Nigerian Journal of Medical Imaging and Radiation Therapy

BASIC ECG INTERPRETATION SKILL COMPETENCIES FOR TRAINEE ECHOSONOGRAPHERS IN NIGERIA: A PROPOSED CURRICULUM

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ARTICLE INFO

Keywords:
Echocardiography, Electrocardiography, ECG interpretative skills, Curriculum, Radiographers Registration Board of Nigeria.
Conflict of interest: None

ABSTRACT

Background: Electrical disturbances impact echocardiographic parameters in several disease states of the heart. Research shows that basic knowledge of ECG is an essential prerequisite in the successful learning and practice of Echocardiography.

Objective: To highlight the importance of basic ECG knowledge in the study and practice of Echocardiography and to suggest necessary content of the needed curriculum of study for interpretative ECG skill for trainee echocardiographers.

Method: In this critical review we searched online literature to identify ECG interpretation competencies relevant to trainee/practicing echocardiographers. Information was retrieved from PubMed, PubMed Central, SPIE Digital Library, ResearchGate and Medline using relevant MeSH terms and phrases.

Results: The learning objectives and course outlines are hereby defined and enumerated. Basic ECG interpretation competency for echosonographers is defined in perspective and the use of Wigger's diagram to identify common readings that may constitute potential risks to stress echo procedure are highlighted.

Conclusion: A clinical echocardiographer must be able to demonstrate basic understanding of ECG tracings. Basic ECG training is not only essential for echo reporting but can also equip a practicing echosonographer with sufficient knowledge to ascertain when stress echo is contradicted in the subject especially in the absence of a supervising cardiologist.

INTRODUCTION

Echocardiography (Echo) is an imaging modality regarded as highly valuable in the diagnosis and evaluation of cardiac anatomy, function, and hemodynamics, and hence is the most commonly used imaging procedure for the diagnosis of heart disease [1,2]. The Inter-societal Commission for the Accreditation of Echocardiography Laboratories (1999) defines the cardiac sonographer as an allied health practitioner who, as the result of comprehensive, specialized education in the medical and technical aspects of diagnostic cardiac sonography, is qualified to perform echocardiographic examinations in compliance with protocols and techniques, as outlined in its document titled: *Essentials and Standards* [3]. While Echo offers real-time evaluation of cardiac anatomy, function, and hemodynamics [1], electrocardiogram (ECG) on the other hand depicts the electrical behavior of the heart [4,5], and hence defines cardiac rhythm [6].

Since many cardiac abnormalities alter the heart's electrical activity, and cause changes in the ECG tracing [6], the modality has become an essential cardiac diagnostic tool that produces record of the electrical activities of the heart, and conveys useful information for the study and follow-up of some patients with cardiovascular diseases [7]. It is well appreciated by clinicians that abnormal ECG changes can precede pathological echocardiographic findings in patients with underlying cardiac pathology, such as hypertrophic cardiomyopathy, and that electrical alterations convey additional clinical information to the imaging of cardiac structure and function in these patients [8,9]. It has been reported that ECG left ventricular hypertrophy (LVH) and echo LVH for instance, are distinct entities and can occur exclusive of each other in the same group of subjects [10]. According to Anderson et al [11], ECG is vital to identification of athletes with high risks of sudden deaths related to cardiovascular disorder. Today, portable personal wearable ECG monitors exist with which patients can monitor their heart rhythm from the comfort of their homes and offices [12]. This is particularly important when the heart rhythm is to be monitored over a long period of time to isolate transient abnormal rhythms which could explain the patient's symptoms [13].

Beyond diagnosis of abnormal electrical feedback from the heart, ECG is an indispensable tool in certain Echocardiography (Echo) procedures. During Echo studies, ECG is used to assess cardiac rhythms. This is important for measurement of certain parameters such as Doppler assessment of the aortic valve. It has become near-common knowledge in Echo that Doppler assessment of the aortic valve could be significantly misleading if conducted during a cardiac cycle with premature ventricular contraction (PVC) or the cycle immediately following the PVC [14]. This is because of poor inotropic force associated with PVC which could cause an underestimation of the aortic valve velocity. Also, given the compensatory increase in the force of contraction in the normal cycle immediately following the PVC in keeping with Frank-Starling's law [15], an increased velocity could be recorded at the aortic valve which can give a false impression of aortic stenosis [14].

One of the most important applications of ECG in Echo is the timing of events. To calculate the ejection fraction either by Teicholz [16] or Simpson's biplane method of discs evaluation of aortic annulus, aortic root, sinotubular junction, and descending aorta, [17], the ECG tracing is utilized to identify the Isovolumic contraction time (IVCT) and Isovolumic relaxation time (IVRT) for end-diastolic and end-systolic measurements respectively [18]. Echo is important in the evaluation of diastolic function [19] which involves consideration of multiple parameters. Measurement of such parameters like the E/A ratio, septal and lateral velocity by Tissue Doppler Imaging (TDI), and pulmonary vein systolic/diastolic (S/D) ratio and velocity of Atrial-wave reversal, require precise timing which can only be achieved by reading the ECG tracings for the appropriate cardiac cycle [20].

Furthermore, the job description of most Cardiac Sonographers includes conducting stress echocardiographic studies. This involves the use of ECG and Echocardiography to evaluate the response of the heart to increased workload [21]. This can usually unmask occult wall motion abnormalities owing to coronary arteries which are not obvious in resting state. Stress echo is also used in the evaluation of several other non-ischaemic heart conditions such as Athlete's heart, diastolic dysfunction, pulmonary hypertension, congenital heart disease and valvular diseases [22, 23, 24, 25]. According to Kossaify, et al [26], to avoid or minimize complications during a stress echo study, it is important that protocols, indications and contraindications are strictly adhered to. Absolute contraindications for this procedure include severe Ventricular Arrhythmias and acute myocardial infarction whereas a trial fibrillation could constitute a relative contraindication [27,21]. Identification of abnormal rhythms indicative of these conditions is a reason to terminate the procedure or seek the guidance of Physician-in-charge. This implies that a sonographer who is not able to appreciate these changes on ECG is not only unqualified to handle these procedures but also constitutes a risk to the patient.

A review of the Radiographers Registration Board of Nigeria (RRBN) Cardiac ultrasound curriculum shows that little or no emphasis is placed on comprehensive review of ECG techniques and interpretative skills but rather emphasizes hands-on echo skills. This might be under the assumption that Radiographers possess the required ECG interpretative skills as healthcare practitioners and as stakeholders in Cardiac

Ultrasound practice. Based on the foregoing it has become imperative to review the current training curriculum for echocardiography in Nigeria with a view to making it fit for purpose and producing professionals that meet minimum standards for safe echo practice.

This critical review is intended to provide a framework for training Echocardiographers in Nigeria in basic 12-lead ECG interpretation to equip them with the skills necessary to identify common changes in the ECG tracing that may signal emergency heart conditions contraindicating certain echo procedures, such as stress echo, for purpose of patients' safety and to ensure that echocardiography training in Nigeria meets international best standards.

RATIONALE

Anecdotal evidence suggests that radiographers constitute majority of the practicing sonography professionals in Nigeria and the Radiographers Registration Board of Nigeria (RRBN) is the only body currently certifying sonographers in Nigeria. The RRBN through the Institute of Radiography also organizes ultrasound programs in general and Cardiac/Vascular specialties leading to award of PGDs. These programs are predominantly for radiographers who are registered with the body. We recognize that setting goals and objectives for target learners is the important initial step and a core prerequisite for effective curriculum development [28]. It is important that echocardiography students learn the appropriate cardiac anatomy, ECG lead placement, and the electro-physiology mechanism associated with each specific ECG pattern, as well as the systematic approach behind ECG interpretation. Common findings, such as bundle branch blocks, left anterior fascicular block, premature ventricular/atrial complexes, electronic pacemakers, and left ventricular hypertrophy, have been identified as essential to the daily interpretation of ECGs [5].

METHODS

We thoroughly searched online literature to identify ECG interpretation competencies relevant to trainee/practicing echocardiographers. We evaluated existing training curriculum of reputed training institutions leading to the award of professional certifications in echocardiography in some advanced countries of the world. Information was retrieved from PubMed, PubMed Central, SPIE Digital Library, ResearchGate and Medline using the following MeSH terms and phrases: electrocardiography, electrocardiogram, electrocardiography interpretation, cardiac echo, cardiac sonography, electrocardiography interpretative skills, echocardiogram, echocardiography curriculum, echocardiography training, echocardiography education, electrocardiography skills in echocardiography. Abstracts of primary and secondary sources were evaluated for relevance by title and contents. Particular attention was paid to works that featured both ECG and echocardiography or explained the rationale for ECG interpretation skills in echo training in their curriculum.

RESULTS

In this review we identify the learning objectives as outlined in fig I and course outline as enumerated in fig II. We define basic ECG interpretation competency for echosonographers as the capacity to adequately and competently differentiate between normal and abnormal ECG readings, use of Wigger's diagram to time mechanical events of the heart on Echocardiography and to identify common readings that may constitute potential risks to stress echo procedure. We recognize that technical details of the processing and recording of ECGs must be made familiar to echocardiographers.

DISCUSSION

We appreciate the good intention of the RRBN to produce clinically competent Radiographers and Sonographers to satisfy the manpower need in this aspect of health care. This underpins the ongoing drive to encourage and empower more Sonographers in the subspecialty areas such as echocardiography to close the obvious manpower gap. However, the project must be wholesome if we are to produce personnel with the requisite skill competencies. ECG technique and interpretation seem not to have been given the desired place in the existing curriculum of training for echocardiographers in Nigeria. The field of ECG is so broad that even the most experienced of cardiologists and physicians could still find it challenging. According to Nagueh et al [19], the primary role of the cardiac sonographer is to obtain diagnostic recordings of cardiac ultrasonography images and Doppler hemodynamic data. These researchers are of the view that since the modality is strictly operator-dependent, optimal performance requires highly skilled and well-educated personnel who can continuously combine known clinical information, ultrasonographic image content, and related physiologic data to deliver an examination that is both comprehensive and accurate. Experts also recommend electrocardiography interpretation as part of curriculum for the training of echocardiographers [1,2,19].

Electrical disturbances impact echocardiographic parameters in several disease states. For instance, PVCs affect the stroke volume through the aortic valve which in turn affects the measured pressure gradient across the valve [14]. This knowledge is very important in the assessment of the aortic valve for valvular stenosis. A beat immediately following PVC would demonstrate higher pressure gradient, and could be misinterpreted as a higher grade of valvular stenosis by a novice cardiac sonographer [15]. This is the same for most parametric assessments in Echocardiography; they often require the guidance of ECG tracing for precise timing and identification of significant arrhythmias. This is of more consequence in the Nigerian context where the cardiac sonographer does not only perform the echocardiograms but also interprets them for clinical implementation by the referring physicians.

One step towards the development of an ECG curriculum for Echocardiographers is to identify the level of ECG interpretative skills required to perform a full protocol Echocardiogram and stress Echo [16]. For stress Echocardiography, researchers recommend attention to abnormal electrical rhythms before and during the study [21, 27], warning that onset of ST segment elevation myocardial infarction should prompt the echocardiographer to terminate the study. This is very important in the Nigerian setting where most of these studies would be performed in diagnostic centres, of which some may not have a supervising cardiologist onsite.

To understand timing of cardiac events off of the ECG tracing, the echocardiographer should be able to understand the various components of an ECG tracing and understand what each segment depicts. An understanding of these electrical events and their corresponding mechanical cardiac responses forms the basics of ECG interpretation and sets the tone for appreciation of timing and arrhythmias as well as changes in intervals and segments [29].

Another important aspect of this review is the observation that in advanced countries, regulatory bodies in similar stead as the RRBN tend to provide the platform for accredited autonomous professional training institutions to train personnel in ultrasonography who in turn register and sit for professional examinations set up and moderated by the professional regulatory board. This should be adopted in Nigeria as it would engender stricter control in training, encourage professionalism and avert institutional conflict of interest. We believe that when regulation and certification are separated from training, monopoly would give way to competition and striving for excellence.

CONCLUSION

In this study, attempt has been made to identify roles of ECG in Echocardiography, necessary ECG competencies for a Cardiac sonographer and an overview of a basic course outline for ECG training of cardiac sonographers. Training of sonographers should be ceded to autonomous professional training institutions while the professional board should certify and regulate both training and practice.

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