CLINICAL AUDIT OF ECHOCARDIOGRAPHY SERVICES UTILIZATION AT ECHOCARDIOGRAPHY SUITE, UNIVERSITY COLLEGE HOSPITAL, IBADAN.

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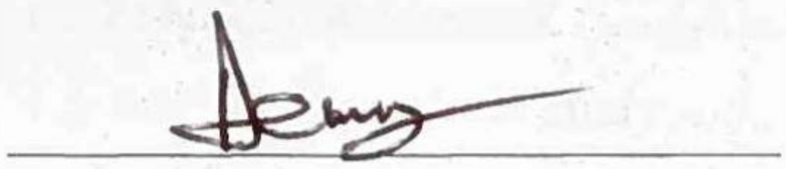
Certification

This work was done by the candidate, Dr Oni Opeyemi Olalekan, under my supervision at the Department of Epidemiology and Medical Statistics, Faculty of Public Health, College of Medicine, Ibadan.



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Abstract

Background: Cardiovascular diseases are the major cause of death worldwide. Since its discovery in the 20th century, echocardiography(ECHO) has become one of the pivotal tools in assessing the structural and functional characteristics of the heart. With the increase in requests and demand for ECHO, there has risen an unwanted problem- inappropriate requests for ECHO. There has therefore arisen the need to audit ECHO labs for the appropriateness of ECHO requests.

Methodology: The study was a descriptive, cross sectional study involving a review of the records of all requests and services provided by the unit in the past sixteen months. The patients referred from the out- patient clinics and in-patient wards for echocardiography (ECHO) from 1st of June, 2015 till 30th of September, 2016 were collated and analysed for patterns of referral as well as the indications for echocardiography. Eligible participants in the study were people referred for ECHO to the ECHO suite of University College Hospital, Ibadan. They consisted of male and female adults aged 18 years and above.

The ejection fractions (EF) of the various groups were evaluated and analysed. Other measures of cardiac chamber dimension and function were also assessed. Principal exposure variables are echocardiography assessment and the indications for echocardiography. The outcome variables are categories of appropriateness of echocardiography which are appropriate, inappropriate and uncertain. Other outcome variables include echocardiography findings which are categorized into normal and abnormal findings, preserved or reduced left ventricular ejection fraction (LVEF).

Results: a total of 2174 ECHOs were done during the period of review. The most common indication was hypertension (16%), closely followed by hypertensive heart disease (12.4%). Other major indications were symptoms and signs suggestive of cardiovascular disease, imaging evidence of possible cardiac disease, pre- surgical assessment of patients and peri-chemotherapy assessment of the heart. The percentage of appropriate, inappropriate and uncertain indications according to the 2011 appropriate use criteria for transthoracic echocardiography were 41.4%, 31.1% and 0.1% respectively. Less than ten percent (9.3%) of the indications could not be classified by the 2011 AUC while 18.1% of the ECHOs had no indication.

All classifications of the indications had normal findings, with appropriate, inappropriate and unclassified having 23.6%, 24% and 27.9% respectively. Those with abnormal findings in the appropriate group had unduly elevated blood pressure, left atrial dilatation and reduced ejection fraction. However, those with the inappropriate group had no significant difference in the LVEF while in the unclassified group, the left atrial diameter and systolic blood pressure was not significantly different.

Conclusion: The percentage of appropriate indications was low in this study as compared to others, largely because the most common indication was inappropriate and over 18% of the studies had no indications. The appropriate indications seemed to have a superior discriminant ability as compared to the other classes of indications as those with abnormal findings tended to have features both of diastolic and systolic dysfunction. There is a need to ensure appropriate indications are filled for ECHO request forms. The 2011 AUC guideline may also be review to expand the uncertain group of indications.

Key words: ECHO, appropriate, hypertension, Ibadan, ejection fraction

CHAPTER ONE
INTRODUCTION

1.1 Background

Echocardiography has evolved since its discovery in the 1950s as a simple, non-invasive, relatively cheap and objective tool for assessing cardiac function. (Krishnamoorthy, Sengupta et al. 2007) It was limited to modes like B- mode, M-mode but doppler evaluation has been introduced over the years. This has greatly helped in proper assessment of the cardiac chambers and the valves. This has helped also in determining pressure gradients non-invasively. Trans oesophageal echocardiography also evolved a few decades ago which has increased spatial resolution with improved evaluation of the atrial appendages and the mitral valvular apparatus.

The relatively low cost, the minimal patient discomfort involved and the real time imaging of cardiac structures and function of echocardiography makes it an invaluable tool in cardiovascular imaging- as compared to other modalities like ventriculography, cardiac computed tomography imaging and magnetic resonance imaging. The non-invasiveness of transthoracic echocardiography also is a major advantage. This has led to the development of miniaturized hand-held devices which can be used on the field for cardiovascular assessment and shorten time to diagnosis of various cardiac disorders.

Diverse medical problems- both systemic and cardiac specific- may benefit from cardiovascular assessment using echocardiography. Cardiac disorders like cardiomyopathies, congenital heart diseases, ischaemic heart disease, constrictive pericarditis, endomyocardial fibrosis, rheumatic heart disease, degenerative valvular heart disease are some of the cardiac specific disorders. Many systemic problems could also benefit from Echo, including stroke,

(Kolo, Sanya et al. 2010) infective endocarditis, muscular dystrophies, Ehler-Danlos syndrome, Marfans syndrome, Downs syndrome, Adult polycystic kidney disease among others.

The presence of various risk factors among people groups and well the recognition of various indices of cardiac dysfunction prompts referrals for echocardiography. Also, the anticipation of possible change in cardiovascular status following an intervention like the administration of cytotoxic drugs may prompt referrals for echo. The pre-operative cardiovascular assessment of patients may also warrant the referral for echo as required.

Nigeria is blessed with a population of about one hundred and sixty thousand people (Jude, Aliyu et al. 2014) and has an array of cardiovascular risk factors for which people seek proper cardiovascular evaluation. History taking and physical examination have been used as invaluable screening tools over the years for various risk factors. However, history taking and physical examination are limited and there is a need for improvement in cardiovascular assessment and diagnosis of on-going or established target organ damage so as to institute appropriate levels of prevention and intervention.

Chief among cardiovascular risk factors is hypertension, which is the number one cause of cardiovascular morbidity and mortality in many developed and developing nations, and indeed, the world. Hypertension has a prevalence of about 47% in Nigeria, (Ekanem, Opara et al. 2013) with most regions reporting higher prevalence in urban regions as compared to local communities. It has been known to cause an array of cardiovascular diseases like left ventricular hypertrophy, cardiomegaly, stroke and renal failure.

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Nigeria was once essentially free of diabetes mellitus (DM). However, with the westernization of diet and lifestyle, the epidemiologic transition of diseases from communicable to non- communicable diseases have engulfed Nigeria and most of sub-Saharan Africa. Diabetes mellitus has a prevalence of 4.8% in Nigeria (Ogunmola, Olaifa et al. 2013), with many hospital-based studies posting much higher figures. Diabetes mellitus is essentially a vasculopathy, which damages almost very organ system in the body, including the heart. It is a known cause of acute coronary syndromes, ischaemic heart disease, peripheral vascular disease and stroke. To prevent these, many general practitioners and medical doctors specializing in various fields refer their patients to the Echo suite for echocardiography.

1.2 Problem statements

- Ignorance of the profile of people referred to the ECHO lab
- Ignorance of the appropriateness of the indications for ECHO in ECHO lab, University College Hospital, the premier teaching hospital in Nigeria.
- Ignorance of the patterns of ECHO results according to the various classes of appropriateness.

1.3 Justification of the study

It is also noteworthy, however, that a tool with such wide applicability like echo is prone to abuse and misuse. It has been speculated that where ready aids like echocardiography and electrocardiography exists, the mind goes to sleep. Thus, what should have been a complement to sound reasoning following proper history and physical exam now becomes

the primary screening tool. This would contribute on the long term to over burdening of the health sector, incurring of undue cost- for both patients and cardiologists, and brain drain.

The need to cut health care costs have become a major topic of discussion worldwide for health care givers, insurance bodies as well as policy makers at various levels. Investigations that are not appropriately requested are not being paid for by insurance bodies, making health care givers tighten their reins as regards requesting investigations appropriately.

1.4 Aim and objectives

The main aim of this study is to evaluate appropriateness of echocardiography use among patients referred to Echo suite, University College hospital, Ibadan

Specific objectives include:

1. To evaluate the profile of people referred for echocardiography at the echo suite.
2. To determine the appropriateness of the indications for echocardiography at the echo suite.
3. To evaluate the concordance/correlation between the indications and the results of the echocardiography.

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CHAPTER TWO

LITERATURE REVIEW

2.1 Historical Perspective of Cardiovascular Evaluation

Cardiovascular diseases like myocardial infarction and stroke have become the number one cause of morbidity and mortality in adults worldwide. This has been an established fact for most of the developed world where they have evolved through the epidemiologic transition of diseases into the present stage of delayed degenerative diseases, causing about 50% of total mortality. This has led physicians, scientists, technologists and para health workers to seek for ways of detecting cardiovascular problems early and to evaluate the heart and other target organs for possible damage.

History taking and physical examination are the time tested and trusted evaluation tools utilized in evaluating patients and the first point of call in cardiovascular risk factor assessment. The limitations of history and physical examination are however obvious, being often ineffective in predicting athletes with increased risk for sudden cardiac death (Anderson, Grenier et al. 2014)

Chest X- rays were the first to be developed/discovered in 1895(Cosmacini and Piacentini 2008) which help with evaluating the cardiac silhouette, with specific cardiac chamber enlargement giving unique configurations. The resultant pulmonary edema and pleural effusion was also visualized. However, it was grossly limited as regards evaluating the electrical function of the heart. This lead to the development of the electrocardiogram.

Electrocardiogram, which was first invented in the 19th century (Yang, Liu et al. 2015) soon became a pivotal tool in evaluating the heart, more so when certain patterns were noticed to correlate with atrial enlargement, myocardial ischaemia- infarction, left ventricular hypertrophy, among others. However, it is limited in assessing cardiac function and structurally changes of each cardiac chamber.

Imaging structures using sound was first noted in the 1920s where sound was used to detect flaws in metals. (Krishnamoorthy, Sengupta et al. 2007) Subsequently in the 1950s, Edler fine-tuned echocardiography (echo) while Feigenbaum in the 1960s did extensive work on standardizing the performance of echocardiography. Since then, echo has become a cornerstone in cardiovascular examination for structural and functional abnormalities. It has been referred to as the single most useful diagnostic test in the evaluation of patients with heart failure. (Kirkpatrick, Vannan et al. 2007) It has been used to evaluate cardiac valves, their structural and functional integrity and the grading of dysfunction. It also has been used to detect pericardial abnormalities, grade the degree of pericardial effusion as well as assess for cardiac tamponade, among others.

2.2 Demand for Echocardiography

Echocardiography is being requested by most health care disciplines with a view to improving diagnosis, defining-detecting aetiology of health problems, following up the care of patients as well as planning health care delivery.(Garbi, McDonagh et al. 2015) From year 2000 till 2008, the rate of outpatient requests for echocardiography had increased by 85% in Boston.(Rahimi, York et al. 2011) Also, with increase in clinical trials and revelations of the importance of assessing left ventricular function, there has been a corresponding increase in

referrals for echocardiography, with a 12500% increase in referrals in some parts of the UK over a 6 year period.(Gillespie, Struthers et al. 1996)

However, with the increasing utility and demand for echocardiography in clinical practice came an unwanted event- abuse of echocardiography. Most of the request patterns of doctors for echo have not been audited for evaluation of its impact on clinical practice as well as the contribution of the results of cardiac sonography to the management of patients. The American college of cardiology foundation published an appropriate use criterion, first in 2007 where clinical practice was considered and audited vis-à-vis echocardiography. A revision of this was done in 2011, (American College of Cardiology Foundation Appropriate Use Criteria Task, American Society of et al. 2011) with classification of indications into appropriate, inappropriate and uncertain.

However, certain schools of thought are not in agreement with these criteria, arguing that there is value in having a normal Echo result. They also noted that there is a place for assessment of patients with Echocardiography prior to upstream referral to specialists as required and the test is useful irrespective of change in the line of management. (Bedeker, Lachman et al. 2015)

It is yet to be known whether patterns of echocardiography referrals conform to the recommendations of this body or not. This calls for an evaluation of patterns of referral as well as the indications for echocardiography. (Williams, Currie et al. 2003)

2.3 Factors influencing the growth of Echocardiography utilization

There has been a phenomenal growth in requests for cardiac imaging, especially non-invasive cardiac imaging, with echocardiography constituting about 30% of all non-invasive

imaging between 1999 and 2008. There are a couple of factors which are responsible for this. First is the growth in population worldwide, with the developing countries having a higher growth rate than the developed ones. Nigeria for instance, with a growth rate of 2.8-3.2% has grown from 16 million in 1911 to an estimated 167 million as at 2011. This has affected the economy, incidence and prevalence of diseases-both communicable and non-communicable with an attendant increase in cardiovascular diseases. This would have contributed to the increase demand for Echocardiography.

There is also the financial gain that motivates the performance of medical tests for individuals whether the indications are appropriate or not. This especially serves the purpose of private organisations or even government establishments which need the increase in revenue. However, it does not make for good practice. Another possible reason for this may be sincere ignorance on the part of those that refer people and those that perform these tests. This is not surprising as the reading culture is fast disappearing in some parts of the world, especially the developing countries.

The increase in unemployment and the untold economic hardship has also led to the development of health care law with litigation been marshalled against misconduct in the health care industry. This has both its merit and demerit, as medical practitioners in a bid to ensure their backs are covered now request for all sorts of investigations, including echocardiography whether required or not. This has caused an astronomical increase in health care costs worldwide. Thankfully, the institution of health insurance and its steady growth in various parts of the world has led to a reduction in the demand for inappropriate investigations.

2.4 Potential impact of cost on pattern of presentation and utilization of health services, especially echocardiography

Echocardiography is a relatively cheap, non-invasive imaging modality that is essentially devoid of side effects. However, the cost, which is about $75 (at the time of this review at the ECHO lab in question), may still be largely be inaccessible to most people in a country like Nigeria where 70% of the populace live within the poverty belt and 95% of the patients pay out pocket for health services. Most Nigerians live on less than $1 per day, suggesting that more than two thirds of the population may find echocardiography inaccessible if they ever need one.

The National health insurance scheme, the main insurance scheme in Nigeria was commissioned in 2005. (Onoka, Onwujekwe et al. 2013) Since then, the numbers of enrolees in the scheme have continued to rise, comprising primarily of those in government establishments. However, most of the populace continue to pay out of pocket for health services, making health care accessibility difficult. (Okoronkwo, Ekpemiro et al. 2016) This has the potential to limit both the number of people as well as alter the pattern of people presenting for echocardiography.

Ibadan is a capital city, arguably the most populous city in south western Nigeria. The University college hospital, which is located in this city, sub serves the city with its catchment area reaching to the entire south western Nigeria. Referrals are received from the entire country for care in various disciplines. While a sizeable number of the citizenry of Ibadan are literate, most are illiterate. The socio-economic status of people is closely linked to their level of education, with the politicians and businessmen being the wealthiest, educated people being in the middle class and the illiterate being the poorest.

The ability to afford to pay for echo will likely skew the actual presentation of people for echo, as the poorest often can neither afford to pay out of pocket nor are they on any insurance scheme.

2.5 Possible expected pattern of distribution of patient presentation for echocardiography

The prevalence of various cardiovascular risk factors in Nigeria may be a guide to the expected pattern of referrals for Echocardiography. For instance, of the well-known traditional cardiovascular risk factors, hypertension happens to have the highest prevalence in Nigeria, with population-based studies quoting figures ranging from 44-52.5%.(Ofili, Ncama et al. 2015, Oluyombo, Olamoyegun et al. 2015, Ezeala-Adikaibe, Orjioke et al. 2016) Arterial hypertension was found to be the most common reason for echocardiogram requests by family physicians by Barbier *et al.*(Barbier, Alimento et al. 2008) In Italy, (Cuspidi, Negri et al. 2010) out of 2449 subjects that were recruited for the study, 745(30.4%) had hypertension as the indication, making it the most common indication. A study of all the Echocardiographs done over a period of one year was done by Ansa *et al*, (Ansa, Odigwe et al. 2013) which revealed hypertensive heart disease as the major indication for echocardiography in their centre in southern Nigeria. Hypertension is known to cause structural and functional heart changes, predispose to atherosclerosis, aortic dissection, stroke, retinopathy and renal failure. Referrals for echocardiography are therefore expected from family physicians, nephrologists, neurologists, cardiologists, and ophthalmologists, among others. Indeed, Oyedeji *et al (Oyedeji, Akintunde et al. 2014)* found that hypertension was the most common indication of echocardiography in their health care facility in south western Nigeria.

Diabetes mellitus, another major risk factor for cardiovascular disease, is known to cause coronary artery disease, putting patients at risk for myocardial infarction. It also known to cause diastolic dysfunction, putting patients at increased risk for developing heart failure. It has a prevalence of 6-6.8% (Oluyombo, Olamoyegun et al. 2015, Salas, Acosta et al. 2016), which is about 6 fold less than that of hypertension. Referrals are therefore expected at a ratio of six hypertensives for every diabetic sent for echocardiography. Referrals are also expected from doctors wherever diabetics are managed, especially from family physicians, ophthalmologists, surgeons, endocrinologists, other internal medicine physicians and oncologists.

Dyslipidaemia, which essentially refers to abnormality in the levels of serum lipids in the body, is actually a constellation of various lipid parameters. While excess low density lipids and triglycerides are known to confer various degrees of cardiovascular risk, low high density lipids are also recognized by many authorities as a cardiovascular risk. However, most published documents show that low density lipoproteins are the main cause of dyslipidaemia-related cardiovascular disease and that control of it shows a marked reduction in cardiovascular risk. Dyslipidaemia has a prevalence of 37.1% in Nigeria, meaning that at least one out of every three Nigerians has elevated serum low density lipoprotein cholesterol. (Ugwuja, Ogbonna et al. 2013) This is one of the major factors responsible for myocardial infarction in the developed world and may be a reason why patients are referred to the echocardiography suite for cardiac structural and functional evaluation. However, though myocardial infarction is present in Nigeria, the prevalence is relatively low (Sani, Adamu et al. 2006) as compared to other developed countries and some developing countries like India. This may therefore reduce the number of dyslipidaemic referrals to the Echo lab.

Obesity has grown to epidemic proportions in most of the developed world, with staggering prevalence of 35% being quoted from places like Chile. (Kain, Hernandez Cordero et al. 2014) However, Nigeria, largely a developing country, has a relatively lower prevalence of obesity. A study done by Okafor *et al*, using the standard criterion of $\geq 30 kg/m^2$ revealed a prevalence of 21.1%, suggesting that one out every 5 adult Nigerians are obese. Obesity has been shown to have a several concomitant co-morbidities like hypertension, diabetes and dyslipidaemia- a constellation referred to as the metabolic syndrome. Once it sets in, metabolic syndrome has been found to be associated with a poor outcome in patients with unstable angina and non ST segment elevation myocardial infarction. (Kul, Uyarel et al. 2014)

The detection of an abnormal electrocardiogram has been a source of echo referrals. However, it has been discovered that electrocardiogram interpretations by physicians in primary care are often unreliable, leading to fruitless echo requests. This suggests that ECGs should always be interpreted by specialists to ensure that only truly abnormal ECGs are acted on. It has also been verified that once an ECG is truly abnormal, a follow up echocardiogram request is justified and often revealing. (Williams, Currie et al. 2003)

There are other cardiac specific disorders that may be easily noticeable by doctors, leading to requests for echocardiography. These include blunt chest trauma with suspected haemopericardium, patients that require a pre-op echocardiography assessment, (Barber and Fletcher 2014) patients about to have chemotherapy, diagnosis of infective endocarditis, (Cecchi, Chirillo et al. 2013) cardiomegaly on chest radiograph, confirmation of central line placement, (Arellano, Nurmohamed et al. 2014) among others.

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There are other echocardiography modalities like contrast echo, trans-oesophageal echo and stress echo which are not routinely performed in the echo lab intended for this study. Therefore, these are not emphasized.

Table 1: Showing the prevalence of Hypertension in Nigeria.

Author	Hypertension (%)
Ogunmola et al (Ogunmola, Olaifa et al. 2013)	66.4
Ekanem et al (Ekanem, Opara et al. 2013)	47
Akpan et al (Akpan, Ekrikpo et al. 2015)	44.3(rural) vs 28.6(urban)

2.6 Guidelines for echocardiography indications

The American college of Radiology as well as the American college of cardiology foundation (ACCF) jointly stated that "concept of appropriateness, as applied to health care, balances risk and benefit of a treatment, test, or procedure in the context of available resources for an individual patient with specific characteristics."(Carr, Hendel et al. 2013) The ACCF, in conjunction with American Society of Echocardiography (ASE), American Heart Association (AHA), in collaboration with some other societies also defined an appropriate imaging study as one in which the expected incremental information, combined with clinical judgment, exceeds the expected negative consequence by a sufficiently wide margin for a specific indication that the procedure is generally considered acceptable care and a reasonable approach for the indication.

2.7 Update of guidelines

The initial Appropriate Use Criteria (AUC) for transthoracic echocardiography was first released in 2007(Douglas, Khandheria et al. 2007). It addressed a variety of clinical scenarios

which lead to requests for echocardiography. Ward *et al* (Ward, Mansour et al. 2008) utilized this guideline in 1,553 patients. The 2007 AUC categorized Echo indications into two- appropriate or inappropriate. They found that 89% of the indications were appropriate while 11% were inappropriate. An Italy based study Another study by Kirkpatrick *et al* (Kirkpatrick, Ky et al. 2009) noted that out of 368 outpatient echocardiography indications, 206 (56%) were appropriate, 31 (8%) were inappropriate, and 131 (35%) were unclassifiable. This showed a deficiency in the 2007 AUC guideline, which failed to address more than a third of indications for echocardiography at this center. Willens *et al*(Willens, Hendel et al. 2011) also noted that the 2007 AUC was unable to classify 99(16%) of the 625 echocardiogram requests.

The relatively narrow spectrum of this initial guideline, coupled with the emergence of new evidence for benefit of imaging, led to the development of a new AUC. The subsequent guideline, which was released in 2011(American College of Cardiology Foundation Appropriate Use Criteria Task, American Society of et al. 2011), expanded the transthoracic indication spectrum of indications. It also included trans-oesophageal and stress echocardiography.

Both criteria were compared for performance in an outpatient setting by Bhatia *et al* (Bhatia, Carne et al. 2012)- the percentage of appropriate indications which was 83% in the initial criteria, fell to 71% with the latter criteria- suggesting that with increase in evidence, some indications which were initially considered appropriate were found to be not. Another group of investigators (Alqarqaz, Koneru et al. 2012) utilized both AUC criteria also in an outpatient setting. They prospectively looked at 170 patients for two months, and discovered that the former guideline failed to classify 14% of the patients- all of whom were well

classified by the latter guideline. Willens *et al* (Willens, Hendel et al. 2011) also discovered that the 2011 AUC, when applied to the same 625 Echo requests, reduced the unclassified category from 16% to 1% This suggests that the 2011 AUC guideline is superior to the former and should be used instead.

The latest guideline has been used in some parts of the world to evaluate the indications for echocardiography. A study done in Dallas, USA (Matulevicius, Rohatgi et al. 2013) showed that 91.8% of five hundred and thirty-five patients reviewed had appropriate indications for ECHO, showing a good conformity of practice to the guidelines. Another study done in Lebanon showed that 74.66% of patients also conformed to the criteria, having appropriate indications. (Ramch and Kossaify 2016) Alqarqaz *et al* (Alqarqaz, Koneru et al. 2012) also found that 77% of the 170 patients studied had appropriate indications for echocardiography.

2.8 Challenges: how appropriate is appropriate?

Some questions have been raised about the utility of the appropriate use criteria in real world setting *vis-a-vis* the impact on clinical care, utility of normal results, among others. Some other challenges which have been highlighted include the issues surrounding documentation and classification and the corresponding impact on results. Though Alqarqaz *et al* (Alqarqaz, Koneru et al. 2012) were able to show from their study that "appropriate Echos" were associated with new and major echocardiographic findings, and "patient care intervention was significantly associated with the appropriate Echos", change in clinical care may be challenging to abstract from the medical records. This has been considered a problem in spite of the electronic revolution of medical records and the advancement in technology.

In addition to this, appropriate may not always lead to active change in care. For instance, patients receiving cardio toxic chemotherapy being followed up for functional changes in the

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In addition to this, appropriate may not always lead to active change in care. For instance, patients receiving cardio toxic chemotherapy being followed up for functional changes in the

heart will not have the chemotherapy stopped. This is because most of these malignancies are life threatening and curation in the primary target, with associated improvement in mean survival and better quality of life. A refusal to change therapy in this case is therefore not because the Echo was not important, suggesting that a change in the line of therapy is not an absolute yardstick for evaluating the appropriateness of echocardiography.

The consideration of practice environment (inpatient vs. outpatient, etc.) may also be important. The threshold for requesting investigations to diagnose problems and rule out important differentials is lower in out-patient settings than the other because of the risk of missing out important information. There should therefore be an increase in the volume of inappropriate echocardiography indications for outpatient rather than in-patient requests. This has been suggested by a retrospective study of 450 transthoracic echocardiograms (TTE) done in 2011(Bhatia, Carne et al. 2012). They grouped their patients into three- academic outpatient, community outpatient and academic in-patient. The largest volume of inappropriate echocardiograms were those requested from academic outpatient clinics (30%) whereas those requested from in patient service had the lowest inappropriate indications (14%). There was also an interesting discovery from the study, with the percentage of inappropriate indications being higher among the academic outpatient (30%) than the community outpatient (21%). This suggests requests made to answer questions to solve problems tend to be more appropriate than those asked for the sake of research- which is often just to add to the body of knowledge.

However, the ASE has addressed some of the concerns above, stating that appropriate does not always mean a TTE is necessary. A patient with easy fatigability may benefit from an echocardiogram to either diagnose a cardiac cause for his symptoms or rule out cardiac

aetiology for the easy fatigability. However, this does not make echocardiography necessary in the algorithm of evaluation of every kind of easy fatigability. This is because a carefully taken history and physical examination may lead to the appropriate diagnosis, with no need for echo.

It is also incorrect to assume TTE offered no benefit even if therapy was not changed. The anxiety of being ignorant about the structure and function of the heart can be allayed by an echocardiogram, even if the result is normal. Patients that will have ordinarily referred upstream to a tertiary or even quaternary health care center could be better managed following the additional information made available by the echocardiography.

The potential for abuse of echocardiography has been noticed by the American college of cardiology over the years. This led to the first publication of the set of appropriate use criteria in 2007. A second edition was published in 2011 which revised the former document and added use of trans-oesophageal echocardiography, among others.

An appropriate imaging study is one in which the expected incremental information, combined with clinical judgment, exceeds the expected negative consequence by a sufficiently wide margin for a specific indication, such that the procedure is generally considered acceptable care and a reasonable approach for the indication.

2.9 The appropriate use criteria echo app

It has been observed that the 2011 AUC guideline is a bulky document with about 39 pages and 202 indications. It is cumbersome to carry the guideline about as a printed document and apply in an echo lab. It could be posted on the wall and echo cardiographers or cardiologists could quickly cast a glance at the wall while checking for the appropriateness of the

indications before performing ECHOs. However, an intuitive innovation that was developed recently is a web-based appropriate use criteria echo app which is a user friendly, interactive application that can be easily downloaded from app stores.

This app is a workable alternative to carrying printed sheets or scrolling through the PDF format on the phone. Its use was published in 2011 by Bhave *et al* (Bhave, Mansour et al. 2011), with an average study entry time of 55 seconds per patient. They were also able to conclude, having used it on 258 patients, that it is a useful point of care device that can be installed at various clinics or centres where ECHOs are requested.

2.10 Importance of profile of patients presenting for echocardiography

The importance of knowing the patterns of referrals for Echocardiography cannot be overemphasized. First, it helps to become aware of the patterns of practice of various medical disciplines vis-a-vis their request for echo. Secondly, it helps to be able to judge if practice patterns conform to the recommended pattern in the light of appropriate use criteria for echocardiography. Third, it creates a template for planning and projection of echo services in the hospital, as well as the possible need to educate those whose practice is unacceptable. It will also help to be able to detect what impact the prevalence of various cardiovascular risk factors has on the request of doctors for echocardiography.

2.11 Future perspectives

There has been a growth of appropriate indications between the 2007and 2011 guideline review, with a 42% increase noted as compared to 24% and 12% for uncertain and inappropriate respectively. Bhatia and colleagues (Bhatia, Ivers et al. 2015) have proposed a

study that will look into physician practice and its impact on request patterns for Echo. The methodology emphasizes the following points:

(1) A lecture outlining the AUC and most recent available evidence highlighting appropriate use of TTE,

(2) Access to the American Society of Echocardiography mobile phone app, and

(3) Individualized feedback reports e-mailed monthly summarizing TTE ordering behavior including information on inappropriate TTEs and brief explanations of the inappropriate designation. The control group will receive no education on TTE appropriate use and order TTEs as usual practice.

Rameh *et al (Rameh and Koşsaify 2016)* also proposed a quality improvement initiative, which is summarized as follows:

1. Control of echo requests by a cardiologist prior to the echo examination;

2. Regular lectures for the medical staff, including cardiology fellows and interns concerning the AUC 2011;

3. Placement of large posters summarizing all AUC 2011 in the medical staff meeting room and in the echo laboratory;

4. Performance of daily auditing by the cardiology fellows in the echo laboratory regarding echo requisitions; and

5. Monthly feedback regarding ordering behavior sent through e-mail to all cardiologists.

It has also been noted that the AUC 2011 is not a set of rights and wrongs but instead a guide. Therefore, in appraising echo laboratories, an allowance of less than 20% inappropriate indications has been made by the ACCF/ASE. However, any lab with greater than 20% of inappropriate indications should be audited accordingly.

When this study is concluded, it should shed some more light on trends of practice as regards referral for Echo, as well as the impact of information-education on referrals.

CHAPTER THREE

METHODOLOGY

3.1 Study Location

The study was carried out at the Cardiology Unit of the University College Hospital. University College Hospital is located in Ibadan, the capital city of Oyo state. It is the Premier Teaching Hospital in Nigeria and the major tertiary centre in the state, sub-serving the whole state and neighbouring states within the South- West Geo-political zone. It is equipped with 800 beds and it serves all the towns and the capital city of Oyo state, as well as the other states in its geo political zone. Patients actually come from beyond the South West, because of the tertiary and quaternary services. This hospital is also blessed with many clinical specialties and is the centre for training for many sub-specialties all over Nigeria. Most clinical specialties refer patients for echocardiography for various reasons.

Echocardiography commenced in UCH about 2 decades ago and has become a cornerstone tool in evaluating cardiac structure and function. It is presently well staffed with physiologists, cardiac nurses and cardiologists. Echocardiography is done routinely every Wednesday, though it is also done on any day of the week for emergencies, as occasion demands. The study spanned a period of sixteen months.

3.2 Study Population

Eligible participants in the study were people referred for echocardiography to the echo suite of University College Hospital, Ibadan. They were male and female individuals aged 12 years and above.

3.3 Study Design

The study was a descriptive, cross sectional study involving a review of the records of all requests and services provided by the unit in the past one year, and a three-month assessment of current requests and the patients.

3.4 Inclusion Criteria for Cases

1. Individuals aged 12 years and above
2. Referred for echocardiography to the ECHO suite of University College Hospital, Ibadan

3.5 Exclusion Criteria for Cases

1. Age less than 12 years at the time of echocardiographic evaluation
2. Patients with incomplete data

3.6 Sample Size

A total sampling method was used, which essentially consisted of all the patients that were referred for Echocardiography from June 2015 till September 2016. All those who satisfied the inclusion criteria were incorporated into the study.

3.7 Data Collection

The cardiac structure and function of the subjects and controls will be evaluated at the Echocardiography Suite of the hospital.

Data was collected using a proforma consisting of the following sections

- Demographic information: age sex, hospital number, date of investigation, phone number

- Anthropometric Information: height, weight\
- Indications for referral
- Doctor referring patient
- Echocardiographic Variables-M-mode, Pulsed wave
- Conclusion
- Diagnosis

3.8 Echocardiography Records Collation

Echocardiography records from 1st of June, 2015 till 30th of September, 2016 was collated and analysed for patterns of referral as well as the indications for echocardiography. Also, the ejection fractions of the various groups were evaluated and analysed. Other measures of cardiac chamber dimension and function were also assessed.

3.9 Data Management

Data was collected using a standard proforma. Analysis was done using Statistical Package for Social Sciences (SPSS) version 20. Continuous variables were expressed as means and categorical variables expressed as percentages. Differences in categorical variables were assessed using chi square test while that of continuous variables were evaluated using T-test. A two tailed P value <0.05 was considered significant.

3.10 Ethical Considerations

3.11 Ethical clearance

This was obtained from the joint University of Ibadan and University College Hospital Ethical Committee-Institutional Review Board.

3.11 Confidentiality of Data

Personal details obtained from participants, including information and data obtained were treated with utmost confidentiality.

3.12 Voluntary Participation

Patients who participated had to give a written informed consent (Appendix 1). Participants were free to withdraw from the study at any given time without loss of benefit or reprisal.

3.13 Beneficence to Participants

There was no monetary inducement or coercion to join the study.

3.14 Non Maleficence to Participants

The study did not expose the participants to any pre-empted danger.

CHAPTER FOUR

RESULTS

A total of 2174 echocardiography studies was done between June 2015 and September 2016. Out of these, 394 people were referred for Echocardiography with no indications for the test on their request cards. There were a couple of missing values as regards certain variables, which are reflected on the tables as appropriate.

Table 2: Profile of patients who presented at ECHO suite, University College Hospital, Ibadan from 1st of June 2015 till September 31st, 2016

Variables	N	Minimum	Maximum	Mean ± Standard Deviation
Height (cm)	1917	106.5	196	165±9.7
Weight (Kg)	1919	30	160	74.4±16.4
Age (years)	2123	12	95	55±16.4
Systolic BP(mmHg)	1464	60	230	134±21.6
Diastolic BP (mmHg)	1464	30	150	84±13.5
Aortic root diameter (cm)	2158	1.6	5.8	2.87±0.43
Aortic valve opening (cm)	2147	0.52	4.2	1.96±0.32
Left atrial diameter (cm)	2157	1.1	7.4	3.67±0.71
Interventricular septal diameter in diastole (cm)	2155	0.3	2.5	0.94±0.24
Interventricular septal diameter in systole (cm)	2152	0.3	4.3	1.3±0.37
Posterior wall thickness in diastole	2155	0.1	2.1	0.94±0.24
Posterior wall thickness in systole (cm)	2153	0.13	4.5	1.44±0.38
Left ventricular internal diameter in diastole (cm)	2154	1.2	9.3	4.92±0.93
Left ventricular internal diameter in systole (cm)	2154	0.7	8	3.2±1.1
End diastolic volume (cm^3)	2147	11.2	479.6	119.6±55
End systolic volume (cm^3)	2147	1.1	366	48.7±45.3
Stroke volume(cm^3)	2146	4.4	251	71.5±26.1

Fractional shortening (%)	2152	2	77	36.2±11.2
Ejection fraction (%)	2152	5	97.7	63.9±15.8
Trans-mitral Early velocity(cm/s)	2131	0.1	2.7	0.73±0.24
Trans-mitral late diastolic velocity(cm/s)	2094	0.1	4.7	0.68±0.25
Early deceleration time (msec)	1881	40	512	190±62.4

The appropriate use criteria -2011 edition- has total of 98 indications for transthoracic echocardiography. These are categorized into appropriate, inappropriate and uncertain. A total of 34 indications were applicable to this ECHO lab. These are listed below in table 2.

Table 3: Indications for Echocardiography at the ECHO suite, University College Hospital Ibadan.

Number of Indication	Summary of indication	Number of Referrals	Percentage of Referrals
1	Symptoms or conditions potentially related to suspected cardiac aetiology	240	11
2	Prior testing that is concerning for heart disease or structural abnormality	120	5.5
4	Frequent VPCs or exercise induced VPCs	1	0.0
5	Sustained or non-sustained atrial fibrillation, SVT or VT	8	0.4
6	Asymptomatic isolated sinus bradycardia	17	0.8
7	Clinical symptoms or signs consistent with a cardiac diagnosis known to cause light headedness/pre syncope/syncope	5	0.2
9	Syncope with no symptoms/signs of CV disease	3	0.1
13	Routine perioperative evaluation of ventricular function with no symptoms/signs of CV disease	227	10.4
15	Evaluation of suspected pulmonary hypertension, RV function and Pulmonary artery pressure	12	0.6
21	Acute chest pain with suspected MI and non-diagnostic ECG	2	0.1
28	Suspected Pulmonary embolism in order to establish diagnosis	2	0.1
29	Known acute pulmonary embolism to guide therapy	7	0.3
31	Re-evaluation of known pulmonary embolism after thrombolysis or thrombectomy	1	0.0
34	Initial evaluation when there is a reasonable suspicion of valvular or structural heart disease	5	0.2
37	Re-evaluation of known valvular heart disease with a change in clinical status to guide therapy	1	0.0
47	Initial post-op evaluation of prosthetic valve	1	0.0
52	Initial evaluation of suspected infective endo-	3	0.1

	carditis with positive blood cultures/a new murmur		
55	Re-evaluation of infective endocarditis at high risk of progression/ a change in clinical status	1	0.0
57	Suspected Cardiac mass	2	0.1
58	Suspected cardiovascular source of embolus	1	0.0
59	Suspected pericardial conditions	2	0.1
61	Re-evaluation of known pericardial effusion to guide management or therapy	6	0.3
63	Evaluation of the ascending aorta in the setting of a known or suspected connective tissue disease	2	0.1
67	Initial evaluation of suspected hypertensive heart disease	186	8.6
68	Routine evaluation of systemic hypertension without symptoms or signs of hypertensive heart disease	351	16
70	Initial evaluation of known or suspected HF (systolic and diastolic) based on symptoms or signs	124	5.7
71	Re-evaluation of known HF with a change in clinical status	1	0.01
72	Re-evaluation of the known HF with a clear precipitating change in medication or diet	2	0.1
73	Re-evaluation of known HF to guide therapy	2	0.1
79	Routine surveillance of implanted device without a change in clinical status or cardiac exam	1	0.0
86	Initial evaluation of known or suspected cardiomyopathy	21	1
87	Re-evaluation of known cardiomyopathy with change in clinical status or cardiac exam or to guide therapy	2	0.1
91	Baseline and serial re-evaluations in a patient undergoing therapy with cardio toxic agents	70	3.2
92	Initial evaluation of known or suspected adult congenital heart disease	3	0.1

NB: Seven hundred and thirty-three (33.7%) of echocardiography tests done were not classified as 339(15.6%) of these had indications that were not addressed by the 2011 AUC

document. The other 394(18.1%) requests had no indication for echocardiography on the request forms.

Of the 1578 ECHOs that could be evaluated by the 2011 appropriate use criteria, 56.9% of them were appropriate, 43% were inappropriate and 0.001 were uncertain. Table 3 below shows the ECHOs addressed by the 2011 AUC, including those with no indications and those that could not be classified by the AUC.

Table 4: Appropriateness of Indications for Echocardiography

Indication	Number	Percentage
Appropriate	898	41.3
Inappropriate	678	31.1
Unclassified	203	9.3
No indication	394	18.1
Uncertain	2	0.1

Table 5 below shows the characteristics of the ECHO results according to the indications for ECHO. Those with appropriate, inappropriate and unclassified indications had 23.6%, 24% and 27.9% normal results respectively. Those appropriate indications clearly showed a significant difference between those with normal and those with abnormal ECHOs in terms of their systolic blood pressures, left ventricular ejection fractions and their left atrial sizes. Other details are in table 5 below.

Table 5: Classification of ejection fraction, left atrial diameter and blood pressure according to the appropriateness of the indication for Echocardiography

Appropriate-Variables	Normal study(n=210)	Abnormal study(n=681)	P value
Ejection fraction (%)	68.7±8.6	58.9±18.2	0.000
Left atrial diameter (cm)	3.31±0.46	3.86±0.81	0.000
Systolic blood pressure (mmHg)	127.8±18.8	132.4±22.5	0.025
Inappropriate-Variables	Normal study(n=115)	Abnormal study(n=364)	P value
Ejection fraction (%)	68.9±9.54	68.4±12.8	0.61
Left atrial diameter (cm)	3.37±0.42	3.59±0.58	0.000
Systolic blood pressure (mmHg)	136.4±18.6	142.1±21.6	0.011
Unclassified-Variables	Normal study(n=39)	Abnormal study(n=101)	P value
Ejection fraction (%)	70.3±7.1	66.3±12.9	0.035
Left atrial diameter (cm)	2.77±0.39	2.87±0.4	0.107
Systolic blood pressure (mmHg)	127.3±16.6	130.2±20.4	0.421

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Table six below shows the characteristics of participants who had normal Echocardiography results.

Table 6: Variables of people with normal study

Variables	N	Minimum	Maximum	Mean ± Standard Deviation
Height (cm)	430	130	195	165.8±10.1
Weight (Kg)	431	30	138	74±16.4
Age (years)	480	13	89	46.2±15
Systolic BP(mmHg)	345	90	200	130.9±18.8
Diastolic BP (mmHg)	345	50	125	83.9±11.7
Aortic root diameter (cm)	484	1.8	4.5	2.75±0.4
Aortic valve opening (cm)	481	0.97	2.7	1.95±0.29
Left atrial diameter (cm)	483	1.8	4.8	3.36±0.46
Interventricular septal diameter in diastole (cm)	482	0.4	1.6	0.85±0.2
Interventricular septal diameter in systole (cm)	482	0.3	3.3	1.23±0.29
Posterior wall thickness in diastole	482	0.32	1.4	0.85±0.18
Posterior wall thickness in systole (cm)	481	0.5	2.3	1.37±0.3
Left ventricular internal diameter in diastole (cm)	482	2.8	6.2	4.7±0.54
Left ventricular internal diameter in systole (cm)	482	1.1	4.4	2.9±0.5
End diastolic volume (cm^3)	482	30.6	196	104.6±27.8
End systolic volume (cm^3)	482	2.4	175	33.1±15
Stroke volume(cm^3)	482	17	134	71.8±20.5
Fractional shortening (%)	482	19.5	76	39.1±7.4
Ejection fraction (%)	482	39.6	97	68.8±9
Trans-mitral Early velocity(cm/s)	483	0.2	1.96	0.76±0.18
Trans-mitral late diastolic velocity(cm/s)	484	0.1	1.7	0.61±0.16
Early deceleration time(msec)	432	66	427	188.7±51.9

Table seven shows the difference between the abnormal and normal ECHO studies. Those with normal ECHO results are younger, have lower systolic blood pressure values, have smaller left atrial and aortic root dimensions. Other details can be seen in the table below.

Table 7: Difference of variables between normal study and abnormal ECHO studies

Variables	Normal (n=430)	Not Normal (n=1487)	Degree of significance
Height (cm)	165.8±10.1	165.2±9.5	0.221
Weight (Kg)	74±16.4	74.5±16.4	0.587
Age (years)	46.2±15	58±15.8	0.000
Systolic BP(mmHg)	130.9±18.8	135.4±22.3	0.001
Diastolic BP (mmHg)	83.9±11.7	84±14.0	0.947
Aortic root diameter (cm)	2.75±0.41	2.9±0.43	0.000
Aortic valve opening (cm)	1.95±0.29	1.96±0.34	0.350
Left atrial diameter (cm)	3.36±0.49	3.76±0.75	0.000
Interventricular septal diameter in diastole (cm)	0.85±0.2	0.96±0.27	0.000
Interventricular septal diameter in systole (cm)	1.24±0.29	1.33±0.38	0.000
Posterior wall thickness in diastole (cm)	0.85±0.18	0.96±0.26	0.000
Posterior wall thickness in systole (cm)	1.37±0.31	1.46±0.39	0.000
Left ventricular internal diameter in diastole (cm)	4.71±0.54	4.98±1	0.000
Left ventricular internal diameter in systole (cm)	2.87±0.5	3.3±1.2	0.000
End diastolic volume (cm^3)	104.6±27.8	123.9±60	0.000
End systolic volume (cm^3)	33.1±15	53.2±50	0.000
Stroke volume(cm^3)	71.8±20.5	71.4±27.5	0.733
Fractional shortening (%)	39.1±7.4	35.3±12	0.000
Ejection fraction (%)	68.8±9	62.4±17	0.000
Trans-mitral Early velocity(cm/s)	0.76±0.18	0.72±0.26	0.001
Trans-mitral late diastolic velocity(cm/s)	0.61±0.16	0.7±0.27	0.000
Early deceleration time (msec)	188.7±51.	191.6±65.2	0.408

Table eight shows the sources of referrals for Echocardiography in University College Hospital, Ibadan. Of the known sources, cardiologists are the chief source of echocardiogram referrals, followed by the surgeons. About a third of the referrals could not be traced to any particular source due to incompleteness of records. Details are seen in the table below.

Table 8: Sources of Referrals for Echocardiography to ECHO lab, UCH

Classification of Sources of Referral	Frequency	Percentage
Cardiologists	660	30.4
Other Internal Medicine Specialists	272	12.5
Surgeons, O&G and Ophthalmologists	336	15.5
Family medicine and Others	174	8
Source of Referral not known	732	33.7

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Table nine shows the sources of referrals responsible for normal echocardiography results. Cardiologists are responsible for the highest percentage of referrals that turn out to be normal, followed closely by the surgeons. Details can be seen in the table below.

Table 9: Sources of Referrals responsible for normal findings

Sources of Referral	Number	Percentages
Cardiologists	132	27.2
Other Internal Medicine Specialists	55	11.3
Surgeons, O&G and Ophthalmologists	95	19.6
Family Physicians and others	40	8.2
Source of Referral not known	163	33.6

CHAPTER FIVE

DISCUSSION

5.1 The profile of people referred for echocardiography at the echo suite

A total of 2174 echocardiography(ECHO) studies were recruited in this study. Hypertension was the most common indication for ECHO (16%). This is comparable to the findings of Oyedeji et al, where hypertension was the most common indication for ECHO. The percentage of 16.1% is however much lower than that in Cuspidi et al (30.4%). This is likely due to the fact that Hypertension and hypertensive heart disease are separate indications in this study (as compared to theirs), with both having a combined prevalence of 24.6%. Oyedeji et al considered hypertension and hypertension related indications together and repointed a joint prevalence of 38.1% in their study. They worked in a similar geo-political zone (just 133km south of our centre). However, their higher prevalence may be due to the type of clinical practice- theirs is a private clinic with a total number of 168 cases over a 2-year period while ours is a public, tertiary hospital which grossed over 1200% of their number of patients, cutting across most disciplines of medicine. The sizeable number of referrals for surgeons, family physicians and other disciplines may have accounted for a salutary effect on the prevalence of hypertension and hypertension-related indications in this study.

The next most common indication is that of symptoms suspect of a potential cardiac aetiology (11%). These comprised of stroke, palpitations, breathlessness, pedal swelling, among others. Other common indications include pre-operative cardiac evaluation (10.4%),

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evaluation of cardiac function in those about to commence cardiotoxic agents (5.7%), prior testing that is concerning heart.disease (5.5%) and heart failure (3.2%).

5.2 The appropriateness of the indications for echocardiography at the echo suite

Most studies have shown that most echocardiogram labs largely comply with AUC criteria, with greater than 70% of the indications being appropriate. Patil et al has 82% of the 1820 indications for echocardiograms done as being appropriate. (Patil, Coggins, Kusnetzky, & Main, 2012) However, this study found that only 41.1% of the indications for ECHO were appropriate. This is in stark contrast to the findings from most studies. This could be possibly explained by the unduly high proportion of those ECHO requests that had no indication. If these were taken out, the adjusted prevalence of appropriate indications will be 50.4% Another reason is that the most common indication for ECHO in our lab, hypertension, is classified as inappropriate by the AUC 2011. This causes a sharp fall in the percentage of appropriate indications.

Two hundred and three ECHOs were done which could not be classified by the 2011 AUC. Some of these indications include cancer, chronic kidney disease, Prostate enlargement, simple multinodular goitre, sickle cell anaemia, suspected COPD, Ischaemic heart disease, routine ECHO, suspected stroke and diabetes mellitus, among others. While it is true that some of these conditions may get complicated and require ECHO, they do not qualify as standalone indications, nor were they addressed as being either inappropriate or uncertain in the 2011 AUC.

An unpleasant finding is that of 394 ECHOs being done at the lab with absolutely no indication. This is more in number than the highest ranking indication for ECHO (16% vs18.1%) This has not been commonly reported.

5.3 The correlation between the indications and the results of the echocardiography

All classifications of indications for ECHO revealed normal findings, with appropriate, inappropriate and unclassified yielding percentages of 23.6%, 24% and 27.9% respectively.

The results of the ECHOs done for those with appropriate indications showed a significant difference in the systolic blood pressure, left ventricular ejection fraction and left atrial diameter among those with normal as compared to those with abnormal findings. This suggests that those with abnormal findings on ECHO had significantly higher blood pressure readings than their counterparts, had reduced systolic function and had larger left atrial diameters- a measure of diastolic dysfunction. It is interesting to note that this pattern is not found in the other classifications, as those with inappropriate indications had similar left ventricular ejection fractions regardless of whether the ECHO report ended up being normal or not. However, for those who had abnormal ECHO results, the systolic blood pressure was significantly higher as compared to those with normal results. This suggests that there may be a yet undefined blood pressure cut-off point at which ECHO may be indicated- regardless of the duration of hypertension or presence of other risk factors.

Those with unclassified indication for ECHOs had significantly lower left ventricular ejection fractions among those with abnormal ECHO finding as compared with those who had normal ECHOs. However, their left atrial diameters and systolic blood pressures were essentially same in both groups.

The summary of this is that the appropriate indications have good discriminant ability, with those having abnormal ECHO findings having elevated blood pressure as compared to those with normal findings. The findings from inappropriate indications' analysis suggests that there may be a yet to be defined cut off point, at which uncontrolled blood pressure may be a stand-alone indication for ECHO. The unclassified indications may be sorted out individually and standardized based on individual merit or demerit.

Over 2000 ECHOs were done during the period of review. Only 41.1% of the indications were appropriate according to the 2011 AUC, a percentage that is quite low as compared to figures from most parts of the world. The main reasons are that hypertension, the most common indication for ECHO in this study, is an inappropriate indication. However, 74% of people referred with inappropriate indications had left atrial enlargement. Their blood pressures were also significantly higher than those with normal findings on ECHO. Over 18% of the ECHOs done had no indication whatsoever. Cardiologists are also the chief source of referral for ECHOs to the lab.

5.4 Conclusions

The audit of the ECHO lab showed that the percentage of appropriate indications for ECHO is relatively low and the inappropriate indications unduly high. However, more than 70% of people who were referred with inappropriate indications (of which hypertension was chief) had left atrial enlargement, a feature of hypertensive heart disease. This suggests that hypertension may be re-classified as an appropriate indication for ECHO, at least in Africans. There is a need to corroborate this finding in other studies.

5.5 Limitations

The profile of patients referred for ECHO to the lab is not exhaustive. Important information such as occupational status, level of education, source of funding for ECHO, and even patient satisfaction with the services rendered at the ECHO lab are pivotal pieces of information that make for a holistic assessment of the functioning of the lab. These are not routinely nor periodically collected.

This study is also limited by the available data and the medical record system that is presently operational in the hospital, where individual case notes have to perused to see if each ECHO did have a positive, pivotal impact on patient management or not. This could be easy to do if an electronic medical record system were operational and checklists in this regard were incorporated into day-to-day functioning of the hospital.

5.6 Recommendations

There is a need for the following:

1. Putting checks and balances in the referral system to limit omission of variables. Referral forms without clearly stated indications would have to be filled before they are accepted at the ECHO lab.
2. Expansion of the 2011 AUC guideline to include subsections that address unclassified indications.
3. A new ECHO referral/request form should be designed, based essentially on the 2011 AUC document.

4. The information about the guideline should be disseminated to all stakeholders. The ECHO AUC app on google play should also be used by residents and house officers who fill request forms on behalf of their senior colleagues.

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Appendix I- Informed Consent Form

IRB Number _____

This approval will elapse on ___/___/___

Title of Research- Clinical Audit of echocardiography services utilization at Echo Suite, University College Hospital, Ibadan

Name of Researcher- Dr ONI, Opeyemi Olalekan of Department of Medicine, University College Hospital.

Purpose of Research- To audit of echocardiography services utilization at Echo Suite, University College Hospital, Ibadan.

Procedure of Research- A questionnaire will be administered to you which you will be required to fill appropriately. Some details will also be obtained from your echocardiography result

Consequences of Research participants desire to withdraw/Procedure for orderly termination of research participation- You can withdraw from the research at any time. Please note that some information that has been obtained before you choose to withdraw may be used in reports and publications. However, we promise to comply with your wishes as much as possible.

Modality for providing treatment in case of an adverse event- in case you suffer any injury as a direct consequence of the conduct of this research, we will bear the cost of your care at UCH.

Risks: The study poses no risk to participants.

What happens to research participants when research is over- Those with significant heart problems discovered during this research will be referred to the cardiology unit of university college hospital for expert care and follow-up

Sharing of benefits- if benefits evolve from this research, there is no plan to contact participants either now or in the future about such.

I have fully explained this research to _____ and have given sufficient information, including risks and benefits, to make an informed decision.

_____ _____

Date Signature

Name _____

Statement of person giving consent: I have read the description of the research. I have also talked it over with the doctor to my satisfaction. I understand that my participation is voluntary. I know enough about the purpose, methods, risks and benefits of the research study to judge that I want to partake in it. I understand that I may freely stop participating in this study at any time. I have received a copy of this consent form and additional information sheet to keep for myself.

Date _____ Signature/ thumb print _____

Name _____

Researchers' contact address- Department of Medicine, University College Hospital, Ibadan.

Researchers' phone number- 08060450458

Researchers' email address-

Appendix II- Ethical Approval

INSTITUTE FOR ADVANCED MEDICAL RESEARCH AND TRAINING (IAMRAT)
College of Medicine, University of Ibadan, Ibadan, Nigeria.

Director. **Prof. Catherine O. Falade.** *MBBS (Ib), M.Sc. FMCP, FWACP*
Tel: 0803 326 4593, 0802 360 9151
e-mail: cfalade@comui.edu.ng lillyfunke@yahoo.com

UI/UCH EC Registration Number: **NHREC/05/01/2008a**

NOTICE OF FULL APPROVAL AFTER FULL COMMITTEE REVIEW

Re: Clinical Audit of Echocardiography Services Utilization at Echocardiography Suite, University College Hospital, Ibadan

UI/UCH Ethics Committee assigned number: UI/EC/16/0168

Name of Principal Investigator: **Dr. O. O. Oni**

Address of Principal Investigator: Department of Epidemiology & Medical Statistics.
College of Medicine,
University of Ibadan, Ibadan

Date of receipt of valid application: 14/06/2016

Date of meeting when final determination on ethical approval was made: N/A

This is to inform you that the research described in the submitted protocol, the consent forms, and other participant information materials have been reviewed and *given full approval by the UI/UCH Ethics Committee.*

This approval dates from 28/07/2016 to 27/07/2017. If there is delay in starting the research, please inform the UI/UCH Ethics Committee so that the dates of approval can be adjusted accordingly. Note that no participant accrual or activity related to this research may be conducted outside of these dates. *All informed consent forms used in this study must carry the* UI/UCH EC *assigned number and duration of* UI/UCH EC *approval of the study.* It is expected that you submit your annual report as well as an annual request for the project renewal to the UI/UCH EC early in order to obtain renewal of your approval to avoid disruption of your research.

The National Code for Health Research Ethics requires you to comply with all institutional guidelines, rules and regulations and with the tenets of the Code including ensuring that all adverse events are reported promptly to the UI/UCH EC. *No changes are permitted in the research without prior approval by the* UI/UCH EC *except in circumstances outlined in the Code. The* UI/UCH EC *reserves the right to conduct compliance visit to your research site without previous notification.*

UI/UCH EC APPROVED COLLEGE OF MEDICINE

Professor Catherine O. Falade
Director, IAMRAT
Chairperson, UI/UCH Ethics Committee
E-mail: uiuchec@gmail.com

Appendix III: Data Entry Form

Profile of clients presenting for echocardiography at Echo suite, University College Hospital, Ibadan.

- Serial Number

Name
Hospital Number
Age
Sex
Height
Weight
Body Mass Index
Phone Number
Referring Doctor
Referring Clinic/Ward
Indication for Echo
Conclusion of Echo

Echocardiographic Variables

- LAD

AOD
AVO
IVSTd
IVSTs
PWd
PWs
LVIDd
LVIDs
FS
EF
Trans-mitral E
Trans-mitral A
E deceleration time

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