 doctors, 3/4 nurses, 6/8 community workers) successfully completed training and assessments, and participated in echocardiography screening.

Discussion

Assessments were most challenging for participants who did not speak English as their first language and did not have any prior formal health qualifications. Notwithstanding this, 4/6 community workers from Timor-Leste and 4/4 Aboriginal community workers from Australia passed the assessments (two required a re-sit examination).

The reasons for failing the practical exam included failures to identify mitral regurgitation, failure to obtain all required views, failure to store data properly and failure to optimise echocardiographic views appropriately.

2012 World Heart Federation criteria for echocardiographic diagnosis of rheumatic heart disease in people aged 20 years of less (11).

Echocardiographic criteria for RHD*

Definite RHD (either A, B, C or D):
A) Pathological MR and at least two morphologic features of RHD of the MV
B) MS mean gradient ≥ 4 mmHg
C) Pathological AR and at least two morphologic features of RHD of the AV
D) Borderline disease of both the aortic and mitral valves

Borderline RHD (either A, B or C):
A) At least two morphological features of RHD of the MV without pathological MR or MS
B) Pathological MR
C) Pathological AR

Echocardiographic criteria for pathological regurgitation
(all four Doppler criteria must be met)

Pathological MR	Pathological AR
1. Seen in 2 views	1. Seen in 2 views
2. In at least one view, jet length ≥2 cm#	2. In at least one view jet length ≥1 cm#
3. Peak velocity ≥3m/sec	3. Peak velocity ≥3m/sec
4. Pan-systolic jet in at least one envelope	4. Pan-diastolic jet in at least one envelope

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Morphological features of RHD

Mitral Valve	Aortic Valve
1. AMVL thickening ≥3mm†	1. Irregular or focal thickening
2. Chordal thickening	2. Coaptation defect
3. Restricted leaflet motion	3. Restricted leaflet motion
4. Excessive leaflet tip motion during systole	4. Prolapse

Congenital anomalies must be excluded. #A regurgitant jet length should be measured from the vena contracta to the last pixel of regurgitant color (blue or red) on non-magnified (non-zoomed) images. †AMVL thickness should be measured during diastole at full excursion. Measurement should be taken at the thickest portion of the leaflet, including focal thickening, beading, and nodularity. Measurement should be performed on a frame with maximal separation of chordae from the leaflet tissue. Valve thickness can only be assessed if the images were acquired at optimal gain settings without harmonics and with a frequency ≥2.0 MHz. Abnormal thickening of the AMVL is age-specific and defined as follows: ≥3 mm for individuals ≤20 years of age; ≥4 mm for individuals 21–40 years of age; ≥5 mm for individuals >40 years of age. †Restricted leaflet motion of either the anterior or the posterior MV leaflet is usually the result of chordal shortening or fusion, commissural fusion, or leaflet thickening. ‡Excessive leaflet tip motion is the result of elongation of the primary chords, and is defined as displacement of an involved leaflet's tip or edge towards the left atrium resulting in abnormal coaptation and regurgitation. Excessive leaflet tip motion does not need to meet the standard echocardiographic definition of MV prolapse disease, as that refers to a different disease process. This feature applies to only those <35 years of age. In the presence of a flail MV leaflet in the young (<20 years of age) this single morphologic feature is sufficient to meet the morphologic criteria for RHD (that is, where the criteria state "at least two morphologic features of RHD of the MV" a flail leaflet in a person <20 years of age is sufficient). §In the parasternal short axis view, the right and noncoronary aortic cusp closure line often appears echogenic (thickened) in healthy individuals and this phenotype should be considered as normal. Abbreviations: AMVL, anterior MV leaflet; RHD, rheumatic heart disease.

Echocardiographic variables for stratification of risk of progression of echocardiography screening detected rheumatic heart disease, modified from *Nunes et al* (32).

Variables used to determine score	
Variable	**Points**
Mitral valve	
Anterior leaflet thickening	3
Excessive leaflet tip motion	3
Regurgitation jet length ≥20mm	6
Aortic valve	
Irregular or focal thickening	4
Any regurgitation	5
Risk stratification based on total score	
Risk group	**Total score**
Low risk of progression	0 – 6
Moderate risk of progression	7 – 9
High risk of progression	≥10