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Review Article

Insight into ECG: the crucial contribution of ECG technicians in cardiological monitoring and diagnosis

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ABSTRACT

The electrocardiogram (ECG) is an indispensable non-invasive diagnostic tool which measures the heart's electrical activity and through this, very crucial in diagnosis and management of cardiovascular diseases, responsible for more than half of global deaths. Whereas advanced ECG technology is instrumental in capturing the heart activity, the expertise of ECG technicians is important for yielding precise and reliable results. This paper describes the crucial role that ECG technicians play in the healthcare system. The responsibilities include preparing patients, lead placement, operating the ECG machine, ensuring data quality control and assisting in the diagnostic process. It is their attention to detail that provides quality ECG data, which is critical in the interpretation of heart conditions, including arrhythmias, ischemia and heart attacks. More so, ECG technicians play a part in the active monitoring of patients with cardiovascular diseases or those going through treatments that influence heart health. Along with the increasing prevalence of cardiovascular conditions, there is the increase in usage of ECG technology in clinical and research settings, creating a demand for highly skilled ECG technicians. Their expertise not only enhances the accuracy of cardiovascular diagnostics but also supports advancements in medical research, helping to develop new treatments and technologies. In a nutshell, ECG technicians are vital members of the healthcare team that directly impacts patient outcomes and the future of cardiological care. Their role is crucial in ensuring that ECG remains a reliable tool for diagnosing and managing heart diseases.

Keywords: Electrocardiogram, ECG technician, Cardiovascular disease, Cardiac diagnostics, ECG interpretation, Arrhythmia detection, Patient monitoring, Heart health, Lead placement, Medical technology, Clinical cardiology, Non-invasive diagnostics, Diagnostic accuracy, Cardiology workforce, Healthcare support staff, ECG data quality, Cardiovascular monitoring, ECG in research, Medical device operation, Technician role in diagnosis

INTRODUCTION

The electrocardiogram, often referred to as an ECG or EKG, is a non-invasive recording of the heart's electrical activity taken from the body's surface. The term ECG originates in the German language. It is called elektro-kardiographie in German.

The biggest cause of death is cardiovascular disease. Therefore, medical professionals must be equipped with the skills and knowledge to interpret ECGs and provide appropriate care as quickly as possible. In many cases, doctors find complex interpretation of the ECG outcome difficult. Errors in analytical leads to a wrong diagnosis and thereby delays the correct treatment course. This activity will seek to familiarize the participant with general principles of ECG mechanics, modes of interpretation and typical ECG findings.[1]

The ECG is used to monitor increasingly patients with hazardous occupations, athletes, patients on anti-arrhythmic therapy and other medications and has a very crucial role in preoperative assessment for surgery done outside cardiothoracic departments. ECG is applied as a research tool in monitoring and evaluating drugs with known effects on the heart.[2]

History

The ECG was invented by Willem Einthoven, a Dutch physician, in 1902. Upon completing very important contributions in clinical research within the following 10 years, the real therapeutic value of ECG then emerged to light. In 1910, ECG abnormalities and other arrhythmias that are related to angina and atherosclerosis were documented. Considered as the "father of electrocardiography," Einthoven won the Nobel Prize in Medicine in 1924 for developing the very fundamental technique concerning the assessment of cardiac disorders.

The ECG is broadly used in health care setups worldwide and is recognized as a sensible method for clinical diagnosis, as well as for screening. For evaluating the severity of cardiovascular diseases, electrocardiograms (ECGs) remain an important non-invasive investigative method.[5]

Overview

The conventional 12-lead electrocardiogram is the most commonly utilized diagnostic test to assess cardiovascular illness.[6] The most important test for interpretation of heart rhythm is the 12-lead electrocardiogram, identification of atrial abnormalities, ventricular hypertrophy, pericarditis, preexcitation, long QT syndromes, conduction system abnormalities, myocardial ischemia and infarction, among others.[7-11] the possibility for ambulatory cardiac rhythm diagnoses has also been made possible by modern technology. For example, cell phones may be used to diagnose atrial fibrillation or atrial flutter without the need for confirming ECGs.[12] Computerized ECG interpretation with the development of machine learning has improved the way physicians read and analyse ECGs.[13,14]

ECG INDICATIONS AND CONTRAINDICATIONS

Indication

In clinical medicine, one of the most helpful diagnostic procedures is the electrocardiogram (ECG). In addition to evaluating patients with electrolyte imbalances, medication toxicities, implanted defibrillators and pacemakers, it is frequently used to identify myocardial damage, ischemia and the existence of past infarction.[15]

Along with being helpful in assessing ischemic coronary disease, the ECG is especially helpful in diagnosing cardiac rhythm abnormalities and assessing syncope when used in combination with ambulatory ECG monitoring.

The examination of primary and secondary cardiomyopathic processes, metabolic diseases and medication side effects are among the other frequent applications of the ECG.[16] For the early identification of potentially fatal diseases, therapeutic care and eligibility for sports activity in this young group, it is essential to appropriately evaluate the resting electrocardiogram and imaging of paediatric athletes.[17]

Contraindications

A patient's rejection is the only definitive reason not to do an ECG. A number of manufacturers provide hypoallergenic substitutes for individuals who may be allergic to or, more frequently, sensitive to the glue used to attach the leads.[17]

Analysis of ECG records

All the following details should be incorporated into the first review of the 12-lead ECG: heart rate and rhythm, P-QRS-T morphology, the presence of a ST segment and PR-QRS-QT intervals. Every ECG should be carefully examined (or "read") in a methodical manner to prevent missing any significant anomalies. The actions listed below should be taken into account.

Rate

Bradycardia against tachycardia versus normal.

Rhythm

Normal sinus vs abnormal rhythms.

Axis

Normal against left deviation versus right deviation.

Intervals

PR, QRS, QT were the intervals.

Abnormality of the chamber

Ventricular hypertrophy, atrial enlargement

QRST duration

T-wave alterations, ST-segment depressions or elevations, Q waves or poor R-wave progression.[18]

12-lead ECG has a heart rate of 99 bpm, PR interval of 154 ms, QRS duration of 92 ms and QT/QTc of 340/437 ms, indicating normal cardiac electrical activity. Diagnosis suggests that there are no abnormalities; this represents an ideal, healthy heart, well-suited for both clinical and educational reference (permission form concerned department) (Figure 1).

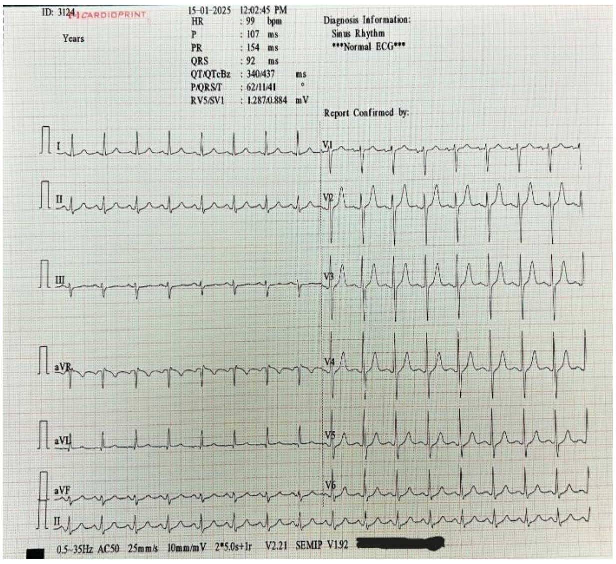

Figure 1: Normal cardiac electrical activity.

P wave

The length and shape of the P-waves show many features of the atria: Activation pathways, fibrosis, dyssynchrony and proper function may all be deduced from the surface P-wave analysis. The ECG can assist in distinguishing between atria enlargements and conduction abnormalities, such as intra- and interatrial block. This work aims to evaluate the most pertinent aberrant patterns and normal atrial morphology.[19]

PR interval

It has included the pause at the AV node and can reflect the lag between the atrial depolarization onset and the initiation of ventricular depolarization. The approximate range is about three to five small squares in width, (120 to 200 ms).[20]

QRS complex

It is indicative of ventricular depolarization because the AV node conducts electricity. Normally, a QRS complex takes between 60 to 100 ms, which is less than three tiny squares. Hyperkalemia or bundle branch obstruction may be indicated by a long QRS. Conversely, an early ventricular contraction or ventricular rhythm may be linked to a large QRS.[21]

Q wave

The Q-wave is a commonly seen small negative deflection in leads I, aVL, V5 and V6 and represents the interventricular septum's depolarization. It usually doesn't exceed 0.1 mV in amplitude and hence, it's not normally noticed on the ECG.

Abnormal Q waves may represent a previous myocardial infarction. An abnormal Q wave is one that is more than 25% of the QRS complex amplitude, deeper than 1 mm or longer than 40 milliseconds (one tiny box on the ECG).[22]

ST segment

Ventricular depolarization comes to a stop and ventricular repolarization begins. Typically, the ST segment lasts between 80 and 120 ms or less than two to three tiny squares.

The PR-interval and the ST-segment are at the same level and are isoelectric lines. Regardless of whether it is raised or depressed, a ST segment departure of 1 mm or more from the baseline at the J point is considered abnormal.[21]

T wave

T wave refers to the extremely sensitive representation of ventricular repolarization towards a variety of stimuli such as hormonal, neurological and even cardiac ones.

It is mostly positive usually during leads which reveal noticeable R waves upstrokes and normally has a size, one-eighth to two thirds the size of the R-wave and the height is supposed to be below 10 mm.[21]

Technique

Electrocardiogram devices capture the variations in electrical activity by drawing a trail on moving graph paper. With the y-axis indicating voltage and the X-axis representing time, the paper moves at 25 mm per second. From 1 second on the x-axis, five huge squares are made, each representing 0.2 seconds. Five smaller squares are then made from each giant square, each representing 0.04 seconds. The ECG machine is calibrated such that the stylus moves 1 cm with a 1 mV increase in voltage.[21]

The typical 12-lead ECG generates six limb leads and six precordial leads using 10 wires. The limb leads are labelled RA, LA, RL and LL, but they also include leads I, II, III, aVL, aVR and aVF. To avoid confusion, they are color-coded: the right leg is black, the left leg is green, the left arm is yellow and the right arm is red. The precordial leads, V1 through V6, are placed on the chest surface.[24]

The "angle of Louis" method can be used to determine the correct placement of ECG leads as follows.

On the left and right sides of the sternal border, respectively, are V1 and V2. The fifth intercostal space along the mid-clavicular line is where V4is placed. V4 should be placed before V3. V3 is midway between V2 and V4. V5 lies directly between V4 and V6. The sixth intercostal space on the midaxillary line is where V6 can be found. A fifth intercostal space should serve as a horizontal point of alignment for leads V4, V5 and V6.

A standard 12-lead ECG setup is seen Figure 2. Although limb electrodes (red, yellow, green and black) record activity in the frontal plane, chest electrodes (V1–V6) are placed to record the activity in the horizontal plane. For the proper acquisition of the best signal for an accurate evaluation of the electrical activity of the heart from different angles, the patient has to stay supine.

Figure 2: Standard 12-lead ECG setup.

CRUCIAL ROLE OF ECG TECHNICIANS

The main responsibility of an electrocardiogram technician, sometimes referred to as a cardiographic technician, ECG tech or EKG tech, is to perform electrocardiograms on patients. Many cardiac conditions can be diagnosed with an electrocardiogram, often known as an EKG or ECG. It analyzes the electrical activity of the heart.[25] They aid in cardiovascular monitoring and diagnosis in the following significant ways:

In Figure 3, ECG Technician is performing an ECG, attaching electrodes to a patient lying down to monitor heart activity. (Permission from the concerned department and consernt from the patient).

Figure 3: Standard 12-lead ECG setup.

Patient preparation

The patient usually lies peacefully in the supine position while the conventional 12-lead ECG is being conducted. It is important to make sure that the skin in the places where the leads are to be inserted is clean and free of extra hair. To help with lead apposition, the skin in these places may occasionally be prepared with a light abrasive pad.[26]

Lead positioning

To record the electrical activity of the heart, precise electrode positioning is necessary. The technician is in charge of precisely placing the electrodes on the patient's chest and limbs. Because improper placement might lead to distorted or confused ECG data, which can impede effective diagnosis, this step is essential.

Operating ECG machine

Even though the ECG equipment is very sophisticated, the technician needs to know how to use it properly. This entails adjusting the machine's settings, making sure it is calibrated and resolving any problems that could come up along the process. The technician must monitor the machine during the test to ensure that it is functioning properly and collecting accurate data.

Data review and quality control

The technician examines the ECG data once it has been captured to look for any possible mistakes or artefacts. This entails locating problems such as inadequate electrode contact, interference from movement or device failure. The technician might have to repeat the test or modify the electrodes if the results are unclear or inaccurate.

Supporting diagnosis

Although ECG technicians are not in charge of making medical diagnoses, the calibre of the data they offer is essential for cardiologists and other medical professionals to accurately interpret. Important information that aids in the detection of irregular rhythms, cardiac illness or heart attack symptoms can be obtained from a properly performed ECG. By guaranteeing the accuracy and dependability of the data, the technician so indirectly aids in the diagnostic procedure.

Impact on cardiological care

In order to guarantee the precision and dependability of the data needed to diagnose cardiovascular disorders, ECG specialists are crucial. Their knowledge directly affects the early identification and efficient treatment of cardiac conditions. In order to diagnose heart attacks, detect ischemia, identify aberrant heart rhythms and monitor patients with pre-existing cardiovascular diseases, accurate ECG records are essential.

ECG professionals offer real-time data that can greatly impact the treatment approach in emergency scenarios, such as suspected heart attacks or arrhythmias. Healthcare professionals can make life-saving judgments about interventions with the aid of a quick and precise ECG. In order to reduce risk and guarantee the best possible care, ECG technicians help with continuous monitoring for patients using drugs that may have cardiac adverse effects in non-emergency situations.

The growing demand for skilled ECG technicians

The need for qualified ECG technicians is growing since cardiovascular diseases continue to rank among the world's leading causes of mortality. ECG technology is being used more and more by medical professionals to diagnose, monitor and treat patients with cardiovascular diseases. From routine check-ups and preoperative assessments to critical care scenarios, technicians are required to support these efforts.

ECG technicians work in clinical and hospital settings, but they also participate in research settings where they use ECGs to examine how new medications or medical equipment affect heart health. Their proficiency with ECG testing guarantees that research is carried out correctly and that the findings are reliable for future developments in medicine.

CONCLUSION

The diagnosis and treatment of cardiovascular disease rely on the electrocardiogram (ECG). It is a very important tool for medical experts because it can capture the electrical activity of the heart without causing any harm. The proficiency of ECG technicians is just as important to the success of these treatments as the use of sophisticated ECG technology in recording heart activity. The precision and dependability of the results are greatly enhanced by ECG experts, who handle everything from patient preparation and electrode installation to running the equipment and guaranteeing data quality.

The quality of the diagnostic data is directly impacted by their meticulous attention to detail and their capacity to troubleshoot possible problems, which is crucial for cardiologists and other healthcare professionals to accurately interpret the data. Additionally, their participation in real-time data analysis is essential in emergency scenarios, guaranteeing prompt and knowledgeable judgments for patients dealing with life-threatening illnesses like arrhythmias or heart attacks.

As the prevalence of cardiovascular disease continues to rise globally, the demand for skilled ECG technicians grows. Their role extends beyond clinical settings to include research, where they contribute to the development of new medical technologies and drugs. The increasing complexity of cardiovascular care and the growing reliance on ECG technology highlight the need for highly trained technicians who are capable of ensuring precise and effective monitoring and diagnosis.

In summary, technicians involved in ECG form a significant component of the medical team and aid in better patient outcomes, medical research and all-round cardiological care. With proper skills, the ECG tool remains one of the most potent weapons in the battle against cardiovascular diseases.

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