

Commentary

Myocardial infarction complicating critical illness

Daniel A King¹ and Yaniv Almog²

¹Fellow, Division of Pulmonary and Critical Care Medicine, University of Maryland Medical Center, Baltimore, MD, USA

²Director, Medical Intensive Care Unit, Soroka University Medical Center, Beer-Sheva, Israel

Corresponding author: Yaniv Almog, almogya@bgu.ac.il

Published online: 2 November 2005

This article is online at <http://ccforum.com/content/9/6/634>

© 2005 BioMed Central Ltd

Critical Care 2005, **9**:634-635 (DOI 10.1186/cc3893)

See related research by Lim *et al.* in this issue [<http://ccforum.com/content/9/6/R636>]

Abstract

Cardiac troponins are highly sensitive and specific indicators of myocardial injury. Although the mechanism of this injury is not entirely clear, it carries important prognostic information. Elevated serum levels of cardiac troponins have been described in a wide variety of conditions other than myocardial infarction (MI). The current study is an important first step in trying to determine the exact frequency of MI among critically ill patients with elevated troponin. At present, the rate of MI in these patients is unknown and its implications on outcome and management will have to await future prospective clinical trials.

In this issue of *Critical Care*, Lim and colleagues examine the frequency of myocardial infarction (MI) among a non-selected group of critically ill patients [1].

Cardiac troponins I (cTnI) and T, myocardial regulatory proteins of the thin actin filament, are considered highly sensitive and specific indicators of myocardial injury. Over the past decade, measuring cardiac troponin levels has become the corner stone of detecting myocardial injury to the extent that it is now an inseparable part of the current guidelines for diagnosis and management of acute coronary syndromes (ACS) and MI [2].

It is well established that reasons other than thrombotic MI can cause elevated serum levels of cardiac troponins [3,4]. Such elevation has been described in severe sepsis, pulmonary thromboembolism, and a wide variety of additional conditions. The mechanism responsible for this myocardial injury is unclear. Aggravation of pre-existing ACS in the context of extreme stress associated with critical illness and uncoupling of oxidative phosphorylation during sepsis have been described [5]. Systemic inflammatory response syndrome-induced cytokine-mediated (lipopolysaccharides, tumor necrosis factor- α , interleukin-1 β , and interleukin-6) direct myocardial injury and increase in intra-cellular calcium in cardiac cells have also been implicated [6,7]. Regardless

of the mechanism, it is widely accepted that in addition to indicating myocardial injury, troponin elevation provides prognostic information. Debate still exists though whether such elevation is an independent outcome predictor or should be viewed as a surrogate of organ failure in the broader context of multi-organ dysfunction. Whereas some have suggested that cTnI levels correlate with myocardial damage and poor outcome [8,9], the study by Lim and colleagues [1], as well as studies by our group and others [10,11], could not confirm this association. Recently, the natriuretic peptides have emerged as promising prognostic markers in patients with congestive heart failure, chronic ischemic heart disease and ACS as well as in patients with severe sepsis [12-14]. These data are consistent with the notion that a biological marker could be of supplementary value in assessing prognosis, and myocardial dysfunction.

To what extent does troponin elevation in critically ill patients reflect a thrombotic ACS is obviously a different question. It can be easily postulated that patients with critical coronary lesions are more likely to develop a thrombotic MI while critically ill. The imbalance between pro- and anti-coagulant mechanisms as well as endothelial dysfunction so characteristic of sepsis may play an important role in limiting coronary flow. In addition, tachycardia hypoxemia and diminished oxygen delivery may tip the balance of regional myocardial oxygen consumption over the critical edge. Bhatti and colleagues [15] showed that, among patients admitted to an intensive care unit (ICU) due to gastrointestinal bleeding, those with risk factors for ischemic heart disease developed ACS more frequently than those without and that this subgroup tended to have longer ICU stay. Another observational cohort study suggested that the occurrence of clinically recognized cardiac dysfunction is common (21.2%) among critically ill medical patients and is an independent determinant of hospital mortality. The finding of acute cardiac

injury, assessed using serial blood measurements of cTnI, was also common (15.8%), but did not independently contribute to hospital mortality [11].

It is clear that elevated troponin levels alone are unable to differentiate between thrombotic and non-thrombotic etiologies. In their article, Lim and colleagues [1] take an important first step in trying to answer a vital question; what is the true frequency of MI among acutely ill patients with elevated troponin? The *a priori* defined criteria used to diagnose MI were a combination of elevated troponin and electrocardiogram (ECG) changes as well as echocardiographic evidence of new myocardial wall motion anomalies. They found that of the 93 patients for whom both troponin measurements and ECG recordings were available, 44 (47.3%) had elevated troponin levels and 24 (25.8%) had MI. Although troponin elevation was not an independent outcome predictor, MI was associated with a significantly higher mortality rate and was found to be an independent predictor of hospital mortality [1]; however, only 23 patients had echocardiograms and none had angiography performed. Moreover, no data were provided indicating whether the wall motion abnormalities found were diffuse or segmental and, importantly, whether a correlation was found between ECG territory and echocardiograms. Even though the ECG criteria were defined as either ST elevation or depression, most MIs were eventually categorized as non-ST MIs. Thus, an unequivocal determination of the exact frequency of MI in the ICU setting is not presently possible.

The importance of ACS complicating critical illness is beyond merely an additional prognostic marker. Ultimately, therapeutic modalities such as anti-platelet agents, beta blockers whenever relevant, statins and possibly even revascularization once the patient is stable enough, may all become relevant if we wish to change a patient's course and outcome. At present, however, the exact frequency of MI in the setting of critical illness, the best way to diagnose it and its implications on outcome and management strategies will have to await future prospective clinical trials.

Competing interests

The author(s) declare that they have no competing interests.

References

- Lim W, Qushmaq I, Cook DJ, Crowther MA, Heels-Ansdell D, Devereaux PJ, the Troponin T Trials Group: **Elevated troponin and myocardial infarction in the intensive care unit: a prospective study.** *Crit Care* 2005, **9**:R636-R644.
- Alpert JS, Thygesen K, Antman E, Bassand JP: **Myocardial infarction redefined - a consensus document of The Joint European Society of Cardiology/American College of Cardiology Committee for the redefinition of myocardial infarction.** *J Am Coll Cardiol* 2000, **36**:959-969.
- Hamm CW, Giannitsis E, Katus HA: **Cardiac troponin elevations in patients without acute coronary syndrome.** *Circulation* 2002, **106**:2871-2872.
- Jeremias A, Gibson CM: **Narrative review: alternative causes for elevated cardiac troponin levels when acute coronary syndromes are excluded.** *Ann Intern Med* 2005, **142**:786-791.
- Budinger GR, Duranteau J, Chandel NS, Schumacker PT: **Hibernation during hypoxia in cardiomyocytes. Role of mitochondria as the O₂ sensor.** *J Biol Chem* 1998, **273**:3320-3326.
- Ammann P, Pfisterer M, Fehr T, Rickli H: **Raised cardiac troponins.** *Br Med J* 2004, **328**:1028-1029.
- Zhu X, Bernecker OY, Manohar NS, Hajjar RJ, Hellman J, Ichinose F, Valdivia HH, Schmidt U: **Increased leakage of sarcoplasmic reticulum Ca²⁺ contributes to abnormal myocyte Ca²⁺ handling and shortening in sepsis.** *Crit Care Med* 2005, **33**:598-604.
- Ammann P, Maggiorini M, Bertel O, Haenseler E, Joller-Jemelka HI, Oechslin E, Minder EI, Rickli H, Fehr T: **Troponin as a risk factor for mortality in critically ill patients without acute coronary syndromes.** *J Am Coll Cardiol* 2003, **41**:2004-2009.
- Wright RS, Williams BA, Cramner H, Gallahue F, Willmore T, Lewis L, Ladenson JH, Jaffe AS: **Elevations of cardiac troponin I are associated with increased short-term mortality in noncardiac critically ill emergency department patients.** *Am J Cardiol* 2002, **90**:634-636.
- King DA, Codish S, Novack V, Barski L, Almog Y: **The role of cardiac troponin I as a prognosticator in critically ill medical patients: a prospective observational cohort study.** *Crit Care* 2005, **9**:R390-395.
- Kollef MH, Ladenson JH, Eisenberg PR: **Clinically recognized cardiac dysfunction: an independent determinant of mortality among critically ill patients. Is there a role for serial measurement of cardiac troponin I?** *Chest* 1997, **111**:1340-1347.
- Brueckmann M, Huhle G, Lang S, Haase KK, Bertsch T, Weiss C, Kaden JJ, Putensen C, Borggrefe M, Hoffmann U: **Prognostic value of plasma N-terminal pro-brain natriuretic peptide in patients with severe sepsis.** *Circulation* 2005, **112**:527-534.
- Kragelund C, Gronning B, Kober L, Hildebrandt P, Steffensen R: **N-terminal pro-B-type natriuretic peptide and long-term mortality in stable coronary heart disease.** *N Engl J Med* 2005, **352**:666-675.
- Roch A, Allardet-Servent J, Michelet P, Oddoze C, Forel JM, Barrau K, Loundou A, Perrin G, Auffray JP, Portugal H, et al.: **NH₂ terminal pro-brain natriuretic peptide plasma level as an early marker of prognosis and cardiac dysfunction in septic shock patients.** *Crit Care Med* 2005, **33**:1001-1007.
- Bhatti N, Amoateng-Adjepong Y, Qamar A, Manthous CA: **Myocardial infarction in critically ill patients presenting with gastrointestinal hemorrhage: retrospective analysis of risks and outcomes.** *Chest* 1998, **114**:1137-1142.