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CLINICAL APPROPRIATENESS OF REFERRALS TO THE ECHOCARDIOGRAPHY CLINIC AT THE CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL

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A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg in partial fulfillment of the requirements for the degree of Master of Public Health.

Johannesburg, 2017

DECLARATION

I, Farai Dube, declare that this research report is my own work. It is being submitted for the degree of Master of Public Health at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

_____

Signed on this 15 day of June, 2017

DEDICATION

I dedicate this research report to:
My late father Kenneth James Dube, who not only modeled a great love for life and others, but also taught me to strive to give my best at all times and my mother Gloria Dube.

The love of my life, my wife Portia Stembiso Dube (without whose love and support I would have not completed this work) and my children Joshua Nkosinathi and Eliana Shona Dube.

All of them make everything good, perfect and worth fighting for.

With God on my side nothing is impossible.

ABSTRACT

Background

South Africa is grappling with a quadruple burden of disease, and cardiovascular diseases with other non-communicable diseases are on the increase. Echocardiography is an expensive but vital basic screening and diagnostic tool for cardiac patients. Appropriate use criteria (AUC) have been developed for echocardiography to assist with avoiding unnecessary echocardiograms.

Aim and Objectives of the study

The aim of the study was to determine the clinical appropriateness of referrals to the echocardiography clinic at Chris Hani Baragwanath Academic Hospital using AUC. The specific objectives were:

1. Describe the socio-demographic profile of patients referred for echocardiography
2. Determine the clinical appropriateness of echocardiography referrals
3. Describe the clinical profile of patients referred for echocardiography
4. Determine whether socio-demographic and clinical profile influence the appropriateness of echocardiography referral

Methods

During July 2015, a cross-sectional study was conducted among all new patients referred to the echocardiography clinic at the Chris Hani Baragwanath Academic Hospital (CHBAH). Following informed consent, patient demographic information was collected. Clinical and echocardiography reports were obtained for all new patients and analyzed, using the 2011 AUC criteria for echocardiography.
The data were analysed using Minitab version 16.

Results

The majority of the study participants (n=270) were black African (88.3%); they had a mean age of 53 years (SD ±16.6) and 63.1% were female. The study found that 93.3% of new patients were appropriately referred, 3.7% (n=10) were inappropriately referred and 3.0% (n=8) had uncertain indications for echocardiography. Hypertension 45.5% (n=123/270) was the most common

clinical diagnosis on echocardiogram request, with the post-echocardiogram evaluation confirming that 41.6% (111/267) of all the patients had hypertensive heart disease. An HIV positive status was documented in only 10.6% (n=29) of the patients.

Conclusion

The AUC is a useful tool and yielded similar results at the CHBAH. There is a high burden of hypertensive heart disease in this population, which requires specific prevention strategies.

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I wish to express my sincere appreciation and gratitude to my supervisor, Professor Laetitia Rispel, without whose encouragement, guidance and extensive support I would have not completed this research report.

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Finally, I thank my God for bountiful mercies and grace, for giving me the opportunity, wisdom and strength to complete this research report and bringing me this far.

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ACRONYMS & ABBREVIATIONS

ACS	Acute coronary syndrome
AIDS	Acquired immune deficiency syndrome
ARF	Acute rheumatic fever
APC	Atrial premature contraction
AUC	Appropriate Use Criteria
CABG	Coronary artery bypass grafting surgery
CAD	Coronary artery disease
CHBAH	Chris Hani Baragwanath Academic Hospital
CMJAH	Charlotte Maxeke Johannesburg Academic Hospital
CMR	Cardiovascular magnetic resonance
CRT	Cardiac resynchronization therapy
CT	Computed tomography
ECG	Electrocardiogram
DALYs	Daily adjusted life years
HF	Heart Failure
HIV	Human Immunodeficiency Virus
ICD	Implantable cardioverter-defibrillator
LBBB	Left bundle branch block
LMICs	Low and middle-income countries
LV	Left ventricular
MI	Myocardial infarction
NCD	Non-communicable Disease
PCI	Percutaneous coronary intervention
PHC	Primary health care center
PLHIV	People living with HIV
RF	Rheumatic fever
RHD	Rheumatic heart disease
SPECT MPI	Single-photon emission computed tomography myocardial perfusion imaging
STEMI	ST-segment elevation myocardial infarction

SVT	Supraventricular tachycardia
TEE	Trans-esophageal Echocardiography
TIA	Transient ischemic attack
TIMI	Thrombolysis in Myocardial Infarction
TTE	Transthoracic Echocardiography
VPC	Ventricular premature contraction
VT	Ventricular tachycardia
UK	United Kingdom
USA	United States of America
3DE	Three-dimensional Echocardiography

CHAPTER 1: INTRODUCTION AND LITERATURE REVIEW

1. Background

Non-communicable diseases (NCDs) constitute a major and growing public health problem (Murray and Lopez, 2013). NCDs are diseases or conditions that affect individuals over an extended period of time, and for which there are no known causative agents that are transmitted from one individual to another (Murray and Lopez, 2013). The 2010 global burden of disease study found that NCDs such as ischemic heart disease and stroke, were among the top ten causes of disability adjusted life years (DALYs) lost (Murray and Lopez, 2013). In 2015, the World Health Organization (WHO) estimated around 38 million NCD deaths each year, the majority (28 million) occurring in low- and middle-income countries (LMICs) (WHO, 2015). According to WHO projections, the total number of deaths from NCDs will increase to 55 million by 2030 if no decisive action is taken to prevent such deaths (WHO, 2013).

South Africa is grappling with a heavy, quadruple burden of disease, namely maternal and child illnesses; infectious diseases such as Human Immunodeficiency Virus (HIV) and tuberculosis (TB); NCDs such as cardiovascular diseases and diabetes; and violence and injuries (Coovadia et al., 2009). NCDs are on the increase due to a combination of demographic, epidemiological, environmental and dietary factors (Spires *et al.*, 2016). Furthermore, the success of the country's HIV treatment program means that people living with HIV (PLHIV) are surviving longer. Cardiovascular disease alone or as a consequence of HIV illness and its treatment as well as other lifestyle diseases are on the rise (including hypertension, diabetes, cancers and chronic respiratory diseases) (Becker *et al.*, 2010). More and more Africans are presenting for care for acute coronary syndromes (ACS) at younger ages (Becker *et al.*, 2010). At the same time, the health care system is not well equipped to deal with the demands of chronic disease care and treatment (Hofman, 2014). This is exacerbated by the high burden of valvular heart disease

due to rheumatic heart disease (RHD), especially in rural and poor urban communities.

Globally rheumatic fever and rheumatic heart disease (RF/RHD) is the most common cardiovascular disease in children and young adults affecting about 15.6 million people worldwide with 282 000 new cases and 233 000 deaths each year (Robertson *et al.*, 2006). The widespread use of penicillin for the treatment of streptococcal pharyngitis and improvement in living conditions, has led to a dramatic decline in incidence and prevalence of RF/RHD in high-income countries.

There is a dearth of information on RF/RHD in LMICs (Carapetis *et al.*, 2005). The 2012 echocardiographic screening program in school-aged children found a prevalence of 4.9 per 1000 in Uganda, 2.3 per 1000 in Mozambique and 0.9 per 1000 in India (Roberts *et al.*, 2013). In South Africa, national prevalence data on RF/RHD is not available. A 1972 clinical study in Soweto, Johannesburg found a prevalence of 7.1 per 1000 schoolchildren, while a 1984 study in Inanda, Durban found a prevalence of 1.0 per 1000 schoolchildren (Robertson *et al.*, 2006). A study undertaken in 2006 and 2007 by the adult Division of Cardiology at Chris Hani Baragwanath Academic Hospital (CHBAH) found a high incidence of new patients (23.5 per 100 000) presenting with RHD for the first time (Sliwa *et al.*, 2010). The median age of diagnosis of RHD was 41 (interquartile range of 30-55) in males and 42 (interquartile range 31-55) in females (Sliwa *et al.*, 2010). In contrast there has been a noticeable decline in the pediatric population of acute rheumatic fever (ARF) at the same hospital over the past two decades (Cilliers, 2014).

At a population level, the screening for RHD has been enhanced by the evolution of echocardiography with its greatly improved sensitivity (Roberts *et al.*, 2013). This has led to widespread request for the use of echocardiography to screen school going children for RHD during the period from 2007 to 2012. However, concerns have been raised about the specificity of echocardiography since the interpretation of minor abnormalities is posing new challenges (Roberts *et al.*,

2013). These include mild mitral regurgitation which may be normal in young children.

Although prevention remains the cornerstone of public health measures to reduce the disease burden of ARF and RHD (Robertson *et al.*, 2006), secondary antibiotic prophylaxis aims at preventing recurrent attacks of ARF, which is a major risk factor of RHD. However, despite the existence of Department of Health secondary prophylaxis guidelines (Republic of South Africa), adherence to these guidelines has been suboptimal (Robertson *et al.*, 2005). In light of the declining incidence of ARF in South Africa, echocardiographic screening has been suggested for the diagnosis of RHD (Cilliers, 2014), because echocardiography would diagnose asymptomatic or sub-clinical RHD in patients who could be targeted for secondary antibiotic prophylaxis.

If the above interventions do not yield the desired results during childhood and early adulthood these patients present in late adulthood with established rheumatic valvular heart disease, with the majority of them requiring expensive, high risk cardiothoracic surgical intervention. Furthermore, some referred patients present too late to hospital when very little can be done from a clinical perspective to assist them.

This situation is exacerbated by the large number of patients awaiting surgical intervention at the cardiothoracic surgery department at the Charlotte Maxeke Johannesburg Academic Hospital (CMJAH) in Gauteng Province (Papo, 2013). In 2015, almost half of these patients awaiting surgery were referred by the Division of Cardiology at the CHBAH. Many of these patients awaiting surgery will not have their operations timeously with devastating consequences, which include recurrent hospital admissions, complications and death. The situation is further complicated by complaints from cardiologists in the Division of Cardiology at CHBAH of unnecessary, inappropriate and excessive referrals to the echocardiography clinic, which put medical and nursing staff under undue pressure. This is because the echocardiography clinic does the initial assessment of the majority of patients who need cardiology services, prior to

their referral to other specialist clinics within the CHBAH, or back to their respective hospitals and primary health care (PHC) clinics.

In light of the challenges highlighted above, the aim of this study was to examine the clinical appropriateness of referrals to the echocardiography clinic at the CHBAH, in order to make recommendations on:

- The possible development or revision of referral criteria to the Echo clinic to ensure that the diagnostic tool of echocardiography is used appropriately and cost-effectively;
- Possible strategies to reduce missed opportunities for secondary prevention of cardiac complications due to RF/RH.

The remainder of this chapter sets the scene for the study that was conducted by describing the study setting, outlining the problem statement, presenting a review of existing literature, and summarizing the rationale for the study. The chapter concludes with the study aim and objectives.

1.2 Study Setting

The setting for the study was the echocardiography clinic in the Division of Cardiology at the CHBAH.

CHBAH is one of South Africa's ten central hospitals, and one of the four central hospitals in Gauteng Province (Don-Wauchope et al., 2010). It is one of South Africa's busiest central hospitals, the world's third largest hospital, and one of the teaching hospitals of the University of the Witwatersrand, Johannesburg. The hospital occupies 173 acres of land, and has 3 200 beds and about 6 760 staff members. Every year about 150 000 inpatient and 500 000 outpatient cases are recorded.

The Department of Medicine admits around 120 patients per day and is one of the busiest in the country. Within the Department of Medicine, the Division of Cardiology of the CHBAH is a referral center for the estimated Soweto population of 1.2 million, Southern Gauteng, Heidelberg and parts of the North West

Province. The division is also a referral center for other sub-Saharan African countries, notably Swaziland, Lesotho, Zimbabwe and Botswana. The majority of patients who need cardiology services are referred to the echocardiography clinic for initial assessment, and then referred to other specialist clinics within the Division of Cardiology or back to their respective hospitals and PHC clinics for follow up. Echocardiography clinic referral criteria are communicated to referring clinicians periodically and on a per need basis because junior medical staff i.e. registrars, medical officers and interns rotate within different divisions at least every four months.

The red star on the map in Figure1.2 below shows the approximate location of the CHBAH in Soweto, Gauteng Province.



Figure 1.2: Map of Gauteng (2016)
(Source: www.places.co.za)

At the time of the study, the researcher was a cardiology fellow in the Division of Cardiology at CHBAH, providing clinical care in both the medical wards, and consulting patients in the echocardiography clinic.

1.3 Problem statement

The study was premised on the following:

1. There is a dearth of information on the socio-demographic and/or clinical profile of patients referred to the echocardiography clinic.

2. There is a lack of information on the clinical appropriateness of referrals to the echocardiography clinic at the CHBAH.

3. As the CHBAH is a tertiary referral center, there are a lot of patient referrals to the echocardiography clinic, resulting in long patient waiting times and heavy staff load, at times frustration as well as conflict among the referring clinicians on the one hand, and staff at the echocardiography clinic on the other hand. This is exacerbated by the perceptions among echocardiography clinic staff that there are a lot of inappropriate referrals to the clinic.

1.4 Literature Review

1.4.1 *Definition of terms*

Echocardiogram

An echocardiogram is the use of ultrasound to study the structure and function of the heart and the blood vessels (Armstrong, 2010). It is routinely used in the diagnosis, management and follow-up of patients with suspected or known cardiac disease (Armstrong, 2010). Types of tests that are performed typically include trans-thoracic echocardiography (TTE), trans-esophageal echocardiography (TEE) and three-dimensional echocardiography (3D E).

Appropriate use criteria for echocardiography

Appropriate use criteria (AUC) are a set of criteria developed by the American College of Cardiology Foundation in response to the dramatic growth rate of cardiac imaging and concerns about excessive utilization (Douglas *et al.*, 2007). They are meant to eliminate unnecessary testing and promote optimal patient care (Douglas *et al.*, 2007). They were initially developed in 2007 and then revised in 2011 (Douglas *et al.*, 2007). Prior to 2007 there was no validated tool to guide echocardiography requests and use. Echocardiography is a high cost

diagnostic imaging modality and the appropriateness of its use improves the overall quality of service rendered to the patient.

AUC of echocardiography are scored on a scale of 1 to 9, with 7 to 9 deemed appropriate use, 4 to 6 uncertain use and 1 to 3 inappropriate use (Douglas *et al.*, 2007). These criteria are meant to guide the rationale use of echocardiography. The table below shows the various categories of echocardiography use and Appendix 7 is a full list of the criteria and their scoring.

Table 1.4.1: Appropriate Use criteria categories

	Appropriate Use Criteria Categories
1	TTE for general evaluation of cardiac structure and function
	Suspected Cardiac Etiology-General with TTE
	Arrhythmias with TTE
	Light-headedness/Pre-syncope/Syncope with TTE
	Evaluation of Ventricular Function with TTE
	Perioperative Evaluation with TTE
	Pulmonary Hypertension with TTE
2	TTE for Cardiovascular evaluation in an Acute setting
	Hypotension or Hemodynamic Instability with TTE
	Myocardial Ischemia/Infarction with TTE
	Evaluation of Ventricular Function after ACS with TTE
	Respiratory Failure with TTE
	Pulmonary Embolism with TTE
	Cardiac Trauma with TTE
3	TTE for evaluation of valvular function
	Murmur or Click with TTE
	Native Valvular Stenosis with TTE
	Native Valvular Regurgitation with TTE
	Prosthetic Valves With TTE
	Infective Endocarditis (Native or Prosthetic Valves) With TTE
	TTE for evaluation of intra-cardiac and extra-cardiac structures and chambers

	Appropriate Use Criteria Categories
	TTE for evaluation of aortic disease
4	TTE for evaluation of hypertension, HF, or cardiomyopathy
	Hypertension With TTE
	HF With TTE
	Device Evaluation (Including Pacemaker, ICD, or CRT) with TTE
	Ventricular Assist Devices and Cardiac Transplantation With TTE
	Cardiomyopathies With TTE
	TTE for adult congenital heart disease
5	TEE
	TEE as Initial or Supplemental Test—General Uses
	TEE as Initial or Supplemental Test—Valvular Disease
	TEE as Initial or Supplemental Test—Embolic Event
	TEE as Initial Test—Atrial Fibrillation/Flutter

1.4.2 Studies on clinical appropriateness of echocardiography referrals

In the United States of America (USA), AUC have been evaluated at academic medical centers and community settings and several common themes emerged (Douglas *et al.*, 2007). The majority of clinical scenarios for which TTEs were ordered, were captured by AUC indications (11% to 16% of TTEs were unclassified) (Ward *et al.*, 2008; Willens *et al.*, 2009). Across the implementation studies there are remarkably similar rates of appropriate and inappropriate use of TTE. Among those with an AUC indication the majority were rated as appropriate (87% to 91%) and the rate of inappropriate TTEs was consistently low (9% to 13%).

Ballo *et al* in their 2011 study on AUC criteria in hospitalized patients found that the large majority of echocardiography indications (98.8%) were classifiable according to the AUC with good inter-observer reproducibility (Ballo *et al.*, 2012). In their study, those cases with inappropriate indications were younger and patients were more often referred by non-cardiologists (Ballo *et al.*, 2012). Most causes of inappropriate indications were related to the lack of change in clinical status or the absence of cardiovascular symptoms and signs (Ballo *et al.*, 2012).

Examinations with appropriate or uncertain indications had an impact on clinical decision making more often than those with inappropriate indications (86.7% vs. 14.1%, P<.001) (Ballo *et al.*, 2012).

The study also analyzed a group of discharged patients that were not referred for TTE and found out that TTE might have been appropriate in 16.2% of cases (Ballo *et al.*, 2012). The authors concluded that the application of the AUC criteria were highly feasible in a community setting and recommended strategies to implement the AUC in clinical practice (Ballo *et al.*, 2012).

Ward *et al* (2009) compared the application of AUC for outpatient TTE in academic and community practice in the USA and found the criteria to be feasible (Ward *et al.*, 2009). The study also found that the frequency of appropriate and inappropriate outpatient TTEs to be similar in academic and community practice settings (Ward *et al.*, 2009). There were limitations of using the AUC, suggesting revisions were required to encompass the broad clinical practice of echocardiography in hospital and outpatient settings (Ward *et al.*, 2009). Some of these limitations were addressed in the revised AUC in 2011. Patil *et al* (2012) reported that TTE was appropriate in 82%, inappropriate in 12.3%, uncertain in 5.3%, and non-fitting in 0.4% of the cases studied (Patil *et al.*, 2012).

A study to determine the applicability, limitations and downstream impact of echocardiography utilization based on AUC for trans-thoracic and trans-esophageal echocardiography revealed that implementing AUC had a direct impact, as appropriate studies were significantly more likely to reveal new and major findings, and more likely to result in a patient care intervention based on echocardiography findings (Alqarqaz *et al.*, 2012).

Since the development of AUC published in 2007, the first study done outside the USA was a 2014 study in the United Kingdom (UK). In this UK study, the most common appropriate outpatient indication for echocardiography was “symptoms or condition potentially related to suspected cardiac etiology” (indication 1 in the AUC document), and this constituted 142 studies or 19.8% of all outpatient

studies (Gurzun and Ionescu, 2014). The proportion of appropriate cases was higher among inpatients compared with outpatients (94.4 vs. 83.5%, P <0.005) (Gurzun and Ionescu, 2014).

There is a dearth of studies that have used AUC to examine appropriateness of echocardiography referrals in LMICs or outside the USA or UK (Gurzun and Ionescu, 2014) until 2014.

1.4.3 Studies outside the UK and USA

AI-Kaisey *et al* conducted a study in an Australian regional center and reported 77% appropriate, 20.3% inappropriate, and 2.7 % uncertain TTE indications (AI-Kaisey A, 2015). A 2016 study in Lebanon among 501 eligible patients found that 374 patients (74.66%) were in the appropriate group, 85 patients (16.96%) in the inappropriate group, 20 patients (3.99%) in the uncertain group and 22 patients (4.39%) in the non-fitting category (Rameh and Kossaify, 2016).

The researcher could not find any published studies that have examined the appropriateness of referrals to echocardiography clinics in South Africa. Furthermore, at the CHBAH, the majority of inpatient referrals for TTE are done by non-cardiologists, and there is little information available on the appropriateness of these referrals.

In summary, the literature review found that there is a dearth of the studies on the clinical appropriateness of echocardiography referrals, using the AUC, especially in LMICs. The studies that have used the AUC are shown in Table1.4.3.

Table 1.4.3: Summary of studies that have assessed the clinical application of AUC in echocardiography

	Author and year of publication	**No. of Patients**	**Setting**	**AUC version**	**Appropriateness of requests for Echocardiography (%)**				**Comments**
					NC	A	U	I	
1.	Mansour *et al.,*	2247 (1553 TTE)	USA Academic	2011	2	82	7	11	Abnormal findings more common in **A** than in **I** studies
2.	Bhatia *et al.*, 2012	450	USA Academic	2007	11	89	0	11	**I**:30% in academic OPD, 21% in Community OPD, 14% in academic in-patient setting
			Community	2011	2	71	7	22	
3	Bailey *et al., 2012*	1179	USA Regional Hospital	2007	23	83	0	17	93% of undefined studies (2007) could be classified using 2011 AUC
				2011		96.5	0.4	2.4	

	Author and year of publication	**No. of Patients**	**Setting**	**AUC version**	**Appropriateness of requests for Echocardiography (%)**				**Comments**
					NC	A	U	I	
4	Alqarqaz *et al*., 2012	170	USA Academic	2007	13	86	0	1	**A** studies more likely to show new/major findings resulting in patient care or intervention
				2011		77	14	9	
5	Parikh *et al*., 2012	384	USA Academic	2007	14	77	0	9	Revised criteria successful in addressing increased number of clinical conditions
				2011	5.5	92.2	0.5	1.8	
6	Ballo *et al*., 2012	931	USA Community Hospital, in-patient	2007	12.5	86.7	0	0.8	**A** and **U** indications impacted clinical care more often than **I** ones
				2011	1.2	80.3	5	14.7	

	Author and year of publication	**No. of Patients**	**Setting**	**AUC version**	**Appropriateness of requests for Echocardiography (%)**				**Comments**
					NC	A	U	I	
7	Patil *et al*., 2012	1820	USA Academic	2011	0.4	82	5.3	12.3	
8	Gurzun M.M and Inonescu A., 2014	1070	UK Academic in-patient, Regional Hospital	2011		86	3	11	AUC yields similar results to USA
9	Al-Kaisey *et al.,*		Australia Regional Centre	2011		77	2.7	20.3	

	Author and year of publication	No. of Patients	Setting	AUC version	Appropriateness of requests for Echocardiography (%)				Comments
					NC	A	U	I	
10	Rameh *et al.,* 2016	501	Lebanon Academic Hospital	2011	4.39	74.6	3.99	16.9	

Table 1.4.3: Abbreviation references	
A: Appropriate; NC: Not Classifiable; U: Uncertain I: Inappropriate	Acad: Academic hospital; Regional: Regional hospital Comm: Community hospital; in-pts: In-patients OPD: Outpatients department.

(Mansour et al., 2012, Bhatia et al., 2012, Bailey et al., 2012, Alqarqaz et al., 2012, Parikh et al., 2012, Ballo et al., 2012, Patil et al., 2012, Gurzun and Ionescu, 2014, AI-Kaisey A, 2015, Rameh and Kossaify, 2016)

1.5 Justification for this study

There were several reasons for conducting a study on the appropriateness of echocardiographic referrals to the Division of Cardiology at CHBAH. Firstly, this is a resource-limited environment where the utilization of resources has to be optimized, to prioritise only those who will derive the most benefit to access echocardiography. Secondly the study findings will provide a baseline for service monitoring for the team working in the echocardiography clinic at CHBAH, to assist them in their future training and guideline development initiatives.

Since the development of the AUC criteria, their appropriateness and validity in a resource-limited setting outside the USA, UK, Australia and Lebanon have not been tested. This study will begin to address the knowledge gap, with useful insights for similar study settings, both in South Africa, and other LMIC settings.

1.6 Aim and Objectives

The aim of the study was to determine the clinical appropriateness of referrals to the echocardiography clinic at the CHBAH. The specific objectives of the study were to:

1. Describe the socio-demographic profile of patients referred for echocardiography to the CHBAH;
2. Describe the clinical profile of patients referred for echocardiography;
3. Determine the clinical appropriateness of echocardiography referrals; and
4. Determine whether socio-demographic and clinical profile influence the appropriateness of referral.

The next chapter describes the study methodology.

CHAPTER 2: METHODOLOGY

2.1 Introduction

This chapter describes the overall study approach and methodology used to answer the questions posed in this study.

2.2 Study Setting

The study setting was the echocardiography clinic in the Division of Cardiology at the CHBAH, described in Chapter 1.

2.3 Study Design

This was a cross-sectional, study, conducted at a point in time (July 2015) at the CHBAH.

2.4 Study Population

The study population consisted of all the patients referred to the echocardiography clinic at the CHBAH.

2.5 Study Period

The study period was from 1 July 2015 to 31 July 2015.

2.6 Ethical considerations

Ethical approval was obtained from the Human Research Ethics Committee (Medical) of the University of the Witwatersrand, Johannesburg (Clearance number M150529 shown in Appendix 1a). The Gauteng Department of Health and the Chief Executive Officer of the CHBAH also approved the study (Appendix 1b).

All standard ethical procedures were adhered to. The researcher explained the research process to the support staff working in the echocardiography clinic, especially the importance of the providing information to all patients and obtaining consent for participation in the study. During July 2015, all new patients were informed about the research project and were given a detailed patient information sheet (Appendix 2) upon registration with the echocardiography clinic clerk. For those patients that could not understand the contents of the information sheet, the assistance of a translator was obtained to explain the study. Informed consent was obtained from every patient who participated in the study (Appendix 3).

Participation in the study was voluntary with no direct benefits or penalties for non-participation. After signing consent, participants were given their signed consent forms and advised to give these forms to their attending doctor in the echocardiography clinic. Confidentiality of all information was maintained.

The data capture form did not collect patient's personal or unique identification information and patient confidentiality was maintained. Only the researcher who is a medical specialist had access to all the patients' relevant documents. Once the data was entered into the data capture tool for processing; only the allocated numbers identified the patients and their characteristics.

2.7 Eligibility Criteria

All new patients above the age of 18 years that were referred to the echocardiography clinic for initial assessment were included in the study. Those patients who declined participation or were too sick to give verbal consent on their own were excluded. Other emergency or urgent patients who had been assessed initially in the wards with a portable echocardiography machine and were now sent or referred to the echocardiography clinic for further assessment or verification of echocardiography findings were also excluded from the study.

Patients who attended for repeat or follow up echocardiograms were also not eligible for this study even if they had been lost to follow-up.

2.8 Study Sample

All new patients referred to the echocardiography clinic from the CHBAH referral network during July 2015 and who met the eligibility criteria were included in the study.

2.9 Pilot study

The researcher piloted the data collection sheet with the new patients coming to the clinic in June 2015.

This pilot study assisted the researcher to:

- ensure that the patients understood the information sheet prepared for the study;
- ensure that the clinic staff i.e. clerks and nursing staff also understood the study and where able to explain to patients when asked to clarify;
- ensure that the nursing staff were adequately trained to get the patients to sign the informed consent forms when they came for blood pressure and other basic checkups;
- assess time taken to complete the data collection sheet (Appendix 6), getting information to complete the echocardiography request form (Appendix 4) and echocardiogram report (Appendix 5);
- assess time required for completion of data capture of each data collection sheet into Microsoft Excel to enable future planning for data entry as the study progressed; and
- decide whether to discard or shorten some responses, thereby reducing the time required for fieldwork.

Only minor revisions were made to the data collection form.

2.10 Data collection

Prior to commencement of fieldwork, the researcher set up a meeting at the end of June 2015 with the staff at the echocardiography clinic of the CHBAH to reiterate the purpose of the study, the process to be followed in conducting the study and to enlist their support. The researcher explained that all new patients referred during July 2015 would constitute the study sample. The researcher also rotated through the echocardiography clinic and provided clinical care to patients, and used this opportunity to explain the study to other medical colleagues who were on duty at the echocardiography clinic during the study period.

The first step involved the identification of new patients to the clinic. This was done initially by porters who brought patients to the clinic from the wards, and these new patients were red flagged for inclusion in the study. Also upon registration with the clerks all new patients were identified and given the information sheet for the study. The clerks would also explain to these patients about the study during the registration process.

Patients were then given the opportunity to read the information sheet as they waited for the nursing staff to collect their vital information. The second step involved getting informed consent from the new patients by the clinic nurses during the collection of their vital studies i.e. blood pressure, pulse, weight, etc. This was also an opportunity for the patients to clarify any concerns they had in the privacy of the nurses' consultation area. Patients were required to sign the consent form (Appendix 3) with the nurse and a witness was required for those who gave verbal consent but could not sign the form for various reasons.

Once consent was obtained, the patients waited for their medical consultations and their echocardiograms. Each doctor completed the echocardiography report forms in duplicate. The first copy would normally be stapled into the patient file and the duplicate filed in the clinic by the clerks. The doctors performing the

examinations were asked to collect the consent forms, echocardiography requests and then attach them to the duplicate, which would then be filed. At the end of each clinic, the clerks were required to make copies of these duplicate echocardiography reports and then file both the original documents as well as the copy with the consent form and echocardiography request form for each patient in a separate study file.

At the end of each week the researcher collected all echocardiography forms and requests from the study file, and completed the data collection sheet for each patient (Appendix 6). He also classified each echocardiography request as appropriate, inappropriate or uncertain according to the 2011 AUC criteria (Appendix 7) on the data collection form. Where multiple echocardiography indications could be applied, the indication with the strongest level of appropriateness was selected. However, some patients did not have clear indications for echocardiography and also lacked other pertinent clinical information as documents were lost or were not appropriately completed for various reasons, and these patients were excluded from the final analysis. Figure 2.10.1 summarizes the approach to data collection used in the study.

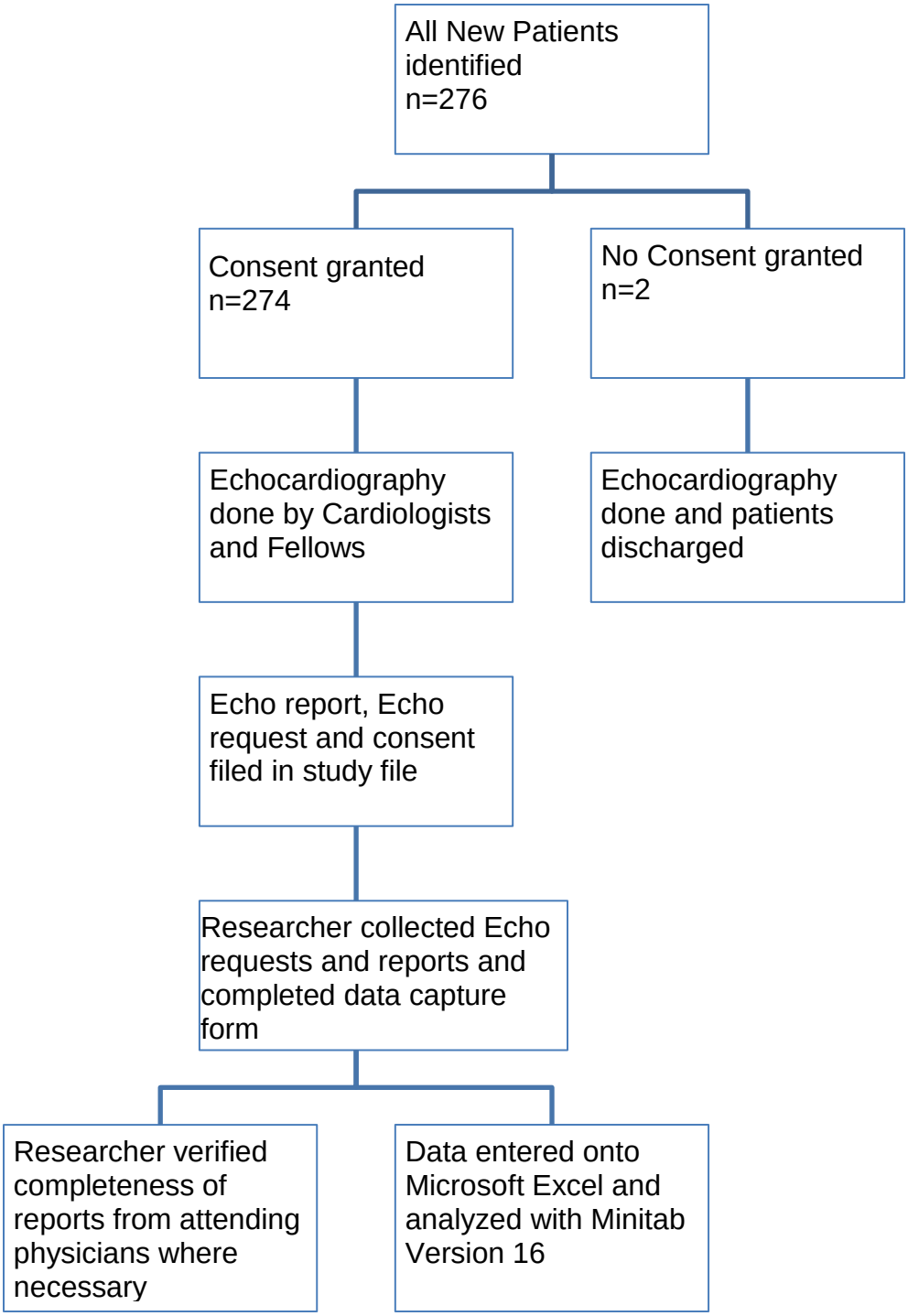


Figure 2.10.1: Summary of data collection and processing

2.11 Data Analysis

All data were collected and kept in a safe storage area, and once all the data had been collected it was entered into a Microsoft Excel spreadsheet for processing, and the spreadsheet was uploaded to Minitab version 16 for analysis.

Descriptive analysis included the calculation of numbers, means and frequencies of some of the following patient characteristics;

a. Demographic information - age, sex, and race, etc.

b. Diagnoses, presenting symptoms, referral information

c. Clinical indications for echocardiography

d. Echocardiography laboratory assessment

e. Referral (e.g. health professional category of referring person, type of facility, etc.)

f. Appropriateness of referral according to the AUC

Multivariate analysis was also done to determine whether some of the socio-demographic variables affected the appropriateness of referral and use of echocardiography.

2.12 Study Limitations and Remediation

This data collection was limited to the month of July 2015 and the new patients that were referred and presented on their booked day for echocardiography during this time. The selection of one month might have introduced bias, as seasonal variations could not be taken into account. However, July is not an unusual month for referrals to the echo clinic and some of the patients had been booked months earlier for their echocardiograms. Furthermore, the selection of the month was influenced by study approval processes, logistics and budgetary considerations.

The AUC have not been validated or used in a resource-limited African setting with a different disease profile, health infrastructure, level of resources, and social context to the USA. HIV and its related cardiac disease and its treatment complications are more common in the South African environment, and no specific criteria addressing this specific group of people have been developed and included in AUC. Although this study begins to address the gap of the AUC in a resource-limited hospital environment, further research is needed to adapt the criteria and to develop a more inclusive tool for resource limited settings.

Another source of ascertainment bias was introduced by the researcher assessing the appropriateness of referral using the criteria, especially in patients who had missing information, and echocardiography indications had to be inferred from the clinical history in the absence of explicitly stated indications. A different researcher might have reached a different clinical assessment. To deal with this bias, the researcher excluded those patient records with insufficient information from the analysis. Furthermore, the researcher who has the skills as a cardiology fellow is the only person who assessed the appropriateness of referrals, thus reducing inter-assessor variation.

The limitations of the use of medical records included the following:

- Incomplete records and inability to communicate with referring medical personnel to get clarity as some of the patients were referred from more than four months ago for echocardiograms, and their clinical conditions might have either improved or deteriorated during the waiting period. So the initial echocardiography indication might have changed.
- Illegibility of writing or failure to obtain good copies of echocardiography reports if the duplicates were of a poor quality.

The sample size also limited the type of analysis that could be done in the study as it was difficult do multiple logistic regression analysis because of the small number of inappropriate referrals found in the study.

However, the study has numerous strengths. It was the first study to focus on echocardiography appropriate use at CHBAH and in South Africa. Its findings will provide a basis for future research on AUC and on the possible revision of the criteria used in the tool for resource-limited settings. The study findings will also assist with the training of medical staff in the hospital on AUC, and help them to reflect on referral practices, and quality of information included in the referral forms.

All ethical guidelines were followed and the researcher took specific steps to minimize bias. The researcher reviewed the echocardiography requests and echocardiography reports and did the data entry to ensure data quality to limit individual variability.

The results of the study are discussed in the next chapter.

CHAPTER 3: RESULTS

3.1 Introduction

In this we study recruited 274 participants with only 2 patients refusing to be part of the study; hence a 99.3% response rate was obtained. Clinical echocardiography indication information was missing from four records. These records were excluded from the final analysis. Hence the final sample for analysis was 270.

3.2 Demographic and social profile

The majority of the study participants 63.1 % (n=173) were women, and 88.3% (n=242) black African (Table 3.2.1). The mean age of patients was 53.2 years (SD ±16.6) years. The mean age of female patients was 53.9 (SD ±17.0) years and for males 51.9 (SD ±16.0) years. Table 3.2.1 shows the socio-demographic profile of all the new patients referred to the echocardiography clinic for the study period and included in the study.

Table 3.2.1: Socio-demographic characteristics of the study participants

Characteristic	**Female**	**Male**	**Total**
Number (%)	160 (63.1)	100 (36.9)	260 (10 missing Gender)
Mean age (Standard Deviation)	53.93 (17.0)	51.91 (16.0)	53.2 (16.6)
Age group (%)			
<20 years			11 (4.1)
21-30 years			20 (7.5)
31-40 years			30 (11.2)
41-50 years			41 (15.4)
51-60 years			69 (25.8)
61-70 years			58 (21.7)
71-80 years			29 (10.9)
>80 years			9 (3.4)
Race			
Black African (%)	154 (63.6)	88 (36.4)	242 (88.3)
Coloured (%)	3 (60.0)	2 (40.0)	5 (1.8)
Indian (%)	4 (66.7)	2 (33.3)	6 (2.2)
White	12 (57.1)	9 (42.9)	21 (7.7)

3.3 Clinical profile of new echocardiography patients

3.3.1 Clinical diagnosis

Before referral to the echocardiography clinic the treating clinicians evaluated patients and reached a clinical diagnosis on which they based their referral.

The most common clinical diagnosis in the study population was hypertension with 123 (44.5%) of the patients having hypertension as one of their clinical diagnosis, followed by congestive cardiac failure in 60 (22.2%) of the patients. Pre-chemotherapy patients referred for baseline echocardiography were 27 (10.0%). Only 12 (4.4%) patients were referred for suspected valvular heart disease and only 29 (10.7%) retro-positive patients had their HIV status documented on the request form. Table 3.3.1 shows the documented clinical diagnosis on the echocardiography request forms. The clinical diagnoses (n=499) exceed the number of patients (n=270) as some patients had more than one clinical diagnoses recorded. However, the percentages in Table 3.3.1 are expressed on the total number of patients.

Table 3.3.1: Clinical Diagnoses recorded *

Clinical Diagnosis	Count	%
Shunt? ASD/VSD	1	0.4
Anemia	7	2.6
Arrhythmia	8	3.0
Atrial Fibrillation	18	6.7
Cancer for Chemotherapy	27	10.0
Cardiomyopathy	21	7.8
Congestive Cardiac Failure (CCF)	60	22.2
Chronic Kidney Disease	24	8.9
Congenital Heart Disease	1	0.4
Connective Tissue Disease	15	5.6
Chronic Obstructive Pulmonary Disease (COPD)	13	4.9
Coronary Syndrome	20	7.4
Cerebrovascular Accident (CVA)	19	7.0
Diabetes	30	11.1
Exclude cardiac disease	3	1.1
Gangrene? Embolic Phenomena	8	3.0
Heart Block	3	1.1
Hypertension	123	45.6
Metabolic Syndrome	5	1.9
Pericardial Disease	4	1.5

Clinical Diagnosis	Count	%
Postpartum Cardiomyopathy	4	1.5
Pulmonary Hypertension	30	11.1
Retroviral Disease	29	10.7
Valvular Heart Disease	12	4.4
Other	14	5.2
Total	499	100

* One patient could have more than one clinical diagnosis

From Table 3.3.1 above the most common indication for echocardiogram was indication #67 “Initial evaluation of suspected hypertensive heart disease”. However at presentation to the echocardiography clinic the systolic BP was 132.4 mmHg and the diastolic blood pressure of 83.1 mmHg and a pulse rate of 86.0 bpm. These patients had already been started on treatment in the ward or from the referral clinic. The average waiting time from echocardiography booking and presentation to the echocardiography clinic was 6.6 days for inpatients and 8.0 days for outpatients. The echocardiography clinic recorded blood pressures were done when most of the patients had been on treatment for at least 5 days.

3.3.2 Echocardiogram assessment

Upon completion of the echocardiograms the cardiologists and fellows were able to make a definitive echocardiogram assessment in 267 patients. Since some of these patients had multiple comorbidities, a total of 308 echocardiography assessments were done. The remaining seven patients were either referred for repeat studies or TEEs or were to be followed up by the senior consultants in the unit for verification of echocardiography findings before an assessment was made. Table 3.3.2 summarizes the final echocardiography assessments.

Table 3.3.2: Echocardiographic Assessment

Echocardiographic Assessment	Count	%
Atrial Fibrillation with Rapid Ventricular Response	5	1.9
Aortic Valve Disease	11	4.1
Cardiomyopathy	51	19.1
Cor-Pulmonale	17	6.4
Coronary Syndrome	5	1.9
Good LV Systolic Function	6	2.3
Hypertensive Heart Disease	111	41.6
Mitral Valve Disease	10	3.8
Myocarditis	1	0.4
No Cardio-embolic Source found	1	0.4
Normal Study	60	22.5
Pericardial Disease	8	3.0
Post-partum Cardiomyopathy	2	0.8
Pulmonary Hypertension	18	6.7
Rheumatic Heart Disease	1	0.4
Shunt ASD/VSD	1	0.4
Total unique echocardiography assessments	308	100
Total number of patients with echocardiography assessments	270	

Hypertensive heart disease was diagnosed in the majority of patients being 41.6% (n=111). Normal studies were found in 22.5% (n=60) of the referred patients, majority of whom were young mostly HIV positive patients being worked up for cancer chemotherapy and they were 27 in total. Excluding all 27 pre-chemotherapy patients from the 60 normal studies would still leave 10.7% (n=33) patients with normal hearts which means that these patients had not been properly assessed clinically before being referred for echocardiogram. 51 patients (19.1%) had a cardiomyopathy and only one patient (0.4%) was diagnosed with rheumatic valvular heart disease.

3.4 Appropriateness of referral

The majority of referrals (93.3%) were appropriate according to the AUC, 3.7% (n=10) patients were inappropriately referred and 3.0% (n=8) patients had uncertain indication for referral Among the 252 appropriate referrals, the majority 66.3% (n=179) were rated 9, indicating a strong indication for echocardiography with the rest being rated 8 (27.0%, n=73) (see Table 3.4.1 below).

Table 3.4.1: Referral Appropriateness

Appropriateness	**AUC Score**	**Count**	**Percentage**
Inappropriate	2	10	3.7
Uncertain	6	8	3.0
Appropriate Referral (weak indication)	8	73	27.0
Appropriate Referral (strong indication)	9	179	66.3
Total		270	

Comparing the referral site or clinics from where patients were referred from, the results show that, there were 95.3% appropriate referrals from inpatient wards at CHBAH, for example the medical and surgical wards, compared to 75% appropriate referrals from other specialist clinics within the hospital like the diabetic, rheumatology, medical outpatients and surgical outpatients or other private doctors and surrounding hospitals. This analysis was based on 85 inpatient referrals and 16 outpatient referrals that had documented referral site.

3.4.2 AUC used in study

The 2011 AUC has a total of 98 indications for transthoracic echocardiography. In this study only 19 of the 98 were used for this population, meaning that the other 79 indications did not apply to the specific circumstances or environment in which we treat our patients. For example from the categories in Table 1.4.1, category 4 dealing with ventricular assist devices and cardiac transplantation does not apply at CHBAH because the hospital did not supply ventricular assistive devices and was not performing heart transplantation in 2015.

More importantly in this study population the indications used are listed in Table 3.4.2 below. The most common appropriate indications were, (2011 AUC indication #67, score 8): "*Initial evaluation of suspected hypertensive heart disease*" (23.7% n=64) and (2011 AUC indication #70, score 9); "*Initial evaluation of known or suspected HF (systolic or diastolic) based on symptoms, signs, or abnormal test results*" (21.9 % n=60). Appendix 7 gives a full list of the 2011 AUC for echocardiography.

Table 3.4.2: TTE Indications According to 2011 AUC

AUC	Score	Indication description	Count (%)
1	9	Symptoms or conditions potentially related to suspected cardiac etiology including but not limited to chest pain, SOB, palpitations, TIA, stroke, or peripheral embolic event.	24 (8.8)
5	9	Sustained or non-sustained atrial fibrillation, SVT or VT	8 (2.9)
6	2	Asymptomatic isolated sinus bradycardia	1 (0.4)
7	9	Clinical symptoms or signs consistent with a cardiac diagnosis known to cause light-headedness/pre-syncope/syncope (including but not limited to aortic stenosis, HCM or HF)	5 (1.8)
10	2	Initial evaluation of ventricular function (e.g., screening) with no symptoms or signs of cardiovascular disease	5 (1.8)
13	2	Routine perioperative evaluation of ventricular function with no symptoms or signs of cardiovascular disease	2 (0.7)
14	6	Routine perioperative evaluation of cardiac structure and function prior to non-cardiac solid organ transplantation	8 (2.9)
15	9	Evaluation of suspected pulmonary hypertension including evaluation of right ventricular function and estimated pulmonary artery pressure	29 (10.6)
22	8	Evaluation of a patient without chest pain but with other features of an ischemic equivalent or laboratory markers indicative of ongoing MI	10 (3.6)
28	2	Suspected pulmonary embolism in order to establish diagnosis	1 (0.4)
34	9	Initial evaluation when there is a reasonable suspicion of valvular or structural heart disease	9 (3.3)
59	9	Suspected pericardial conditions	3 (1.1)
60	2	Routine surveillance of known small pericardial effusion with no change in clinical status	1 (0.4)
63	9	Evaluation of the ascending aorta in the setting of a known or suspected connective tissue disease or genetic condition that predisposes to aortic aneurysm or dissection (e.g., Marfan syndrome)	1 (0.4)
67	8	Initial evaluation of suspected hypertensive heart disease	64 (23.4)
70	9	Initial evaluation of known or suspected HF (systolic or diastolic) based on symptoms, signs, or	60 (21.9)

AUC	Score	Indication description	Count (%)
		abnormal test results	
86	9	Initial evaluation of known or suspected cardiomyopathy (e.g., restrictive, infiltrative, dilated, hypertrophic, or genetic cardiomyopathy)	14 (5.1)
91	9	Baseline and serial re-evaluations in a patient undergoing therapy with cardiotoxic agents	23 (8.4)
92	9	Initial evaluation of known or suspected adult congenital heart disease	2 (0.7)
No			4 (1.5)
Total			270

There were four patients that could not be classified according to the 2011 AUC criteria and were excluded from the study.

Patient 1 was a 55-year-old female who was found to have cardiomegaly on chest X-ray and symptomatic anemia that was referred from the Medical Outpatients Department. No other clinical information was given on the request. However, the subsequent echocardiography showed a structurally normal heart.

Patient 2 was a 52-year-old male with a history of being on steroids and methotrexate. Clinically he was cushingoid from the steroids and had a history of having bullous lung disease. He was referred from an inpatient ward and the echocardiography showed a normal heart.

Patient 3 was a 22-year-old female being investigated for lupus and had bilateral pleural effusions referred from an inpatient ward. The echocardiography however showed a pericardial effusion and normal systolic function and the cardiologist's impression was that of a possible lupus related serositis.

Patient 4 was a 56-year-old female who was diagnosed with a possible myotonic dystrophy and an echocardiography was requested to rule out cardiac involvement. ECG was normal and the patient had a murmur at the apex.

Echocardiography, however, revealed a pericardial effusion with fibrinous strands suggestive of a TB pericarditis.

3.5 Relationship between socio-demographic profile and appropriateness of referral

From Table 3.4.1 3.7% n=10 patients were inappropriately referred for echocardiogram and 3.0% (n=8) patients had uncertain indications for echocardiograms. This small sample precludes a more detailed analysis of the relationship between socio-demographic profile and appropriateness of referral.

Out of the total population of 270 with referral indications only 263 had the patients age documented on their echocardiography requests or echocardiography report form. Figure 3.5.1 below shows the referral appropriateness according to patient age.

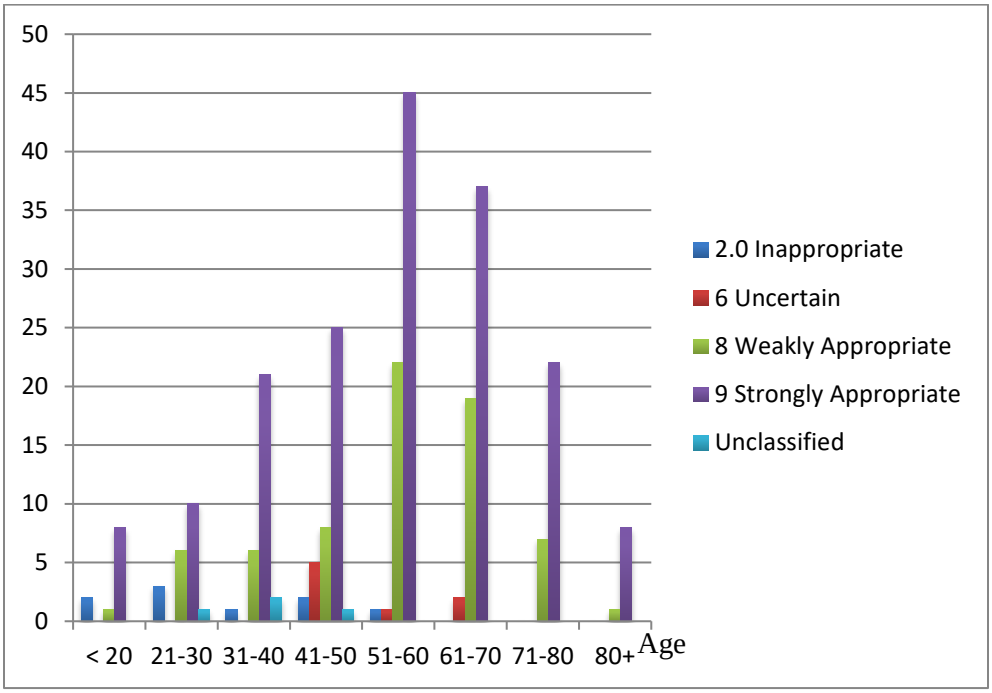


Figure 3.5.1: Referral appropriateness according to patient age

From the Figure 3.5.1 above, inappropriate referrals were mainly in the younger ages and uncertain indications for echocardiogram showed no relationship with

patient ages, whereas there is a discernable normal distribution of weakly appropriate and strongly appropriate indications for echocardiogram for this study population.

3.6 Profile of inappropriate referrals

A total of 10 patients were referred inappropriately: these were young patients ranging from 17 years to 51 years with a mean age of 31 years. Of these inappropriate patient referrals, 80% (n=8/10) of the patients had normal echocardiograms. Some of the common clinical diagnoses in the group include retroviral disease and connective tissue disorders. A clinical profile of the inappropriately referred patients is provided in Appendix 8.

The next chapter will discuss the study findings in light of existing literature and explore the implications of this study. In chapter 5 appropriate recommendations are highlighted as well as possible areas for further investigation.

CHAPTER 4: DISCUSSION

4.1 Introduction

Worldwide there is noticeable trend towards the greater use of technology for clinical diagnosis. Echocardiography is a useful diagnostic tool, which if appropriately utilized can contribute to enhanced diagnosis and lifesaving treatment of patients. On the other hand, potential abuse of echocardiography in a resource-limited setting may prejudice those patients who genuinely require echocardiography for continued management of their cardiovascular conditions. Also, there is the competing cost of performing echocardiography, both on the patients and the health care system. This necessitates that patients coming from home for echocardiography or referred from other hospitals are appropriately referred and the opportunity is well utilized.

This research study explored the appropriateness of referrals to the echocardiography clinic at CHBAH. The remainder of the chapter discusses the findings in light of the study objectives, and the existing literature.

4.2 Socio-demographic profile

The mean age of the CHBAH study population was 53 years, which is lower compared to other similar studies. A study at a teaching hospital in Lebanon had a population with a mean age 65 (Rameh and Kossaify, 2016). Furthermore, the Lebanese study population was predominantly male (59.3%), whereas this CHBAH study population was predominantly female (63.1%) This younger study population at CHBAH may be due to the extra burden imposed by HIV - related cardiovascular diseases and malignancies in young people. This suggests that echocardiography for diagnosis and as an adjunct to chemotherapeutic monitoring may become a necessity in younger people. For example, in our study we had some very young patients who were born with HIV, and are now in their late teens and presenting for assessment of HIV-related malignancies. In

our study, only 10.7% of the patients had an HIV positive status recorded on the request form. This may be because HIV remains highly stigmatized among the CHBAH patient population, or that it was an oversight on the part of clinicians by not recording the HIV status of the patients.

4.3 Clinical profile

Clinical Diagnosis

Hypertension was the most common clinical diagnosis in this population, with 45.6% of patients being diagnosed with it. This highlights the importance of screening for, and treating hypertension in this population from a young age. This is also highlighted further by the fact that some of the other common clinical diagnoses like congestive cardiac failure 22.2% (n=60), chronic kidney disease 8.9% (n=24), cerebrovascular disease 7.0% (n=19) and atrial fibrillation 6.7% (n=18) are hypertension-related (see table 3.3.1). Diabetes, the other common NCD, was found in 11.1% (n=30) of the patients. Hypertension and diabetes have been well described in this population and their economic effects are well elucidated (Hofman, 2014).

The other major clinical problem in the CHBAH population is HIV and 29 patients (10.7%) had an HIV positive status documented on their echocardiography request form. South Africa has the biggest population of HIV positive individuals in sub-Saharan Africa, estimated to be around 6 million people living with HIV (Statistics South Africa, 2016). The country also has the largest HIV treatment program in the world improving life expectancy in this population. A variety of cardiac lesions have been reported in HIV infection and AIDS, including pericardial disease with effusion and tamponade, nonspecific or infectious myocarditis, dilated cardiomyopathy with global left ventricular dysfunction, endocardial valvular disease due to marantic or infective endocarditis, arrhythmias, pulmonary hypertension and neoplastic invasion (Sani *et al.*, 2005). In this treatment era, coronary artery disease and dyslipidemia, drug related cardiotoxicity and cardiac autonomic dysfunction are becoming increasingly prevalent. (Sani *et al.*, 2005).

The 2011 AUC echocardiography do not adequately address the specific HIV and heart disease related indications for echocardiography in a high prevalence region like sub-Saharan Africa. These current criteria were developed before the current massive HIV rollout programs, when there was a lot of focus on HIV prevention and early treatment. Now more work needs to be done to target early detection and treatment of HIV related cardiac disease and echocardiography is useful in this regard. Specifically, in our study we had HIV positive patients with normal hearts being referred for echocardiography, with no other specific cardiac indications suspected besides the HIV diagnosis.

Using the most appropriate clinical diagnosis in each patient the major indication for echocardiography was indication #67 "*Initial evaluation of suspected hypertensive heart disease*", 23.4% (n=64) - see Table 3.4.2.

Echocardiographic Assessment

Hypertensive heart disease was confirmed in 41.6% (n=111), of patients who had an echocardiographic assessment done, while 45.6% (n=123) had been diagnosed with hypertension clinically.

60 patients had normal studies (22.5%) in total, and of these, 33 patients (12.2%) had normal hearts after excluding the cancer patients. Of the total study population this means that 12% of patients actually had normal studies, which mean these studies were not indicated in this group of patients. This again highlights the importance of clinical assessment of patients prior to requesting echocardiograms. From a healthcare utilization and cost perspective, this represents a non-sustainable situation, as already we have a lot of hypertension testing and screening algorithms which should assist us in using the least costly diagnostic test. Unfortunately, hypertension is an asymptomatic condition until it manifests with complications by which time, most of the cardiovascular changes may be irreversible and therefore more costly to treat.

The fact that only one new patient was diagnosed with rheumatic valvular heart disease also highlights the changing disease profile from infective diseases to NCDs such as hypertension and diabetes. This shift also highlights the improved living conditions, the success of the treatment of rheumatic fever during childhood, and improved access to health care services.

4.4 Referral Appropriateness

The 2011 AUC criteria can be successfully applied in this patient population as 98.5% of echocardiogram requests could be classified according to them. However, from Table 3.4.2 out of the 98 criteria only 19 were used in this study, suggesting that an abbreviated list of criteria will be able to adequately cover the majority of indications in a similar population or health care setting. This abbreviated list will however, have to be adjusted as the services at CHBAH increase to cover new services likely to be introduced, such as the use of left ventricular assist devices and heart transplantation. In their study in Lebanon, Rameh and Kossaify (2016) utilized 34 criteria for their study population and other studies have utilized a higher number of indications commensurate with their services provided.

Overall 93.3% (n=252) of all participants were referred appropriately, however the echocardiograms revealed a high number of normal studies even after excluding patients being assessed for cancer chemotherapy initiation. This suggests that there may be a disconnect between making the request and the actual clinical condition of the patient. Some of the reasons may be because clinicians are not assessing patients properly due to time constraints, staff shortages or declining clinical skills. From the results, inpatient wards had 95.3% appropriate referrals compared to 75% from the clinics. This may be due to the fact that in the wards, patients are being assessed at the least by an intern, a registrar and a consultant first before the echocardiogram is requested, whereas in the clinics junior staff may request echocardiograms without necessarily discussing with senior colleagues who may not always be available.

In addition, as discussed above 80% (n=8) of the inappropriate referrals had normal echocardiograms which may suggest that they were inappropriate requests or the need to educate clinicians on the use of echocardiography. It may be reassuring though that in comparison with global trends the overall inappropriate request ratios are lower compared to other settings. For example, in their 2012 study in a community setting in the USA, Ballo *et al* had 14.7% (n=135) inappropriate requests (Ballo et al., 2012). In the 14 Welsh hospital study including two tertiary centers in 2012, the authors also had 11% (n=115) inappropriate requests (Gurzun and Ionescu, 2014). Our relatively lower inappropriate request rate may simply be due to the fact that CHBAH is a tertiary center, and the majority of patients are very sick due to their late presentation for care, whereas in countries with better functioning healthcare systems, patients are screened earlier and present for care at an early stage.

4.4.1 Why are so many patients with normal results referred?

In a high volume hospital like this where the average daily medical intake is about a 120 patients the inappropriate normal requests may also signify a reliance on technology to assess patients as interns will admit an average of 20 patients each every five days for investigation and management. On the intake day, some of these patients may not be assessed properly. Unfortunately, as technology advances, clinicians may become more and more reliant on it. For example, at CHBAH, the protocol is that Interns have to assess intake patients clinically under the supervision of registrars. The registrars, interns and medical officers are then supervised by a consultant in the assessment and management of patients on the post-intake day. However, since CHBAH is the busiest hospital in South Africa, this system does not always work in practice because of staff shortages, work space limitations, and other systemic issues which preclude proper clinical review. Being a teaching hospital as well, some consultants may focus more on the teaching and provide less patient-specific clinical input during their rounds. And the majority of clinicians are not comfortable interpreting some clinical signs suggestive of cardiac disease, and so they use echocardiography

as a safety net in case they missed important findings clinically. So, reliance on technology in such a high output teaching hospital is common.

4.4.2 Comparison with other parts of the world

Since CHBAH is a large tertiary teaching facility with a large referral network one can assume that by the time patients are referred to this facility they will have already been screened at the clinics, other referring hospitals, casualty department and will have at least been assessed by a nurse, medical officers or more senior category of medical professional. These multiple assessments at different levels help to reduce the number of patients inappropriately referred to CHBAH. In other studies, with similarly high referral appropriateness in America, the majority of requests were done by cardiologists or specialist physicians and inappropriate referrals from such highly skilled professionals were partly explained by the practice of defensive medicine, and the different funding models of health care which incentivizes the utilization of certain services (Ballo *et al.,* 2012). To limit the overuse and abuse of echocardiography in the USA, referrals were linked to some form of reimbursement, which would not pay for inappropriate studies mandating the need to appropriately screen patients before requesting echocardiograms.

4.5 Relationship between socio-demographic profile and appropriateness of referral.

In this study, only ten patients (3.7%) were inappropriately referred for echocardiogram and at least 50.0% of them were 30 years or younger. From the narrative in section 3.5 in this group, retroviral disease and connective tissue diseases comprise the commonest diagnoses in this patient category. The fact that 80% of these patients had normal echocardiograms suggests that they were inappropriately referred initially. The younger age group suggests that inappropriately referred patients tend to be younger. In fact, the youngest patient in this study was a 17-year-old female who was referred inappropriately. This

implies that before being considered for echocardiography young people may need to meet more stringent criteria.

There was a trend of improved appropriateness with increasing age in our study population (Figure 3.5.1). This is consistent with natural aging as lifestyle diseases manifest with age. Improved survival into the 70s and 80s mean that more people are diagnosed with cardiovascular diseases as they get older. This finding is consistent with other parts of the world. Improved population survival means an increase in cardiovascular disease burden with its associated high mortality.

Unfortunately, in this study we were not able to do more robust analysis of the inappropriately referred patients due to the small sample population.

4.6 Limitations

This is a single center study carried out by a single investigator and the results may be different if the clinical indications for echocardiography is interpreted by another fellow or consultant cardiologist, or the study is carried out in another institution. For example, we have a very large hematology service and a large renal service and a lot of their patients require screening echocardiograms before chemotherapy or chronic renal dialysis respectively, which may not be the same in other institutions. Also, this study does not address the clinical impact of the echocardiography findings, which is the true measure of the true appropriateness of a diagnostic imaging study (Ward *et al.*, 2008).

Interns, medical officers, registrars and consultants making use of this service have not had any formal training on the utility of echocardiography, so some of the inappropriate requests or the discordance between clinical request and echocardiography findings may be different in another setting with a more homogenously trained staff or with stricter referral protocols. Also in a less busy hospital setting where treating clinicians have time to adequately assess patients,

this may result in less echocardiography requests and more appropriate referrals being made.

As mentioned above this was a sample of patients presenting in a specific month, so choosing a different month may have yielded a different result. However, despite this, useful lessons have been learnt on which future studies can be based on. Firstly, we have set a baseline on which future studies in similar resource limited settings can benchmark their services. The fact that only one patient was diagnosed with a new rheumatic valvular lesion confirms the fact that South Africa is in a transition from infectious diseases to NCDs. This shift demands a specific health system response resulting in changes in resource allocation and training to tackle the socioeconomic effects of NCD's. The abbreviated AUC identified in this study is a useful initial step in developing guidelines and AUC appropriate to South Africa and other LMIC's. And finally the fact that in this study we achieved similar results to studies elsewhere contributes to the validity of the use of AUC in our setting.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

Using a cross-sectional study design, this study sought to investigate the appropriateness of referrals to the echocardiography clinic at CHBAH, a busy large tertiary care hospital. The study generated locally context-specific information on the socio-demographic profile of patients referred; the clinical profile of patients; and the appropriateness of referral.

The study findings confirm that the current practice of echocardiography referrals at the hospital are in line with the practice in other parts of the world. However they also raise the specific population need of providing a quality HIV cardiovascular service in response to the increased survival and higher cardiovascular risks of this population due to HIV/AIDS and its treatment. Already there are 6 million people with HIV and a growing number on treatment in South Africa, hence these people have to access quality cardiovascular services at some point either for prevention or treatment.

The government of South Africa has identified NCDs as a key health focus area going forward, and cardiovascular disease and cancer care are the two highest cost drivers for the health care system. Implementing protocols and practices that maximize efficient use of available resources is important in achieving universal coverage with comprehensive health services.

5.2 Recommendations

As a consequence of this study the following are the recommendations.

Appropriateness of referral

- Use of abbreviated indications will capture the majority of need for TTE in this population, so there is a need to develop a local protocol based on the 2011 AUC criteria. An abbreviated list will be easier to train clinicians on.

- Due to the high burden of HIV/AIDS there is a need to incorporate HIV disease specific indications in this area with a high prevalence of HIV and other infective diseases. So, clear indications for screening and diagnosis of HIV related cardiac disease have to be developed in this regard.

Clinical Profile

- There is a greater need to suspect and screen for hypertension in this population as a significant number of people are found to have echocardiographic features of hypertensive heart disease in those who report being hypertensive. Better utilization of current screening and diagnostic algorithms should be emphasized at all levels of the healthcare system
- Need to create a dedicated service for HIV patients with cardiovascular diseases for further research purposes, and build relevant skills as part of improving the national HIV program. There is a need to understand accelerated cardiovascular disease in the context of HIV with a view of creating strategies to slow this disease progression.

Health care workers

- Share the results of this study with healthcare workers to stimulate debate on appropriate referrals
- Need to train clinical staff on proper clinical assessments and utility of appropriate referrals
- Administrative staff should be trained on the importance of collecting the prescribed social and demographic information from patients.

Hospital Level Recommendations

- Improve the quality of record keeping, especially a reduction in missing information in some of the reports. The hospital quality assurance teams should carry out audits in the wards and specialist clinics to ensure accurate completion of patient documents and appropriate and correct filing.

Policy level

- Current clinical guidelines used in echocardiography should be widely communicated, and the amendment and adoption of appropriate use criteria specific to this environment done to monitor and ensure that all facilities perform within agreed norms. Where problems are identified, strategies should be developed to promptly correct the practice.

- The state should also ensure that cardiac services are able to cope with the expected rise in demand due to changing disease profile, hence the need to measure appropriate use with a view to planning for future expansion of services.

5.3 Conclusion

This study has generated new knowledge on the clinical appropriateness of referrals to the echocardiography clinic at Chris Hani Baragwanath Academic Hospital, using the Appropriate Use Criteria 2011 criteria. As already mentioned above, this is a large teaching hospital with a large referral network in a resource-limited community in sub-Saharan Africa. This is a very busy echocardiography unit with 270 new patients presenting for echocardiography during the month of July 2015. This study is particularly important because it is the first study to use these Appropriate Use Criteria indications in sub-Saharan Africa in general, and in South Africa in particular. The study findings have public health and policy implications, enunciated in the recommendations outlined above.

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Appendix 1a Human Research Ethics Clearance Certificate

R14/49 Dr Farai Dube

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M150529

NAME: (Principal Investigator)	Dr Farai Dube
DEPARTMENT:	Public Health Chris Hani Baragwanath Academic Hospital
PROJECT TITLE:	Clinical Appropriateness of Referrals to the Echocardiography Clinic at the Chris Hani Baragwanath Academic Hospital
DATE CONSIDERED:	29 May 2015
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Prof Laetitia Rispel
APPROVED BY:	Professor P Cleaton-Jones, Chairperson, HREC (Medical)
DATE OF APPROVAL:	06/07/2015

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Secretary in Room 10004, 10th floor, Senate House, University.
I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report**.

Principal Investigator Signature Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Appendix 2 Patient Information Sheet

Clinical appropriateness of referrals to the echocardiography clinic at the Chris Hani Baragwanath Academic Hospital

PATIENT INFORMATION SHEET

Overall what is this study about?

The study would like to get more information about patients who are sent to the echocardiography clinic at Chris Hani Baragwanath Hospital, from other clinics, hospitals or doctors. This information includes things like the age of patients, where they live, and the reasons for their illness.

How we will find this out?

We would like to collect copies of the echo referral forms and copies of the echo reports once the doctors have finished writing them of all new patients coming to the clinic for a couple of months. These forms will be collected by the clerks and given to the doctor, Dr. Farai Dube. Personal details like your name, surname, and hospital number will not be included on each assessment form.

How do I know that the information collected from my records will be kept confidential?

Dr. Dube is a medical doctor who is doing specialist studies and he knows the importance of patient confidentiality and record keeping principles. All patients will be assigned a code on their completed assessment form, and the Investigator will only know this code. All the participants' assessment forms will

be combined and analyzed to look for referral appropriateness and associations. No names will be revealed on analysis and report resulting from this study.

Did you get permission to carry out the study?

Permission to carry out this project was obtained from the University of the Witwatersrand Research Ethics Committees and the Chris Hani Baragwanath Academic Hospital CEO and Research Committee. We will appreciate your participation and we will ask you to sign an informed consent form to participate in the study and to let us have a look at your records.

Will there be any benefits from participating?

There will be no direct benefits to anyone who participates in the study, as participation is voluntary. This means you have the right to refuse to have your information included in the study. But we hope that the study will give us important information about the reasons that patients come to this hospital echo clinic.

Will there be any harm from participating?

There will be no negative consequences for individuals who do not want to be included in the study. However, we would really appreciate it if we could include your information as you are using this clinic. We hope that the information we will get from you will be used to inform our future referral criteria to this busy clinic.

Who controls this project?

Dr. Dube does this project from the Division of Cardiology at Chris Hani Baragwanath Academic Hospital. He is being supervised by a professor at the School of Public Health at the University of the Witwatersrand.

Who do I contact if I want to ask more questions?

We will be happy to answer any questions you have about this study. The University of the Witwatersrand Research Ethics Committee has approved this research. If you have any questions about your rights as a study participant, or questions or concerns about any aspect of the study, you may contact Professor Cleaton-Jones or the ethics office on (011) 717 1234. If you have questions about the research, you may also contact:

Dr. Farai Dube
Division of Cardiology
Chris Hani Baragwanath Academic Hospital
Phone: +27 11-9336275
Email: faraidube@yahoo.com

Or

Professor Laetitia Rispel
School of Public Health
University of the Witwatersrand, Johannesburg
Phone: +27 11-717 2043
Email: laetitia.rispel@wits.ac.za

Appendix 3 Consent Form

Clinical appropriateness of referrals to the echocardiography clinic at the Chris Hani Baragwanath Academic Hospital

CONSENT FORM

I have been given the information sheet on the project entitled: *Clinical appropriateness of referrals to the echocardiography clinic at Chris Hani Baragwanath Academic Hospital.* I have read and understood the Information Sheet and all my questions have been answered satisfactorily.

I understand that it is up to me as a patient to decide whether or not to participate and have my information included in this study. I also understand that there will be no negative consequences for my decision.

I understand that the researchers involved in this project will make every effort to ensure confidentiality when reporting. I consent to participating in this study. I have been given the information sheet with telephone numbers that I may call if I have any questions or concerns about the research.

Patient verbal consent: Yes No

Date:

Patient signature: Date:

OR

Nurses signature: _____ Date: _____

Witness's signature: _____ Date: _____

Appendix 4 Echo Request Form

C.H. BARAGWANATH HOSPITAL
P.O. BERTSHAM
JOHANNESBURG, 2013

TEL: (011) 933 – 8197
FAX: (011) 938 – 8945

CARDIOLOGY DEPARTMENT

ECHO REQUEST FORM

NAME: UF number:

WARD: DATE:

AGE

COMPLETE CLINICAL FINDINGS WITH INDICATION FOR REQUEST:

ECG:

CX Ray:

REFERRING DOCTOR:

(Please print)

#/Bleep number:

Appendix 5 Echocardiogram report

CARDIAC CLINIC

Chris Hani Baragwanath Hospital

ECHOCARDIOGRAM REPORT

Name: Date:

Sex: Age: Hosp Number:

Operator:

CLINICAL DIAGNOSIS:

BP = Heart Rate = beats/min Rhythm:

HT(cm) Weight(kg) BSA

DIMENSIONS:

LVEDD: IVSD: LVPWD: AORTIC ROOT:

LVESD: LVOT: LA: LA Vol:

LV SYSTOLIC FUNCTION:

FS: EF: LV MPI MITRAL S' =

LV DIASTOLIC FUNCTION:

Mitral Inflow: E = A = **Pulmonary Vein Doppler:**

Tissue Doppler: E' = A' = E/E' =

MV E/A =

REGIONAL WALL MOTION ABNORMALITIES:

VALVES:

MITRAL VALVE :

AORTIC VALVE :

TRICUSPID VALVE :

PULMONARY VALVE :

RIGHT VENTRICLE:

TAPSE = Tricuspid S' = RV MPI +

RA: IVC = mm & aspiratory collapse Main pulmonary artery:

HEPATIC VEIN DOPPLER:

PERICARDIUM:

OTHER:

ASSESSMENT:

RECOMMENDATION (S):

REVIEWED BY: Dr Peters

Appendix 6 Data Collection Sheet

For official use only

1. Participant number		
Date of referral:	DD/MM/YY	
3. Date of examination	DD/MM/YY	
Record complete		□Yes…1 □ No…0

SECTION 1: BACKGROUND INFORMATION

For official use only

Gender	□ Male…1 □ Female…2
Age in years	_____
Population group	□ Black…1 □ Coloured…2 □ Indian…3 □ White…4 □ Other…9
Foreign National	□ No…0 □ Yes…1

Referred from	□ CHBAH Inpatient…1 □ CHBAH Outpatient clinic…2 □ Jabulani Hospital and Soweto clinics…3 □ Natalspruit Hospital…4 □ Sebokeng Hospital…5 □ Selby Park Hospital…6 □ Hiedelburg Hospital…7 □ Sebokeng Hospital…8 □ Potchestroom Hospital…9 □ Private GP's/Specialists…10 □ Other…11
CHBAH Inpatient referral	□ Medical Wards…1 □ Surgical and Orthopedics Wards…2 □ Obstetrics and Gynaecology wards…3 □ Other…4
CHBAH Outpatient referral	□ MOPD…1 □ Med REG…2 □ Other Specialist Clinics…3 □ Other…4

Referred by	□ Intern…1 □ Medical Officer…2 □ Registrar…3 □ Fellow…4 □ Consultant…5 □ Cardiologist…6 □ Other…7 □ Not sure…8
Patient follow up post Echo	□ Back to referral clinic/clinician…1 □ Cardiomyopathy clinic…2 □ Valve clinic…3 □ Congenital clinic…4 □ Coronary clinic…5 □ Admitted to Coronary Care Unit…6 □ Admitted to Medical wards…7 □ Other…8

SECTION 2: CLINICAL INFORMATION

Clinical Diagnosis	□ Hypertension…1 □ Valvular Heart Disease…2 □ Arrhythmia…3 □ Cardiomyopathy…4 □ Diabetes…5 □ Coronary Syndrome…6 □ Retroviral Disease…7 □ Pericardial Disease…8 □ Nonspecific clinical findings…9 □ Infective Endocarditis…10 □ Cardiovascular accident (CVA)…11 □ To exclude heart disease …12 □ Other…13
Chest X ray findings noted	□ Yes …1 □ No…2
ECG findings reported	□ Yes…1 □ No…2
Blood Pressure and Pulse	_____

SECTION 3: APPROPRIATENESS OF REFERRAL

For official use only

Request according to AUC indications _____

Request Appropriateness

- □ Yes…1
- □ No…2
- □ Uncertain…3

For official use only

Echocardiographic assessment

- □ Hypertensive Heart Disease…1
- □ Dilated Cardiomyopathy…2
- □ Diastolic Dysfunction…3
- □ Mitral Valve Disease…4
- □ Aortic Valve Disease…5
- □ Tricuspid Valve Disease…6
- □ Pulmonary Hypertension…7
- □ Congenital Heart Disease…8
- □ Pericardial Disease…9
- □ Coronary Syndrome…10
- □ Infective Endocarditis…11
- □ Cardio-embolic Source noted…12
- □ Rheumatic heart disease …13
- □ Normal Echocardiogram…14
- □Other …15

Appendix 7 2011 AUC Criteria

2011 AUC for Echocardiography

ECHOCARDIOGRAPHY APPROPRIATE USE CRITERIA BY INDICATION

INDICATION DESCRIPTION AU SCORE

TTE for general evaluation of cardiac structure and function

Suspected Cardiac Etiology-General with TTE

1 Symptoms or conditions potentially related to suspected cardiac etiology including but not limited to chest pain, SOB, palpitations, TIA, stroke, or peripheral embolic event. A (9)

2 Prior testing that is concerning for heart disease or structural abnormality including but not limited to chest X-ray, baseline scout images for stress echocardiogram, ECG, or cardiac biomarkers A (9)

Arrhythmias with TTE

3 Infrequent APCs or infrequent VPCs without other evidence of heart disease I (2)

4 Frequent VPCs or exercise-induced VPCs A (8)

5 Sustained or non-sustained atrial fibrillation, SVT or VT A (9)

6 Asymptomatic isolated sinus bradycardia I (2)

Light-headedness/Presyncope/Syncope with TTE

7 Clinical symptoms or signs consistent with a cardiac diagnosis known to cause light-headedness/presyncope/syncope (including but not limited to aortic stenosis, HCM or HF) A (9)

8 Light-headedness/presyncope when there are no other symptoms or signs of cardiovascular disease I (3)

9 Syncope when there are no other symptoms or signs of cardiovascular disease A (7)

Evaluation of Ventricular Function with TTE

10 Initial evaluation of ventricular function (e.g., screening) with no symptoms or signs of cardiovascular disease I (2)

11 Routine surveillance of ventricular function with known CAD and no change in clinical status or cardiac exam I (3)

12 Evaluation of LV function with prior ventricular function evaluation showing normal function (.g., prior Echocardiogram, left ventriculogram, CT, SPECT MPI, CMR) in patients in whom there has been no change in clinical status or cardiac exam I (1)

Perioperative Evaluation with TTE

13 Routine perioperative evaluation of ventricular function with no symptoms or signs of cardiovascular disease I (2)

14 Routine perioperative evaluation of cardiac structure and function prior to non-cardiac solid organ transplantation U (6)

Pulmonary Hypertension with TTE

15 Evaluation of suspected pulmonary hypertension including evaluation of right ventricular function and estimated pulmonary artery pressure A (9)

16 Routine surveillance (<1y) of known pulmonary hypertension without change in clinical status or cardiac exam I (3)

17 Routine surveillance (>= 1y) of known pulmonary hypertension without change in clinical status or cardiac exam A (7)

18 Re-evaluation of known pulmonary hypertension if change in clinical status or cardiac exam or to guide therapy A (9)

TTE for Cardiovascular evaluation in an Acute setting

Hypotension or Hemodynamic Instability with TTE

19 Hypotension or hemodynamic instability of uncertain or suspected cardiac etiology A (9)

20 Assessment of volume status in critically ill patient U (5)

Myocardial Ischemia/Infarction with TTE

21 Acute chest pain with suspected MI and non-diagnostic ECG when a resting

echocardiogram can be performed during pain A (9)

22 Evaluation of a patient without chest pain but with other features of an ischemic equivalent or laboratory markers indicative of ongoing MI A (8)

23 Suspected complication of myocardial ischemia or infarction, including but not limited to acute mitral regurgitation, ventricular septal defect, free-wall rupture/tamponade, shock, right ventricular involvement, HF, or thrombus A (9)

Evaluation of Ventricular Function after ACS with TTE

24 Initial evaluation of ventricular function following ACS A (9)

25 Re-evaluation of ventricular function following ACS during recovery phase when results will guide therapy A (9)

Respiratory Failure with TTE

26 Respiratory failure or hypoxemia of uncertain etiology A (8)

27 Respiratory failure or hypoxemia when a non-cardiac etiology of respiratory failure has been established U (5)

Pulmonary Embolism with TTE

28 Suspected pulmonary embolism in order to establish diagnosis I (2)

29 Known acute pulmonary embolism to guide therapy (e.g., thrombectomy and thrombolytics) A (8)

30 Routine surveillance of prior pulmonary embolism with normal right ventricular function and pulmonary artery systolic pressureI (1)

31 Re-evaluation of known pulmonary embolism after thrombolysis or thrombectomy for assessment of change in right ventricular function and or pulmonary artery pressure A (7)

Cardiac Trauma with TTE

32 Severe deceleration injury or chest trauma when valve injury, pericardial effusion, or cardiac injury are possible or suspected A (9)

33 Routine evaluation in the setting of mild chest trauma with no electrocardiographic changes or biomarker elevation I (2)

TTE for evaluation of valvular function

Murmur or Click with TTE

34 Initial evaluation when there is a reasonable suspicion of vulvular or structural heart disease A (9)

35 Initial evaluation when there are no other symptoms or signs of vulvular or structural heart disease I (2)

36 Re-evaluation in a patient without valvular disease on a prior echocardiogram and no change in clinical status or cardiac exam I (1)

37 Re-evaluation of known valvular heart disease with a change in clinical status or cardiac exam or to guide therapy A (9)

Native Valvular Stenosis with TTE

38 Routine surveillance (<3 y) of mild valvular stenosis without a change in clinical status or cardiac exam I (3)

39 Routine surveillance (>=3 y) of mild valvular stenosis without a change in clinical status or cardiac exam A (7)

40 Routine surveillance (<1 y) of moderate to severe valvular stenosis without a change in clinical status or cardiac examI (3)

41 Routine surveillance (>=1 y) of moderate or severe valvular stenosis without a change in clinical status or cardiac examA (8)

Native Valvular Regurgitation with TTE

42 Routine surveillance of trace valvular regurgitation I (1)

43 Routine surveillance (<3 y) of mild valvular regurgitation without a change in clinical status or cardiac exam I (2)

44 Routine surveillance (>=3 y) of mild valvular regurgitation without a change in clinical status or cardiac exam U (4)

45 Routine surveillance (<1 y) of moderate or severe valvular regurgitation without a change in clinical status or cardiac exam U (6)

46 Routine surveillance (>=1 y) of moderate or severe valvular regurgitation without change in clinical status or cardiac examA (8)

Prosthetic Valves With TTE

47 Initial postoperative evaluation of prosthetic valve for establishment of baseline A (9)

48 Routine surveillance (<3 y after valve implantation) of prosthetic valve if no known or suspected valve dysfunction I (3)

49 Routine surveillance (>=3 y after valve implantation) of prosthetic valve if no known or suspected valve dysfunction A (7)

50 Evaluation of prosthetic valve with suspected dysfunction or a change in clinical status or cardiac exam A (9)

51 Re-evaluation of known prosthetic valve dysfunction when it would change management or guide therapy A (9)

Infective Endocarditis (Native or Prosthetic Valves) With TTE

52 Initial evaluation of suspected infective endocarditis with positive blood cultures or a new murmur A (9)

53 Transient fever without evidence of bacteremia or a new murmur I (2)

54 Transient bacteremia with a pathogen not typically associated with infective endocarditis and/or a documented non-endovascular source of infection I (3)

55 Re-evaluation of infective endocarditis at high risk for progression or complication or with a change in clinical status or cardiac exam A (9)

56 Routine surveillance of uncomplicated infective endocarditis when no change in management is contemplated I (2)

TTE for evaluation of intra-cardiac and extra-cardiac structures and chambers

57 Suspected cardiac mass A (9)

58 Suspected cardiovascular source of embolus A (9)

59 Suspected pericardial conditions A (9)

60 Routine surveillance of known small pericardial effusion with no change in clinical statusI (2)

61 Re-evaluation of known pericardial effusion to guide management or therapy

A (8)

62 Guidance of percutaneous non-coronary cardiac procedures including but not limited to pericardiocentesis, septal ablation, or right ventricular biopsy A (9)

TTE for evaluation of aortic disease

63 Evaluation of the ascending aorta in the setting of a known or suspected connective tissue disease or genetic condition that predisposes to aortic aneurysm or dissection (e.g., Marfan syndrome) A (9)

64 Re-evaluation of known ascending aortic dilation or history of aortic dissection to establish a baseline rate of expansion or when the rate of expansion is excessive A (9)

65 Re-evaluation of known ascending aortic dilation or history of aortic dissection with a change in clinical status or cardiac exam or when findings may alter management or therapy A (9)

66 Routine re-evaluation for surveillance of known ascending aortic dilation or history of aortic dissection without a change in clinical status or cardiac exam when findings would not change management or therapy I (3)

TTE for evaluation of hypertension, HF, or cardiomyopathy

Hypertension With TTE

67 Initial evaluation of suspected hypertensive heart disease A (8)

68 Routine evaluation of systemic hypertension without symptoms or signs of hypertensive heart diseaseI (3)

69 Re-evaluation of known hypertensive heart disease without a change in clinical status or cardiac exam U (4)

HF With TTE

70 Initial evaluation of known or suspected HF (systolic or diastolic) based on symptoms, signs, or abnormal test results A (9)

71 Re-evaluation of known HF (systolic or diastolic) with a change in clinical status or cardiac exam without a clear precipitating change in medication or diet A (8)

72 Re-evaluation of known HF (systolic or diastolic) with a change in clinical status or cardiac exam with a clear precipitating change in medication or diet U (4)

73 Re-evaluation of known HF (systolic or diastolic) to guide therapy A (9)

74 Routine surveillance (<1 y) of HF (systolic or diastolic) when there is no change in clinical status or cardiac exam I (2)

75 Routine surveillance (>=1 y) of HF (systolic or diastolic) when there is no change in clinical status or cardiac exam U (6)

Device Evaluation (Including Pacemaker, ICD, or CRT) with TTE

76 Initial evaluation or re-evaluation after revascularization and/or optimal medical therapy to determine candidacy for device therapy and/or to determine optimal choice of device A (9)

77 Initial evaluation for CRT device optimization after implantation U (6)

78 Known implanted pacing device with symptoms possibly due to device complication or suboptimal pacing device settings A (8)

79 Routine surveillance (<1 y) of implanted device without a change in clinical status or cardiac exam I (1)

80 Routine surveillance (>=1 y) of implanted device without a change in clinical status or cardiac exam I (3)

Ventricular Assist Devices and Cardiac Transplantation With TTE

81 To determine candidacy for ventricular assist device A (9)

82 Optimization of ventricular assist device settings A (7)

83 Re-valuation for signs/symptoms suggestive of ventricular assist device-related complications A (9)

84 Monitoring for rejection in a cardiac transplant recipient A (7)

85 Cardiac structure and function evaluation in a potential heart donor A (9)

Cardiomyopathies With TTE

86 Initial evaluation of known or suspected cardiomyopathy (e.g., restrictive, infiltrative, dilated, hypertrophic, or genetic cardiomyopathy) A (9)

87 Re-evaluation of known cardiomyopathy with a change in clinical status or cardiac exam or to guide therapy A (9)

88 Routine surveillance (<1 y) of known cardiomyopathy without a change in clinical status or cardiac exam
I (2)

89 Routine surveillance (>=1 y) of known cardiomyopathy without a change in clinical status or cardiac exam U (5)

90 Screening evaluation for structure and function in first - degree relatives of a patient with an inherited cardiomyopathy A (9)

91 Baseline and serial re-evaluations in a patient undergoing therapy with cardiotoxic agents A (9)

TTE for adult congenital heart disease

92 Initial evaluation of known or suspected adult congenital heart disease A (9)

93 Known adult congenital heart disease with a change in clinical status or cardiac exam A (9)

94 Re-evaluation to guide therapy in known adult congenital heart disease A (9)

95 Routine surveillance (<2 y) of adult congenital heart disease following complete repair
-without a residual structural or hemodynamic abnormality
- without a change in clinical status or cardiac exam I (3)

96 Routine surveillance (>=2 y) of adult congenital heart disease following complete repair
-without residual structural or hemodynamic abnormality
-without a change in clinical status or cardiac exam U (6)

97 Routine surveillance (<1 y) of adult congenital heart disease following incomplete or palliative repair
- with residual structural or hemodynamic abnormality
- without a change in clinical status or cardiac exam U (5)

98 Routine surveillance (>=1 y) of adult congenital heart disease following incomplete or palliative repair
- with residual structural or hemodynamic abnormality

- without a change in clinical status or cardiac exam A (8)

TEE

TEE as Initial or Supplemental Test—General Uses

99 Use of TEE when there is a high likelihood of a non-diagnostic TTE due to patient characteristics or inadequate visualization of relevant structures A (8)

100 Routine use of TEE when a diagnostic TTE is reasonably anticipated to resolve all diagnostic and management concerns I (1)

101 Re-evaluation of prior TEE finding for interval change (e.g., resolution of thrombus after anticoagulation, resolution of vegetation after antibiotic therapy) when a change in therapy is anticipated A (8)

102 Surveillance of prior TEE finding for interval change (e.g., resolution of thrombus after anticoagulation, resolution of vegetation after antibiotic therapy) when no change in therapy is anticipated I (2)

103 Guidance during percutaneous non-coronary cardiac interventions including but not limited to closure device placement, radiofrequency ablation, and percutaneous valve procedures A (9)

104 Suspected acute aortic pathology including but not limited to dissection/transection A (9)

105 Routine assessment of pulmonary veins in an asymptomatic patient status post pulmonary vein isolation I (3)

TEE as Initial or Supplemental Test—Valvular Disease

106 Evaluation of valvular structure and function to assess suitability for, and assist in planning of, an intervention A (9)

107 To diagnose infective endocarditis with a low pretest probability (e.g., transient fever, known alternative source of infection, or negative blood cultures/atypical pathogen for endocarditis) I (3)

108 To diagnose infective endocarditis with a moderate or high pretest probability (e.g., staph bacteremia, fungemia, prosthetic heart valve, or intra-cardiac device) A (9)

TEE as Initial or Supplemental Test—Embolic Event

109 Evaluation for cardiovascular source of embolus with no identified non-cardiac source A (7)

110 Evaluation for cardiovascular source of embolus with a previously identified non-cardiac source U (5)

111 Evaluation for cardiovascular source of embolus with a known cardiac source in which a TEE would not change management I (1)

TEE as Initial Test—Atrial Fibrillation/Flutter

112 Evaluation to facilitate clinical decision making with regard to anticoagulation, cardioversion, and/or radiofrequency ablation A (9)

113 Evaluation when a decision has been made to anticoagulate and not to perform cardioversionI (2)

Appendix 8: Profile of Inappropriate Referrals

The following discussion summarizes the inappropriately referred patients only.

Patient 1 was an 18-year-old female who was referred for assessment for cancer chemotherapy and had a normal heart on echocardiography. But the echocardiography indication was not documented clearly on the echocardiography request form and had to be inferred by the treating cardiologist.

Patient 2 was a 35-year-old male being investigated for possible palpitations. Again this was not clearly indicated in the request form. He had a normal study on echocardiography.

Patient 3 was a 51-year-old female with retroviral disease and no other clear indication for echocardiography was specified. The echocardiography was normal in this patient as well.

Patient 4 was a 43-year-old male with retroviral disease with no other documented indication for an echocardiogram. The echocardiography was also normal.

Patient 5 had no age specified and no indication as well for the echocardiogram request form. She was found to have a normal study.

Patient 6 was a 42-year-old female with no indication noted on the request form. She was found to have a normal study.

Patient 7 was a 17-year-old female with a possible connective tissue disease who had a normal study done

Patient 8 was a 30-year-old diabetic male who was found to have a cardiomyopathy on echocardiography.

Patient 9 was a 24-year-old female also being worked up for a connective tissue disorder, and was found to have a pericardial effusion

Patient 10 was a 26-year-old female with a connective tissue disorder and she had a normal study on echocardiography