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Abstract

In patients with chest pain of suspected cardiac etiology or possible acute coronary syndrome (ACS), cardiac biomarkers are used to aid in diagnosis, treatment, and risk stratification. Cardiac troponin (cTn) point-of-care testing (POCT) exists to assist clinicians and facilities to rapidly make decisions, increase accuracy of diagnosis, increase emergency department (ED) throughput, and decrease ED length-of-stay (LOS). Although many ST Elevation Myocardial Infarction (STEMI) diagnoses are made based off of an initial electrocardiogram (ECG) and patient presentation, cardiac biomarkers also provide further insight to STEMI diagnosis and help clarify varying patient presentations. The purpose of this paper is to evaluate cTn POCT as an evidence-based practice (EBP). A critical appraisal of the literature was performed using 12 articles selected for final synthesis. The final articles were then formally synthesized and discussed in relation to EBP. Results of the EBP evaluation showed that cTn POCT accurately assists in diagnosis when compared to traditional laboratory cTn testing, facilitates risk stratification, increases ED throughput, decreases ED LOS, and aids in meeting the recommended time-to-troponin of 30-60 minutes. However, data regarding general cost effectiveness with cTn POCT was limited and varied with result.

Key words: Troponin, Point-Of-Care Testing, Acute Coronary Syndrome, Myocardial Infarction, Chest Pain

In the United States, chest pain is one of the most common patient complaints when presenting to an emergency department (ED). In chest pain of suspected cardiac etiology, rapid assessment is crucial in determining proper route of treatment and need for immediate intervention. In patients with possible acute coronary syndrome (ACS), electrocardiogram (ECG) risk stratification, physical assessment, and cardiac biomarkers are used to diagnose and treat. With barriers such as ED overcrowding and inadequate staffing, current guidelines regarding time-to-troponin and time-to-treatment are becoming more difficult to meet.

Cardiac troponin is used to evaluate injury to the heart and assist in diagnosis of acute myocardial infarction (AMI). According to the *2010 American Heart Association (AHA) Guidelines for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiovascular Care (ECC)*, "cardiac troponin (cTn) is the preferred biomarker and is useful in diagnosis, risk stratification, and determination of prognosis" (O'Connor et al., 2010, p. S791). Current recommendations for cTn of myocardial injury state that the time-to-troponin should be completed in 30-60 minutes (Lee-Lewandrowski et al., 2011). In order to meet recommended times, EDs perform point-of-care testing (POCT) to improve decisions, diagnostic accuracy, ED throughput, and length-of-stay (LOS).

The author will discuss the use of cTn POCT within EDs and suggest possible evidence based practice (EBP) changes in regard to AMI diagnostic accuracy, cost-ef-

fectiveness, and improved patient outcomes.

Literature Synthesis of Current Practice Guidelines

The benchmark troponin turnaround time of 30-60 minutes recommended by the 2010 AHA guidelines is reinforced by data, research, and practice reviews. In order to improve the quality of patient care throughout the United States, this practice is evaluated to maintain current standards of care. The goal of obtaining a cTn blood sample upon patient presentation is to aid health care providers in timely decision making for AMI and acute chest pain diagnoses (Koehler et al., 2013). Although major strides have been made in increasing POCT sensitivity with cTn, is cTn POCT really decreasing turnaround times compared to traditional laboratory testing? Furthermore, is cTn POCT maintaining accuracy in assisting AMI diagnosis and risk stratification? Current literature indicates that cTn POCT is very much reliable in assisting in diagnosis and meeting time guidelines; however, POCT is not without its shortcomings.

Many articles discuss and evaluate ways to improve decisions, diagnostic accuracy, ED throughput, and LOS. According to Koehler et al. (2013), "the average door-to-result time in receipt of cTn POCT results was decreased by an average of 54 minutes" (table 1) during a study at Memorial Hospital Central in Colorado Springs, CO. With this decrease of 54 minutes in cTn POCT results, Memorial Hospital Central was also able to reduce their average ED LOS "from 290 minutes to 255 minutes" (Koehler et al., 2013, table 1). As a result, Memorial Hospital Central was able to increase ED throughput and decrease length of stay by using POCT for cTn initial analysis.

Takakuwa et al. (2009), performed a large retrospective analysis of data and studied the utilization patterns of cardiac bedside markers, as well as cTn POCT related to ED LOS. Results from the study showed facilities that used cTn POCT also had notable decreased ED lengths of stay (Takakuwa et al., 2009). Additionally, "results showed that patients with positive POC results were given ACC/AHA-recommended treatments (e.g., continuous ECG monitoring, supplemental oxygen, nitroglycerin, morphine sulfate) more frequently due to early positive POC results prompting rapid ED treatment" (Takakuwa et al., 2009, p. 504). This study did not include diagnostic accuracy of cTn POCT or comparative testing to traditional laboratory testing. Nonetheless, cTn POCT practices facilitated quicker physician disposition times and interventions.

A similar large multicenter randomized controlled trial was completed throughout four EDs within the United States to compare central laboratory and cTn POCT related to physician disposition and ED LOS. Results from the "Disposition Impacted by Serial Point of Care Markers in Acute Coronary Syndromes (DISPO-ACS) trial showed that across all sites, POCT did not decrease time to disposition for admitted or discharged patients" (Ryan et al., 2009, p.324). However, the results of overall cTn turnaround time for POCT compared to central laboratory testing were "0.72 hours faster and had an 87.3% success rate of meeting the 30-minute turnaround cTn time target" (Ryan et al., 2009, p. 326). For POCT to significantly alter ED disposition, Ryan et al. (2009) suggests that the "brain-to-brain time must be optimized with physicians who receive and interpret the cTn results" (p. 326). Furthermore, the results of the DISPO-ACS "demonstrate variable direct benefits of POCT, and when benefits are evident these are not as extensive as might be assumed from common conception that rapid results translate into rapid decision making" (Ryan et al., 2009, p. 327).

A recent large multicenter randomized controlled trial was completed in the United Kingdom throughout six hospitals to explore POCT outcome variations and cost effectiveness of cTn POCT. The Randomized Assessment of Treatment using Panel Assay of Cardiac markers (RATPAC) trial results showed that "POCT resulted in more patients being successfully discharged after emergency department assessment, reduced median length of hospital stay but not mean length of stay, and increased use of coronary care" (Bradburn et al., 2012, p. 233). However, the cost effectiveness of POCT during the RATPAC trial showed increased (converted) cost by over 300 U.S. dollars (Bradburn et al., 2012). This increase in cost is unexpected; however, the POC technology and cost is dependent on the facility and overall usage (Bradburn et al., 2012).

In 2012, a study by Meek, Braitberg, Nicolas, and Kwok (2012) "compared defined outcome measures of ED LOS with cTn POCT, individual diagnostic accuracy for POCT, and cost analysis" (p. 287). The results of the study showed the LOS being reduced by four hours with similar diagnostic sensitivity to traditional laboratory testing (Meek et al., 2012). Cost analysis of using the POCT system was estimated from using "the Australasian Triage Scale which show cost savings as a re-

sult of ED LOS" (Meek et al., 2012, p. 291).

The aforementioned studies have provided the largest amount of data regarding cTn POCT, but have limited information regarding cTn POCT diagnostic accuracy compared to traditional laboratory testing. Diagnostic accuracy is essential when using POCT to make disposition decisions from the POCT results. In a large secondary analysis of a prospective, multicenter, blinded observational cohort study of 18 academic EDs, Diercks et al. (2011) reported that the cTn POCT is diagnostically suitable for bedside usage and has testing characteristics similar to traditional laboratory platforms.

Mozina et al. (2010) reported similar findings regarding diagnostic accuracy of cTn POCT results compared to central laboratory results. They reported that the POCT assay showed analytical reliability in concordance with the guidelines of the European Society of Cardiology, American College of Cardiology, and the National Academy of Clinical Biochemistry (Mozina et al., 2010). Mozina et al. (2010) also reported receiving "cTn POCT results in less than 30 minutes 100% of the time compared to the 24.73% cTn results from central laboratory" (p. 10).

Studies conducted by Loten, Attia, Hullick, Marley, and McElduff (2009) addressed the question of POCT accuracy in a study in which in which they analyzed the accuracy of cTn POCT in real life ED conditions. The results from the study showed accuracy between POCT and central laboratory testing that use traditional laboratory criteria; however, when compared to using new criteria, the POCT was not as accurate (Loten et al., 2009). A similar study by Cullen et al. (2012) "examined the accuracy of risk stratification of patients with chest pain at two hours after ED presentation using cTn POCT in comparison to the traditional laboratory approach" (p. 596). The results from the data collected shows "the use of serial cTn POCT only accurately risk stratified patients which allows rapid identification of the high risk patients in whom early admission and ongoing targeted management might be initiated and allows intermediate risk patients to progress to early objective testing" (Cullen et al., 2012, p. 602). Poor sensitivity readings from the POCT were not reported in this study when determining accuracy of cTn readings.

Another study relating to the current recommendations of cTn sensitivity testing with POCT was completed by Lee-Lewandrowski et al. (2011) "to compare two commonly used POCT strategies (one traditional POCT multi-marker panel and a newer POCT method using cTn alone) to a fourth generation, central laboratory cardiac troponin assay on first-draw specimens from patients being evaluated for AMI in the ED" (p. 459). The results from this study showed that there was no difference between POCT and central laboratory testing (Lee-Lewandrowski et al., 2011). However, the study made note that "the quality gap between central laboratories and older POCT methods will continue to widen, unless the performance of the POCT methods is improved" (Lee-Lewandrowski et al., 2011, p. 459).

With a further emphasis on increasing ED disposition with cTn POCT, Deledda, Fermann, Lindsell, Rohlfing, and Gibler (2011) conducted an "observational study to test the theoretical model that cardiac biomarker POCT, patient demographics, triage acuity, disposition, and hospital setting affect time to ED disposition" (p. 1). The data collected suggests that "cardiac biomarker POCT has the potential to speed disposition decision making by about 17 minutes for all patients and about 25 minutes for patients being evaluated for ACS" (Deledda, Fermann, Lindsell, Rohlfing, & Gibler, 2011, p. 5). Additional recommendations from the study include changing ED physician practices and addressing physician analysis patterns of cTn (Deledda et al., 2011). Attitudes regarding quicker physician cTn analysis are a common theme, yet one that is different at each ED using a POCT system. Primary limitations to this study noted were triage acuity and ED disposition without appropriate time stamps from administrative databases. Cost analysis was not available from this study.

Discussion

The relationship between cTn POCT and improved decision making, diagnostic accuracy, ED throughput, and LOS is clearly apparent. Limitations to the usage of cTn POCT noted were varied; however, the data analyzed showed that cTn POCT usage could assist in meeting specific goals of increased ED disposition, decreased LOS, and time-to-troponin of 30-60 minutes. Recommendations given also reinforce the idea that although cTn POCT can facilitate faster disposition times, the interpretation of the cTn POCT results is left to the ED physician to ultimately analyze.

Positive patient outcomes from the use of cTn POCT include: (1) Increased patient satisfaction by faster disposition time, (2) Decreased LOS, (3) Faster diagnosis/

treatment, and (4) Reduced hallway offload/boarding. Hospital benefits include: (1) Improved efficiencies, (2) Increased recommended guideline compliance, (3) Improved ED-1 and ED-2 times, (4) Improved Hospital Consumer Assessment of Healthcare Providers and Systems scores (HCAHPS), and (5) Appropriate resource utilization.

Cost efficiency is a major concern regarding usage and implementation of cTn POCT and POCT in general. Only two current studies addressed and analyzed the cost of POCT within EDs. The general consensus is that POCT results and outcomes outweigh any cost associated with implementing and maintaining POCT; however, this cannot be confirmed through any current (<5 years) literature or studies. Further research is necessary and recommended for proper evaluation.

The author asserts that this evidence based practice (EBP) has a meaningful and appropriate usage within EDs across the United States. POCT machines and hospital operations must be considered when choosing to implement this practice. However, to fully reap the benefits of cTn POCT, a multidisciplinary approach must be used to have essential support throughout the care process. This practice is based on current research and best practice policies to reduce negative outcomes.

Conclusion

In summary, current recommendations for cTn of myocardial injury state that the time-to-troponin result should be completed in 30-60 minutes (Lee-Lewandrowski et al., 2011). To assist in meeting this goal, cTn POCT has become one of the quickest and safest ways to expedite ED disposition, facilitate treatment, decrease LOS, and increase ED throughput. Current evidence proves that cTn POCT accurately aids in AMI diagnosis and risk stratification when compared to traditional laboratory testing. Furthermore, cTn POCT assists in meeting recommended time-to-troponin guidelines faster than most traditional laboratory testing. Although cost effectiveness has yet to be studied in depth, it is apparent that this variable is dependent on the hospital and operating system.

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