Review Article

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Echocardiography Screening for Diagnosis of Latent RHD Using Nurses: Is the Project Feasible for Nepal?

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Abstract

Rheumatic Heart Disease (RHD) is a preventable disease which occurs years or decades after the onset of Acute Rheumatic Fever (ARF) in childhood. The prevalence of RHD is still high in Nepal, with most cases of latent RHD concentrated in the rural, resource-limited setting. The sequelae of latent RHD cases often manifest decades later, causing a significant burden on the health system. Training of non-experts with simple protocols in such remote setting for screening of latent RHD is showing promising results worldwide. Screening of latent RHD is advocated in RHD endemic areas where early detection by echo screening can alleviate a massive burden on morbidity and mortality in the future. More research is needed to explore this possibility in the context of an endemic country like Nepal to tackle the burden of RHD.

Keywords: Latent Rheumatic heart disease, Echocardiography screening, Non-experts

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Introduction

Rheumatic Heart Disease (RHD) is a sequela of Rheumatic Fever (RF), with the progression to valvular heart disease occurring years to decades later after the initial Rheumatic Fever, leading to disabling or fatal complications in cases without earlier intervention. While it was a major health problem in both developed and developing nations, extensive research and intervention have largely reduced the incidence of RHD in the developed countries[1]. However, RHD remains a leading public health problem in developing countries, with devastating effects on children and young adults in their most productive years of life[2]. The 21st century has shown a lack of research in the area of RHD in developing countries, due to which effective policies to combat RHD have been stalling[1,3,4].

Clinically silent RHD diagnosed through echocardiographic screening has been termed latent RHD and classified as borderline and definite RHD according to World Heart Federation (WHF) 2012 criteria[5,6]. Latent RHD has a variable course, with late presentation and diagnosis of patients with RHD, being crucial elements for the high morbidity and mortality in low- and middle-income countries[6-9]. Detecting latent RHD cases in high-endemic areas is largely advocated by studies as both borderline and mild definite RHD cases are at substantial risk of progression and should be enrolled in close clinical follow-up. Children with moderate-to-severe latent RHD found by echocardiographic screening should be considered missed clinical cases and treated accordingly[8,10]. In Nepal, there are limited publications on echo screening. A study published in 2016 from eastern Nepal on echocardiography screening has stated the prevalence of latent RHD to be as high as 10.2 per 1000 children. The silent disease was also found to be 5 times more common than symptomatic cases[9].

Due to its high burden in middle and low-income countries, there has been a growing interest in detecting latent RHD earlier through echocardiography screening[4-6,11], targeting resource-limited settings for widespread coverage, often using non-experts with simpler echo criteria and portable devices[7,12-23]. While several studies are already pinpointing accurate prevalence of latent RHD with the help of simplified criteria and handheld/portable echo machines[16,18,20], the possibility of medical intervention with benzathine penicillin altering the progression of the disease such asymptomatic cases is still being researched in trials like an ongoing GOAL Trial in Uganda[4,24].

Scenario of RHD In Nepal

Nepal is a low-income country in South East Asia with a population of 29.1 million, with about 79.80% population living in rural areas. Nepal has an average life expectancy of 70.48 years with a 0.7 physician per 1000 people ratio. The government spends around 5.6% of the GDP on the health sector[25]. The Human Development Index (HDI) was 0.587 in 2019, at a position of 147 out of 189 countries, with the score in urban areas (0.647) surpassing that of rural areas (0.561) with a large urban-rural gap[26].

RHD is considered a significant public health problem in Nepal, especially among children and young adults, despite limited data until the latter half of the 20th century[27,28]. Owing to the overwhelming disease load, Nepal Heart Foundation (NHF) was established in 1988 which initiated community activities on RHD prevention through the "Save the Children's Heart Program" in 1990. Due to the overwhelming demand for heart valve surgery for severe RHD, tertiary care centers used to have a waitlist that crossed a year, necessitating the need for early detection of RHD and also a comprehensive RHD prevention program in Nepal.

Therefore, the Government of Nepal (GoN), Ministry of Health and Population (MoHP) developed a National RF/RHD prevention and control program in 2007 AD and collaborated with the NHF for its implementation. A study done for assessing the effectiveness of the national RHD program had shown promising results[29,30]. This program was discontinued in 2014 AD due to a change in government policy. Instead, GoN initiated free heart valve surgery program to help the advanced RHD cases.

A hospital-based cross-sectional study published in 2016 AD by Laudari et al. in central Nepal, concluded that RHD is a leading cause of heart failure among young populations, with many of them requiring surgery, while most went through a prolonged duration of medical treatment[31]. In another school-based cross-sectional study by Shrestha et al. in 2016 in Sunsari district in Eastern Nepal, the mean incidence was 1.1 per 1000 children per year[9]. Research conducted by Laudari et al. in 2018 demonstrated a 0.1% Echo prevalence of RHD on students of Chitwan and Nawalparasi districts of Central Nepal[32].

The distribution of RHD in Nepal is disproportionate with the highest prevalence in low socio-economic settings in rural areas[9,31,32]. A study conducted in 2018 AD found the prevalence rate of RHD among school-going children of rural Jajarkot more than 7 times higher than in Kathmandu (7.12 Vs 0.9 per 1000)[33]. The health system is concentrated in urban areas, leaving the rural areas under-staffed. There are around 190 registered cardiologists in Nepal, most based in urban areas[34,35]. However, the major part of the country is rural, where healthcare is mainly provided by auxiliary health staff[36-38].

The limited number of cardiologists in Nepal to make an extensive echocardiographic screening for the detection of latent RHD is challenging. In similar limited resource settings like Nepal, task shifting, which is the reallocation of echocardiographic screening to health workers with fewer qualifications using shorter training periods with simpler criteria[39], is emerging as a promising solution.

Strengthening and expanding such programs may further help prevent progression to severe valvular damage needing surgical intervention. Since echocardiography screening of RHD is important in the early diagnosis of RHD and its management, exploring options for increasing its use in resources limited settings might aid in improving the health outcome in the future[9,29].

NHF has initiated the END RHD CAMPAIGN NEPAL in 2019 with an objective to reduce the burden of RHD in Nepal by 50% by the year 2030.For achieving this target a comprehensive RHD control program is needed which should include echo screening of children in large scale.

Echo screening of RHD using non-experts in Nepal

RHD screening in high-prevalence areas is recommended to detect people who might benefit from follow-up or further evaluation for intervention[19,22-23.] An effective training of non-experts can help in estimating the true prevalence of RHD in the community, and find cases of mild RHD for early treatment and prevention of clinical complications[7]. Emerging research to establish the benefit of providing secondary prophylaxis to all patients with latent RHD4, might further benefit an RHD high-endemic country like Nepal, if there is a well-managed and operative echo screening system in place.

The following factors will need to be determined for an expanded latent RHD detecting echo screening system: feasibility of training the non-experts, the target audience, devices that can be used in rural settings, assessment of adequate training, and use of simplified echo criteria for diagnosis of latent RHD[3].

a) Feasibility and assessment of training with simplified criteria in non-experts (e.g. Paramedics and nurses):

Training non-experts has been successfully implemented for other aspects of secondary prophylaxis such as delivering Benzathine Penicillin G (BPG) in the RF/RHD control Program. Effective training and support had ensured that over 90% of paramedics who had earlier refused to inject BPG due to fear, agreed[30].

The feasibility of training non-expert health workers in a resource-limited setting has been a keenly studied option all over the world. One such study of an 8-week training program in Fiji, designed to train health workers without any prior experience in focused echocardiography for RHD screening, concluded that such training is feasible in settings with limited resources[12]. Another study done from the same country which consisted of a week-long workshop, followed by 2 weeks of supervised field experience demonstrated that nurses can follow a protocol to undertake rheumatic heart disease echocardiography in a developing country with fair accuracy[13].

An RHD screening in Uganda performed by nurses trained on handheld echocardiography (HAND) using a simplified screening approach had reasonable sensitivity and specificity when compared with the reference standard portable echocardiography (STAND)[15].

Another study conducted in New Caledonia, a territory with a high prevalence of RHD, used focused cardiac ultrasound (FCU) as a reference approach for RHD screening in a school children population by mobilizing non-expert staff (2 nurses with specific training) using a pocket-sized echocardiography machine with a simplified set of echocardiographic criteria. It concluded that FCU by non-experts using pocket devices is feasible and yields acceptable sensitivity and specificity for RHD detection when compared with the standard approach, which could be utilized in a resource-limited setting[14].

Various studies in Mozambique[20], Uganda[16], Brazil[18] have also utilized simplified criteria for echocardiography screening to determine RHD prevalence.

A major concern is that the 2012 WHF criteria for echocardiographic diagnosis of RHD[5], are far too complicated for non-expert training. WHF diagnostic guidelines also require continuous wave (CW) Doppler, which is not currently available with HAND[5,15]. Thus, a simplified approach for HAND using combined criteria of mitral regurgitation jet length $\geq$ 1.5 cm or any aortic insufficiency was explored, which showed a high sensitivity for definite RHD21, and had acceptable sensitivity and specificity for non-experts[15].

In a more recent study in 2019, Nunes et al., have identified the five key components of the WHF criteria that have the strongest predictive value for definite RHD and introduced a simpler criterion that requires hand-held ultrasound without spectral Doppler[7,24].

While this simplified score is relatively new and awaits validity, it is highly accurate in recognizing definite RHD and will also be easier to use for rural screenings. It can classify children with latent RHD into low, intermediate, or high-risk groups based on echocardiographic features at diagnosis, which will potentially help explain individual disease progression and outcome to the child and family. Furthermore, it might potentially also help influence the need for secondary prophylaxis[7,24].

b) Target audience: Under the NHF guidelines, the target audience for screening by echocardiography in Nepal are the school-going children of age group five to 15 years[29,30].

c) Devices used in rural settings: Compared to echocardiographic examination, the accuracy of cardiac auscultation is poorer40-42 RHD screening programs using portable echocardiography or handheld machines with simplified criteria for screening in remote areas have consistently shown an acceptable value for RHD screening[16-19].

Definite RHD (either A, B, C, or D) Age ≤ 20 years	Definite RHD (either A, B, C, or D) Age > 20 years
A. Pathological MR and at least two morphological features of RHD of the MV	A. Pathological MR and at least two morphological features of RHD of the MV
B. MS mean gradient ≥ 4 mmHg	B. MS mean gradient ≥ 4 mmHg
C. Pathological AR and at least two morphological features of RHD of the AV	C. Pathological AR and at least two morphological features of RHD of the AV
D. Borderline disease of both the MV and AV	D. Borderline disease of both the MV and AV
Borderline RHD (either A, B, or C)	**Borderline Not Applicable to Those Age >20 Years**
A. At least 2 morphological features of RHD of the MV without pathological MR or MS	
B. Pathological MR	
C. Pathological AR	
Pathological MR	**Pathological AR**
Seen in two views	Seen in two views
In at least one view, jet length ≥ 2 cm	In at least one view, jet length ≥ 1 cm
Velocity ≥ 3 m/s for one complete envelope	Velocity ≥ 3 m/s in early diastole
Pan-systolic jet in at least one envelope	Pan-systolic jet in at least one envelope
MV Morphological Features	**AV Morphological Features**
AMVL thickening ≥ 3 mm (age ≤ 20 years), ≥4 mm (age 21–40 years), ≥5 mm (age > 40 years)	Irregular or focal thickening
Chordal thickening	Coaptation defect
Restricted leaflet motion	Restricted leaflet motion
Excessive leaflet tip motion during systole	Leaflet prolapse

RHD, rheumatic heart disease; MR, mitral regurgitation; MV, mitral valve; MS, mitral stenosis; AR, aortic regurgitation; AV, aortic valve; AMVL, anterior mitral valve leaflet.

Figure 1: World Heart Federation criteria for diagnosing RHD (Reményi et al.) [5]

Variable	β-coefficient	SE	*Z* value	*p*-value	Points
Mitral Valve					
Anterior leaflet thickening	2.941	0.597	4.922	<0.0001	3
Excessive leaflet tip motion	3.102	0.543	5.716	<0.0001	3
Regurgitation jet length ≥ 2 cm	5.601	0.705	7.941	<0.0001	6
Aortic Valve					
Irregular focal thickening	4.460	0.970	4.597	<0.0001	4
Any regurgitation	4.794	0.718	6.679	<0.0001	5

SE, standard error.

Figure 2: Simplified echocardiography scoring system (Nunes et al.)[7]

Limitation And Possibilities

Latent RHD has a variable natural history according to their environmental exposure to streptococcal infections, genetics, age at diagnosis, and other factors. While echocardiography screening can detect RHD in asymptomatic individuals, the efficacy of initiation of secondary prophylaxis in such latent borderline RHD cases is unproved and is still being studied. However, screening of latent RHD is advocated in RHD endemic areas where early detection by echo screening can alleviate a massive burden on morbidity and mortality in the future.

Furthermore, for training to be effective, accurate detection of latent RHD must be explored after optimal training for nurses and paramedics with the development of a structured training curriculum and standardized competency testing. If the screening is done by paramedics in remote setting where experts are in scarcity, then referral of the patient to experts can be done. The definite RHD cases which are then diagnosed can be sent for secondary prophylaxis. The borderline RHD cases could be evaluated in detail using STAND. Thus, a collaboration between the health ministry, heart foundation, cardiologists, physicians, and other health staff involved in the screening program will be required, along with telemedicine wherever necessary.

Conclusion

Presently in Nepal, echocardiography screening program is possible only if we recruit non-experts after training them in focused echocardiography with the use of simplified echo criteria for detecting latent RHD. This tool should be evaluated for its efficacy in rural settings. The experience from similar parts of the world shows that it is a feasible and necessary task for a country like Nepal where the RHD burden is high. This program would help us better understand the prevalence in a largely unscreened rural population for the formulation of National Health Programs on RHD better targeted to cater to the most affected demographics. With further evidence, this could also be used effectively to provide secondary prophylaxis and largely prevent severe valve damage in RHD cases.

Training non-experts (e.g. nurses and paramedics) to perform RHD screening using simplified protocols in the rural setting is a more immediate cost-effective fix in a resource-constrained setting like Nepal. Expanding a national RF/RHD program to include cost-effective and efficient options for widespread latent RHD screening in this area is the need of the hour.

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