



ECG Interpretation and Clinical Application in Cardiology Nursing Practice

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Abstract: This study is dedicated to elucidating the significance of electrocardiography (ECG) in the management of Acute Coronary Syndrome (ACS), particularly in diagnosing and making treatment decisions for patients with ST-Segment Elevation Myocardial Infarction (STEMI) and Non-ST-Segment Elevation Myocardial Infarction (NSTEMI). Through a detailed analysis of ECG waveform changes, we demonstrate how to quickly identify signs of myocardial infarction, and based on these findings, decide whether coronary angiography or emergency revascularization surgery is necessary.

Keywords: electrocardiography, acute coronary syndromes

1. Introduction

In cardiology nursing practice, electrocardiography (ECG) not only provides immediate information on heart rhythm and the conduction system but also reveals clues to various cardiac diseases such as myocardial ischemia, hypertrophy, and electrolyte imbalances. The interpretation of ECGs has shifted from traditional manual analysis to more reliance on advanced algorithms and automated analysis software. However, despite these technological advancements, accurate interpretation of ECGs and their clinical application still require healthcare professionals to have profound specialized knowledge and clinical experience. Currently, the main challenges in ECG interpretation within cardiology nursing include the subjectivity of interpretations, the difficulty in differentiating complex arrhythmias, and a lack of sufficient training resources. With the development of artificial intelligence and machine learning technologies, the automation of ECG interpretation will become more accurate and efficient, providing more reliable support for clinical decision-making.

2. Fundamentals and Key Points of ECG Interpretation

The ECG, a non-invasive cardiac test, charts the heart's electrical activity through distinctive waveforms: P wave (atrial depolarization), QRS complex (ventricular depolarization), T wave (ventricular repolarization), and occasionally the U wave, whose precise role is less clear, reflecting various phases of cardiac function.

Analyzing the ST segment and T wave is also a crucial part of ECG interpretation. Elevation or depression of the ST segment may suggest myocardial ischemia or myocardial infarction. Changes in the T wave, such as inversion or flattening, may also indicate issues like myocardial ischemia or electrolyte imbalances. Additionally, the length of the PR interval is an important parameter for assessing atrioventricular conduction function. Prolongation of the PR interval may indicate impaired function of the atrioventricular node, such as first-degree atrioventricular block.

Here's a simplified overview (Table 1):

Table 1. Simplified overview of ECG interpretation

Lead	Description	Wire Color (US Standard)	Position
I	Measures the voltage between the right arm and left arm electrodes	White (right arm), Black (left arm)	Right arm, Left arm
II	Measures the voltage between the right arm and left leg electrodes	White (right arm), Red (left leg)	Right arm, Left leg
III	Measures the voltage between the left arm and left leg electrodes	Black (left arm), Red (left leg)	Left arm, Left leg
aVR	Measures the voltage from the right arm electrode to a central point	White (right arm)	Right arm
aVL	Measures the voltage from the left arm electrode to a central point	Black (left arm)	Left arm
aVF	Measures the voltage from the left leg electrode to a central point	Red (left leg)	Left leg
V1-V6	Chest leads measuring the heart's horizontal plane	Varies	Chest, specific positions

Interpreting an ECG also requires attention to the direction of the electrical axis, which involves the waveforms in various leads on the ECG. A shift in the cardiac axis can suggest changes in heart structure, such as a leftward shift caused by left ventricular hypertrophy or a rightward shift caused by right ventricular hypertrophy.

ECG interpretation combines patient history, physical symptoms, and lab tests for accurate diagnoses, such as myocardial infarction[1]. Long-term monitoring like Holter is crucial for detecting intermittent arrhythmias, requiring deep knowledge of heart conditions.

3. The Role of ECG in the Diagnosis of Heart Diseases

The electrocardiogram (ECG) plays a crucial role in the diagnosis of heart diseases, providing valuable information about abnormalities in cardiac structure and function. With ECG, physicians can rapidly identify various cardiac conditions such as arrhythmias, myocardial infarction, cardiomyopathies, and electrolyte imbalances, thereby facilitating timely treatment for patients.

Arrhythmias represent a major application area for ECG diagnosis. By analyzing the timing, frequency, morphology, and sequence of ECG waveforms such as P waves, QRS complexes, and T waves, physicians can identify a range of arrhythmias, including sinus rhythm, atrial premature beats, ventricular premature beats, atrial fibrillation, atrial flutter, ventricular tachycardia, and ventricular fibrillation.

ECG is also vital in diagnosing acute myocardial infarction (AMI). Specific ECG changes, such as ST-segment elevation, the emergence of new Q waves, and T-wave inversion, enabling prompt reperfusion therapy to limit the extent of myocardial damage[2].

4. Clinical Application of ECG in Cardiology Nursing

Taking the management of Acute Coronary Syndromes (ACS) as an example, the ECG plays a central role throughout the entire care process. Upon admission of ACS patients, an immediate ECG is conducted to determine the presence of ST-Segment Elevation Myocardial Infarction (STEMI) or Non-ST-Segment Elevation Myocardial Infarction (NSTEMI). The results of the ECG directly influence the choice of emergency interventions, such as the need for coronary angiography and possible revascularization procedures for STEMI patients, while the treatment for NSTEMI patients is more focused on medication management and risk assessment.

Table 2. Various electrocardiogram (ECG) waveforms

Feature	Description
ST-segment elevation	Elevation of the ST segment is a hallmark of STEMI (ST-elevation myocardial infarction), indicating acute injury. Usually seen in contiguous leads based on the affected coronary artery.
ST-segment depression	ST-segment depression can indicate NSTEMI (non-ST elevation myocardial infarction) or unstable angina. It reflects ischemia rather than injury.
T-wave inversion	T-wave inversions may occur in the setting of ischemia or as a post-myocardial infarction (MI) change. They can be transient or persistent.
Pathological Q waves	Development of new Q waves may indicate a completed MI. They represent necrosis and are usually seen after the acute phase of STEMI.

Table 2 displays various electrocardiogram (ECG) waveforms, each representing different states of cardiac electrical activity[3]. In the management of Acute Coronary Syndrome (ACS), the ECG is pivotal for diagnosis. This image shows multiple waveforms including normal P waves, QRS complexes, and T waves. Specifically, in ACS, healthcare providers pay close attention to ST segment changes. For ST-Elevation Myocardial Infarction (STEMI), the ECG typically exhibits significant elevation in the ST segment across multiple contiguous leads, whereas in Non-ST-Elevation Myocardial Infarction (NSTEMI) the ST segment may not be notably elevated but could be accompanied by T wave inversions or other abnormalities. Coronary angiography is conducted to determine whether there is blockage or narrowing in the coronary arteries and to assess the need for revascularization procedures. For patients with STEMI, this intervention is particularly urgent as rapid restoration of blood flow can minimize myocardial damage and improve prognosis. For patients with NSTEMI, ECG monitoring is often used in conjunction with biochemical markers (such as cardiac troponins) to assess the extent of myocardial injury and guide therapeutic and risk stratification decisions, including antiplatelet therapy, anticoagulation, and potential interventional treatments.

ECG monitoring is vital for chronic heart disease management and pre- and post-cardiac surgery care. It helps in tracking disease progression, evaluating treatment effectiveness, guiding surgical decisions, and identifying complications early, improving patient outcomes.

The accurate application of the ECG requires cardiology nurses to possess a high level of professional knowledge and skills. They need to be familiar with the various waveforms, intervals, and segments of the ECG and understand the clinical significance of their normal and abnormal variations. Additionally, correct placement of leads and avoidance of interference signals are crucial for ensuring the accuracy of the ECG. Therefore, regular training and practice are essential for enhancing the ECG application skills of cardiology nurses.

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