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CLINICAL INTERPRETATION AND LABORATORY ADVANCES IN TROPONIN MEASUREMENT

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Annotation. *Troponin is the key biomarker for diagnosing acute myocardial infarction and plays a pivotal role in clinical cardiology. Advances in laboratory assays over the past decades have significantly improved analytical sensitivity and accuracy, enabling detection of very low troponin concentrations. Effective clinical use requires understanding both the analytical and clinical sensitivity and specificity of assays, as well as proper interpretation within the patient's clinical context. Variability among troponin I and T tests and evolving definitions of sensitivity pose challenges for clinicians, emphasizing the need to integrate laboratory results with clinical reasoning. Enhanced understanding of troponin testing is crucial for accurate diagnosis, timely intervention, and improved cardiovascular outcomes.*

Keywords: *troponin, acute myocardial infarction, biomarker, analytical sensitivity, clinical sensitivity, assay accuracy, cardiovascular diagnostics, laboratory testing.*

Troponin is widely recognized as the primary biomarker for the diagnosis of acute myocardial infarction. Over the past twenty years, laboratory techniques for measuring troponin have advanced significantly, leading to lower detection thresholds and enhanced assay precision. While these laboratory developments have greatly improved troponin testing, its effective application in clinical practice also depends on the clinician's ability to interpret the results appropriately. Optimal utilization of

troponin testing requires three key components: the analytical reliability of the assay, the clinical sensitivity and specificity of the test outcomes, and a clear clinical rationale for ordering the test within the appropriate patient context [3,6].

All three components are essential to ensure the effective clinical application of troponin testing. In practice, most clinicians rely on their laboratory teams to determine the analytical performance of assays and often lack detailed knowledge of the underlying laboratory science of troponin measurement. Clinical sensitivity and specificity of troponin tests can be confusing, as definitions have evolved over time and multiple assay types are now available. Moreover, clinicians frequently pay limited attention to integrating troponin results with other relevant clinical information. While review articles provide guidance on assay performance and appropriate use, additional clarification can further support clinical decision-making [2].

The troponin complex consists of three subunits - T, I, C, which regulate the contractile activity of the myocardium. Cardiac troponin T, the tropomyosin-binding subunit, anchors the troponin complex to thin actin filaments. Troponin C, a calcium-binding subunit, binds calcium ions entering the cytoplasm from the sarcoplasmic reticulum upon contraction stimulation. Troponin I, an inhibitory subunit, blocks the hydrolysis of adenosine triphosphate, which is necessary for the interaction of actin and myosin. In the late 1980s, researchers developed immunoassays for troponin I and troponin T. Improvements in antibodies, reagents, and automation have made today's commercial troponin assays extremely sensitive and accurate. Newest, the most sensitive assays are able to detect troponin in the circulation of patients without myocardial injury, possibly due to normal turnover of myocardial cells or the formation of exosomes that release small amounts of free troponin into the circulation [5].

Manufacturers of troponin assays evaluate and report the analytical performance of each test. Analytical sensitivity refers to the lowest concentration of the analyte that can be reliably detected. The precision of the assay is expressed by the coefficient of variation (CV), which reflects the variability of the test relative to analyte concentration; lower analyte concentrations are typically associated with higher CV

values. Ideally, the CV at the diagnostic cut-off should not exceed 10%. Automated assays conducted in central laboratories generally demonstrate higher accuracy and maintain CV levels below 10%, whereas point-of-care troponin tests may exhibit CV values around 10%, roughly an order of magnitude higher than those of central lab analyses. Due to this limited precision, point-of-care assays are not recommended for serial troponin measurements, as inaccuracies can produce misleading apparent increases or decreases in troponin levels [2,3].

Due to the exclusive patent, there is only 1 commercially available troponin T test. The fourth generation of this assay is currently in use in the United States, and the new generation troponin T test, which is more analytically sensitive, is now in use in Europe. There are many commercially available troponin I tests. These tests have also undergone several generations of improvements over the years. Each of the various commercial troponin I assays recognizes a unique amino acid sequence (epitope) of the troponin I molecule, resulting in each assay having different analytical characteristics. These differences have created problems for researchers and regulators who are trying to develop industry standardization for troponin tests. The differences also pose challenges for physicians who are trying to understand published medical reports of troponin testing and apply the research findings to practice [1,4].

Conclusion. Troponin testing remains the cornerstone for the diagnosis of acute myocardial infarction due to its high specificity and sensitivity. Over the past decades, significant advancements in laboratory assays have improved analytical performance, enabling detection of very low troponin concentrations with high accuracy. However, optimal clinical use requires not only reliable laboratory measurements but also careful interpretation within the appropriate clinical context, considering assay variability, clinical sensitivity, and specificity. Point-of-care tests, while convenient, have limitations in precision and are not suitable for serial measurements. Enhanced understanding of assay characteristics and proper integration of troponin results with clinical information are essential for accurate diagnosis, timely intervention, and improved patient outcomes in cardiovascular care.

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