Conversations in Cardiology: Is There Value in Post-PCI Troponin Measurements?

Morton Kern with contributions from Sam Butman, Scottsdale, Arizona: Peter Duffy, Pinehurst, South Carolina; Kirk Garratt, Newark, Delaware; Rajiv Gulati, Mayo Clinic, Rochester, Minnesota; Sandhu Gurpreet, Mayo Clinic, Rochester, Minnesota; Tim Henry, Cincinnati, Ohio; Dean Kereiakes, Cincinnati, Ohio; Ajay Kirtane, Columbia University, New York, New York; Neil Kleiman, Houston, Texas; Jeffery Moses, Columbia University, New York, New York; Srihari S. Naidu, Westchester Medical Center, Valhalla, New York; Duane Pinto, Boston, Massachusetts; David Rizik, Scottsdale, Arizona; Chris White, Ochsner Clinic, New Orleans, Louisiana; Bonnie Weiner, University of Massachusetts, Worchester, Massachusetts

Many of our patients who come to the cath lab will have had measurement of troponin, a serum protein, called a biomarker, which is related to myocardial cell injury and death (Figure 1). The question of when we should measure troponins in patients with chest pain before and/or after percutaneous coronary intervention (PCI) has been discussed in guidelines but questions arise in clinical practice. However, in today's PCI world, a modest elevation of post-PCI troponin does not usually raise any alarms for a different care pathway.

Dr. Peter Duffy from South Carolina asked our expert cath lab group the following question:

"Hi Mort, I've been covering ST-elevation myocardial infarction (STEMI) call for different hospitals in several states over the past few years. One issue that has come up frequently is checking troponins after STEMI.

"Some hospitalist programs will not check any troponins levels after the procedure, others will just check one, others check a serial of two or three but don't wait for a peak, and others will trend [the troponins] until they can document a peak. There seems to be no consistency.

"I know in the old days we checked CPK-MB until we saw a peak. But not seeing a peak is a new way of doing things for me. What are your thoughts? If we don't make changes in patient care after PCI regardless of the troponin level, is there any value in ordering it?"

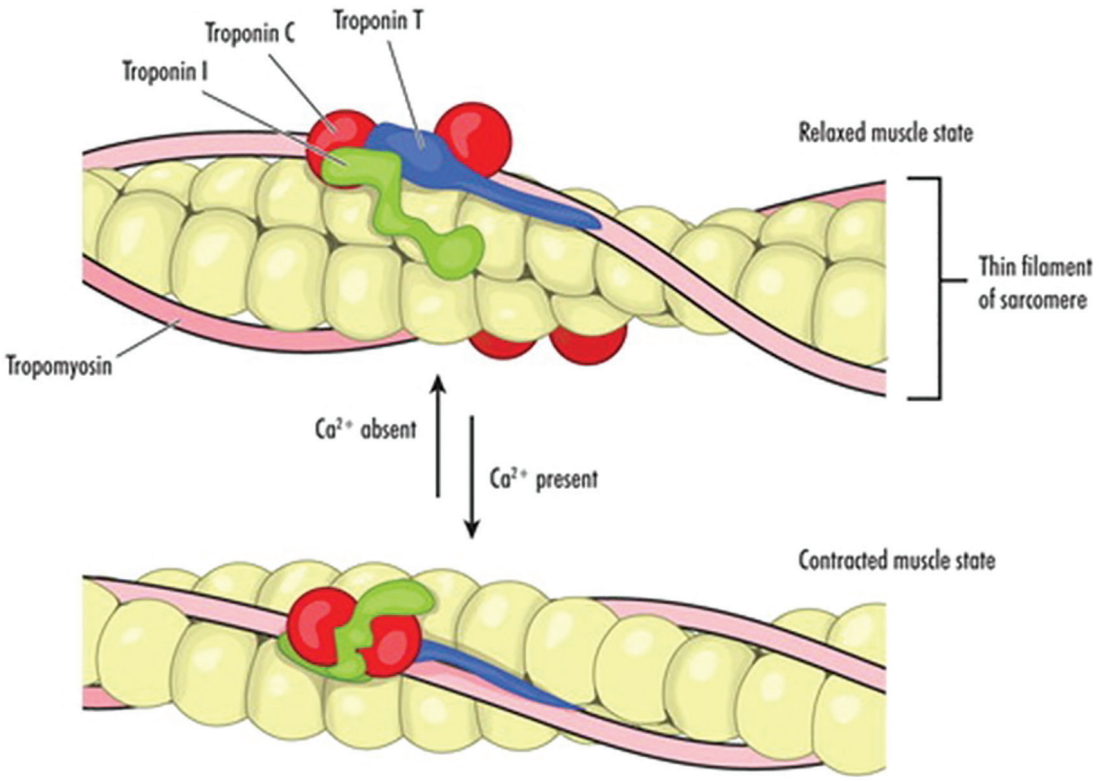

Figure 1. Troponin Activation. Troponin C (red) binds Ca2+, which stabilizes the activated state, where troponin I (green) is no longer bound to actin. Troponin T (blue) anchors the complex on tropomyosin.

Reprinted with permission from Shave R, Baggish A, George K, et al. Exercise-induced cardiac troponin elevation: evidence, mechanisms, and implications. J Am Coll Cardiol. 2010 Jul 13; 56(3): 169-176. doi: 10.1016/j.jacc.2010.03.037

Before addressing Dr. Duffy's question, a quick review of troponins and their use is worthwhile.

Troponin Basics

Troponin is a key diagnostic marker of ischemia and forms the basis for diagnosis of acute coronary syndromes (unstable angina and non STEMI [NSTEMI] or STEMI infarctions). When a patient has ischemic pain without biomarkers, he/she is considered to have unstable angina, whereas the same chest pain patient with positive troponins denotes NSTEMI or STEMI.

The change in troponin level over time (ie, the trajectory of change) also helps identify the timing of the onset of the ischemia (Figure 2). An ascending trajectory suggests ongoing infarction, whereas a descending trajectory is more often associated with a completed infarct or recuperative period.

Troponin elevation without chest pain can also occur in a variety of conditions that are not related to myocardial infarction (Figure 3). Some patients may have a chronically elevated troponin, which confuses the presentation of ischemia. Chronically elevated troponins may be related to renal failure, myocarditis, and heart failure, among other conditions (Figure 4).

Troponin elevation as a marker of periprocedural ischemia or infarction has been used as a measure of both future short- and long-term risk and procedural quality. It is well known that after a STEMI, cardiac troponins correlate with infarct size in the short term and with left ventricular remodeling during the long term.[1] Nevertheless, it is uncertain whether serial troponin measurements provide true value in clinical predictions of STEMI in the era of primary PCI.

Should We Measure Troponins Post PCI in STEMI Patients?

Mort Kern, Long Beach, California: To answer Dr. Duffy's question, my view is that post-STEMI troponins may be associated with long-term prognosis (big infarct, big troponins, bad outcome) but that we are not changing post-PCI STEMI care based on the troponins. While we only do STEMI during working hours (no call team at this VA), our STEMI patients get serial troponins in the ICU for a day. I do not believe there is much value in knowing the trend or absolute number in this postprocedure setting unless there is a complication, or evidence of reinfarction or acute stent thrombosis. I may be uninformed about this, but let's see what others say.

Chris White, Ochsner Clinic, New Orleans, Louisiana: I disagree [with measuring post-PCI troponins]. STEMI post-PCI troponins offer zero value in guiding care or improving outcomes. If you want to understand prognosis, look at the echo. We are wasting a lot

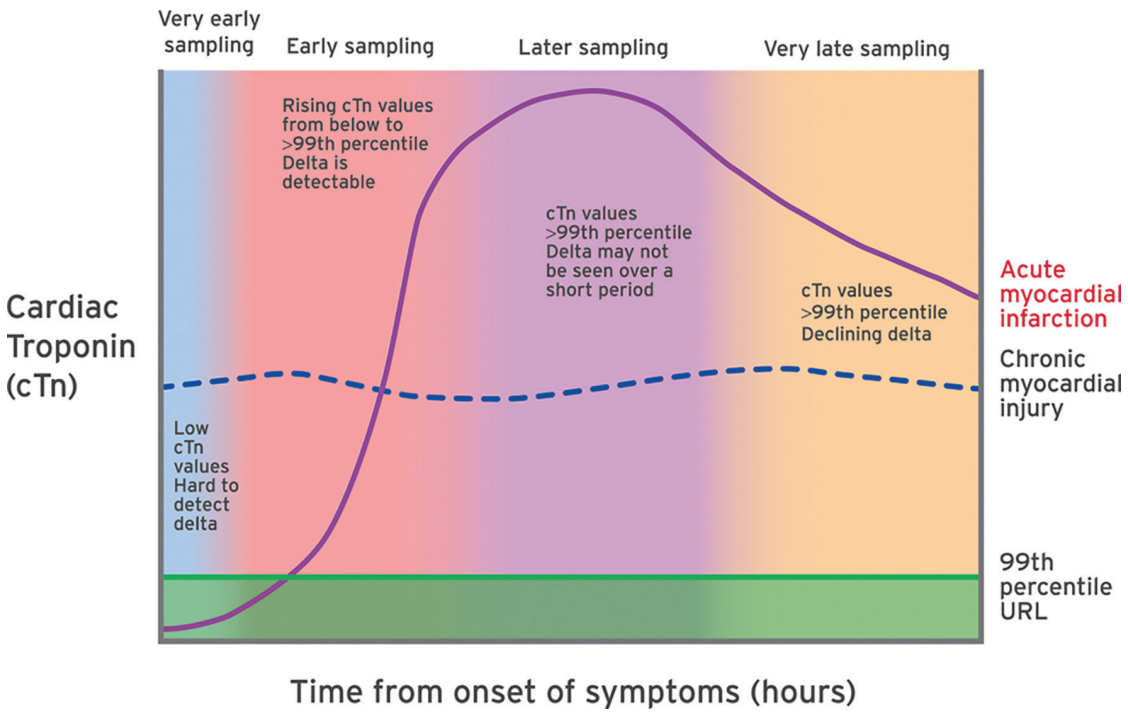

Figure 2. Time Course of Cardiac Troponin (C Tn).

Reprinted from Thygesen K, Alpert JS, Jaffe AS, et al. Fourth Universal Definition of Myocardial Infarction (2018). Circulation. 2018; 138: e618–e651. doi: (10.1161/CIR.0000000000000617)

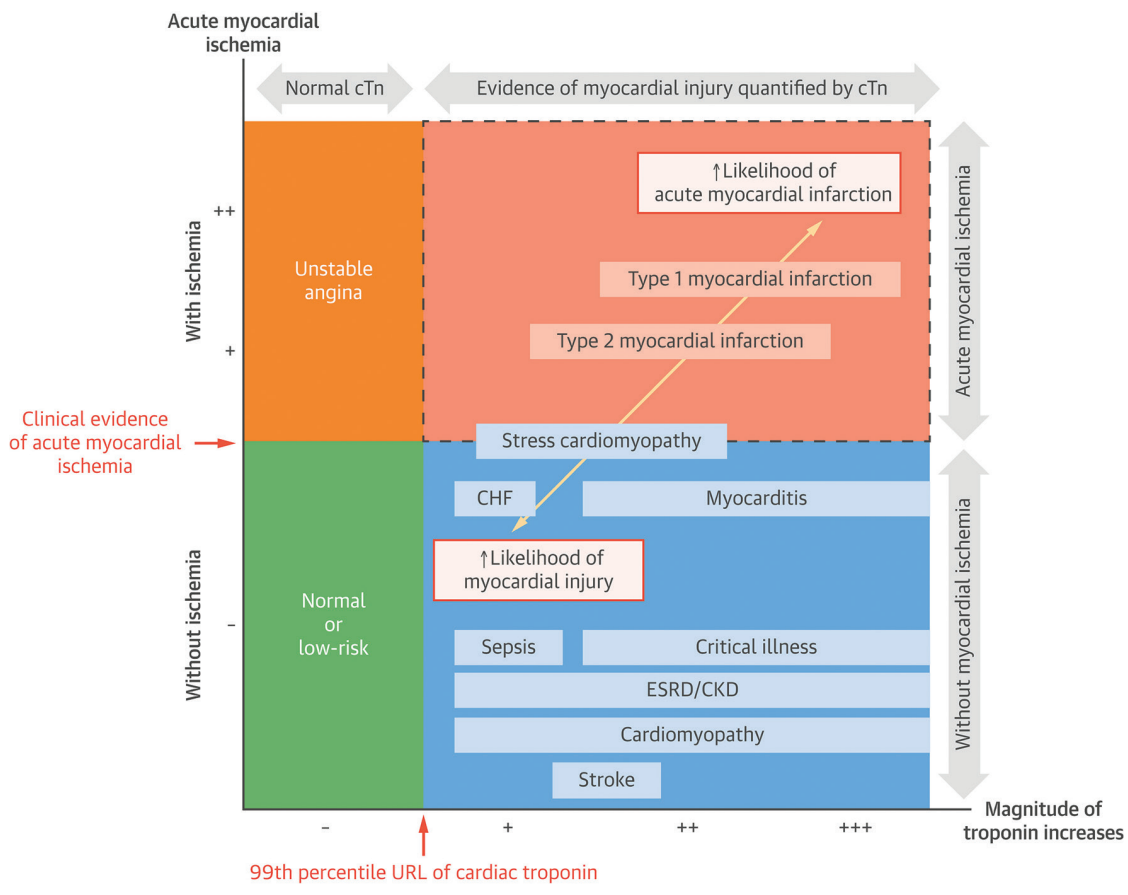

Figure 3. Cardiac and Non Cardiac Causes of Troponin Elevation: Relationship Between cTn Concentrations and the Clinical Evidence of Acute Myocardial Ischemia. The y-axis refers to myocardial ischemia and the x-axis refers to cardiac troponin (cTn) concentrations based on the 99th percentile URL. Those without ischemia and cTn <99th URL are low risk. Those with ischemia with cTn <99th URL have unstable angina. Those without ischemia and increased cTn >99th URL have myocardial injury. Those with ischemia and cTn >99th URL can have type 1 or 2 myocardial infarction.

CHF = congestive heart failure; CKD = chronic kidney disease; ESRD = end-stage renal disease; URL = upper-reference limit.

Reprinted with permission from Sandoval Y, Jaffe AS. Type 2 Myocardial Infarction: JACC Review Topic of the Week. J Am Coll Cardiol. 2019 Apr 16; 73(14): 1846-1860. doi: 10.1016/j.jacc.2019.02.018

of money ordering tests that do not influence patient outcomes or change our management.

Bonnie Weiner, University of Massachusetts, Worchester, Massachusetts: I agree with Mort. I don't think we have as good a correlation with peak troponin as we did with CK. With revascularization, we have the big peak washout phenomenon [post PCI] to deal with. It is really the "area under the curve" that is predictive, so it is equally important, if not more so, to know how soon the peak and fall occurs. Knowing it is on the way down (and then doesn't rise again) is probably clinically relevant.

Kirk Garratt, Newark, Delaware: We stopped following troponins after STEMI managed with PCI years ago. No clear value. Yes, bigger infarcts equal worse prognosis, but we don't need troponins to tell us who is in that group. And like Mort said, peak or summed troponin release isn't actionable information today. It's not a big expense, but it's not good use of resources to trend troponins. I don't need to tell this group how much tighter budgets have gotten postpandemic, so even small savings are welcomed.

Sandhu Gurpreet, Mayo Clinic, Rochester, Minnesota: We stopped checking post-PCI troponins for acute coronary syndromes (ACS) and elective cases over a decade ago. Totally agree with Kirk and others here.

Dean Kereiakes, Cincinnati, Ohio: I agree with Chris and Kirk. Troponins are a quagmire. There are sex-specific differences, different assays, different upper limit of normal (ULN) for each lab, URL issues cloud interpretation when looking at across-center data. Post-PCI and particularly post-STEMI PCI troponins add only cost and confusion.

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— Kirk Garratt, MD

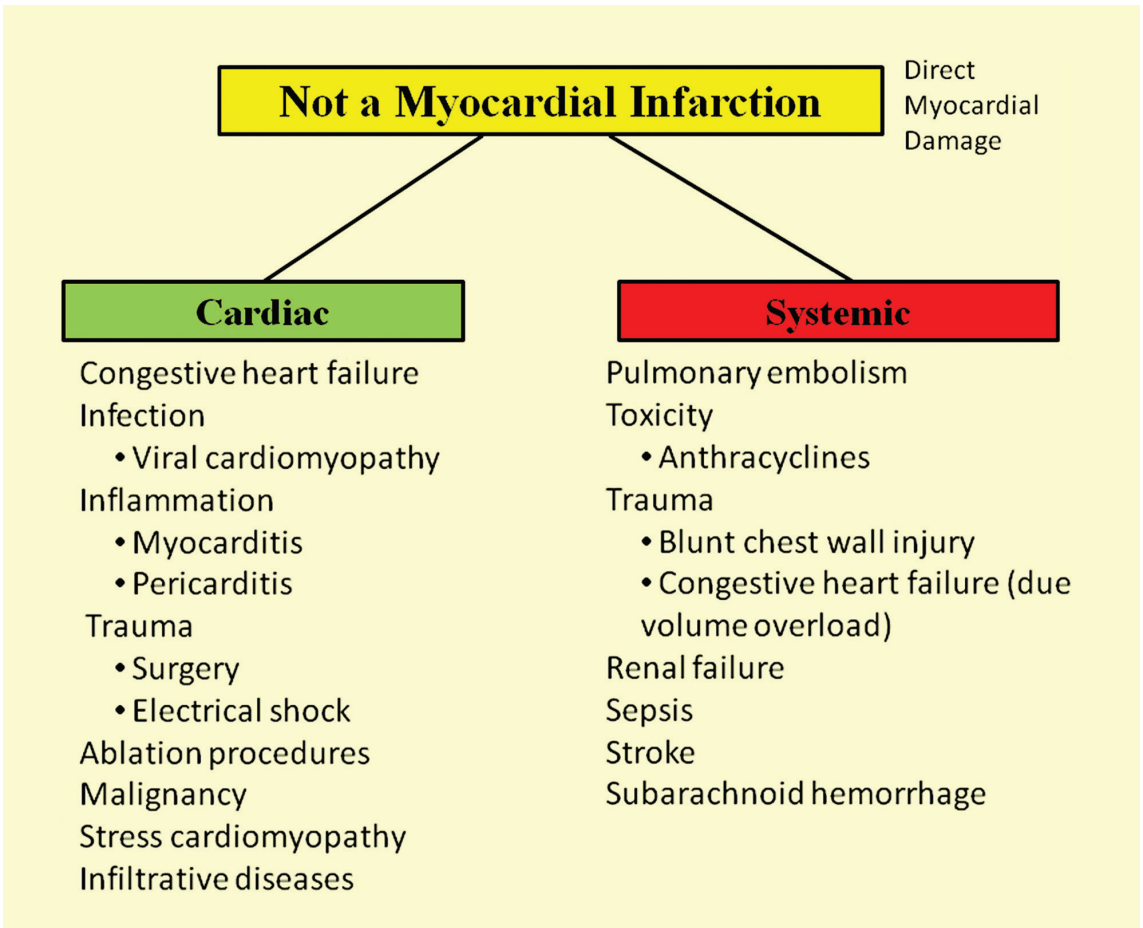

Figure 4. Non Myocardial Infarction Causes of Troponin Elevation. Causes of elevated troponin reflecting direct myocardial damage, other than myocardial infarction (MI), can be classified into 2 broad groups: 1) cardiac etiologies and 2) systemic processes.

Reprinted with permission from Giugliano RP, Braunwald E. The year in acute coronary syndrome. J Am Coll Cardiol. 2014 Jan 28; 63(3): 201-214. doi: 10.1016/j.jacc.2013.10.041

Ajay Kirtane, Columbia University, New York City, New York: I make every effort to "stop the madness" of the teams ordering these serially when I am on service.

Rajiv Gulati, Mayo Clinic, Rochester, Minnesota: OK, I'm going to disagree with the crowd. In my mind, a single next-day troponin is helpful — to ensure it is elevated! Occasionally we'll inadvertently treat bystander stenosis, ie, a patient that is not really a STEMI. A negative next-day troponin will reveal that.

Timothy D. Henry, Cincinnati, Ohio: Here is another contrary opinion. [There is] no need post-PCI troponin, but for STEMI:

1. The diagnosis of STEMI is still based on symptoms and the rise and fall of troponin.
2. There is prognostic value. Post-PCI STEMI troponins are especially important for the myocardial infarction with no obstructive coronary artery disease (MINOCA) patient. If you do an angiogram and there is no culprit, you will miss 5%-7% of STEMI patients that have MINOCA. We just presented a large series of MINOCA STEMI showing worse prognosis. Likely because of under diagnosis and treatment.
3. Troponins are still recommended in the guidelines.
4. Our standardized protocol requires 3 serial troponins. This is a minimal cost in the overall care.
5. 48-hour troponins correlate well with infarct size.
6. In NSTEMI, there is value to knowing a stable or rising troponin to determine timing of PCI.

Kirk Garratt, Newport, Delaware: Tim, you know I respect your thinking. On this one, though. I must disagree with you on every point:

For STEMI:

1. The clinical diagnosis of STEMI is based on meeting 2 of the 3 following criteria: typical symptoms, diagnostic ECG changes and elevated biomarkers. In today's world, we treat almost all STEMIs **before** biomarkers are known.
2. Lots of things have prognostic value that we don't measure routinely because they don't offer enough value and/or aren't actionable. Cardiac MR has a lot to recommend it, but it is not included in the CCU admission order set.
3. You say troponins are especially important for MINOCA patients. This is a unique population with different management needs, but I'm still not sold troponins after cath are important. I'll yield on this one if you can tell me how my management changes if I see a specific troponin pattern.
4. Troponins are still in the guidelines, but I'd have to go back and look, since I don't remember a guideline to measure 3 troponins after PCI for STEMI. And being in the guidelines doesn't mean much; it's the rationale for including something in a guideline that is important. If current guidelines advise post-PCI troponins in STEMI without defining their worth, it is time to change the guidelines!
5. While 48-hour troponins correlate with infarct size, unless you've had a big MI, this doesn't matter. Your care will be the same if your left ventricular ejection fraction (LVEF) is 40%, 45%, or 50%.

For NSTEMI: This is a different population with troponins being used for a specific reason.

Timothy D. Henry, Cincinnati, OH: We use the Zwolle risk score to triage our STEMI patients. Patients with a score ≤3 do not go to CICU and are discharged in <48 hours. Sixty percent are low-risk patients and that's where the money-saving is! A patient with an anterior STEMI with peak troponin of 12 is different than a patient with a peak troponin of 200. Likewise, a MINOCA patient with troponin of 2 is different than with peak troponin of 25. Both clinical care and prognosis are different for each patient. Echos at <48 hours are less predictive and I'm guessing most cardiologists are not getting 3- to 6-month

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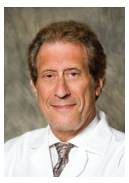
echos on every patient per guidelines. Despite having a standardized protocol at the Minneapolis Heart Hospital, only about 50% of patients got the guideline-recommended follow-up echo. The peak troponin predicts the patient whose ejection fraction (EF) gets better, stays the same, and those that get worse.

In our Midwest STEMI consortium data with >20,000 STEMI activations, peak troponin is consistently predictive. I also suspect that patients without a peak troponin measured will have a worse prognosis.

Srihari S. Naidu, Westchester Medical Center, Valhalla, New York: I would agree with Tim here. In addition to alternate diagnoses as has been discussed, it is still helpful to understand both echo parameters post STEMI and troponin elevation, since most PCI STEMI does not result in transmural necrosis and thus the EF may remain normal, with varying degrees of troponin elevation. While troponin use is not perfect, I don't see the harm [in measuring it] other than cost. Remember the same vial of blood used for smooth muscle antibody (SMA) testing, which is being done routinely on these patients, can be used for the troponin, so I doubt adding troponin adds much cost overall. To me, a preserved EF post STEMI with troponin peak at 10 is much better than the same EF post STEMI with a troponin of 100. What's the harm in knowing that? And on the contrary, I would bet it impacts long-term prognosis. Wouldn't we rather see a small infarct on MRI than a larger one, even if the EF is the same? Troponin helps similarly in this regard, in real time.



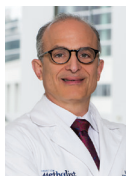
Jeffrey Moses, Columbia University, New York City, New York: Any test that doesn't impact clinical decisions is useless. Post-MI troponin and post-PCI biomarkers fall into this category.

Sam Butman, Scottsdale, Arizona: Jeff's view fits my past and now current locums practice experience and confusions. However, we do live in a world of templates as well as hospitalists. At the minimum, having a morning-after high-sensitivity troponin is often helpful in retrospect for the patient, as well as us, their consultants. On the other hand, there is no need for high-sensitivity troponin in elective interventions unless clinically indicated. It probably is not an all-or-none type thing.

David Rizik, Scottsdale, Arizona: [Troponins post STEMI] are a waste of time and money without clinically meaningful (actionable) value. This approach goes back to what you (Mort) always taught us in medical school in St. Louis; namely, what are you going to do with the information?

Duane Pinto, Boston, Massachusetts: If I want to know if something new has happened after the STEMI/PPCI, I add a CK-MB to a previous lab and then send another. Serial troponins are as useful as the daily Ca/Mg/Phos that are also ordered. "Cycling troponins" again for every change in condition is also useless. There are better signs to know whether someone didn't reperfuse, which could involve looking at the ECG and listening to the chest.

Timothy D. Henry, Cincinnati, OH: [For the skeptics, a quick follow-up], I spoke to 5 of 6 large STEMI systems and they still include a peak troponin in their standardized protocol, which has some variations in timing over the first 24 hours. Here's an important caveat: no one knows what to do with high-sensitivity troponin. Post-STEMI CK-MB is probably the best prognostic marker, but no one uses it. Forty-eight hour high-sensitivity troponin area under curve (AUC) is the next best marker, but a large portion of patients are home by 48 hours. Peak troponin is a relatively strong prognostic marker, but there are no similar prognostic data I know about with high-sensitivity troponin.



Neil Kleiman, Houston, Texas: I still like to see the troponins. If there is recurrent chest pain, they are part of the package when you want to know if there is (or isn't) reinfarction.

The Bottom Line

For diagnosis in ACS, troponins are critical. For STEMI, many patients will go to the cath lab with symptoms and ECG findings regardless of troponin values and often before these findings are available. For routine post PCI of stable patients, troponins are of little value unless there is a complication or evidence of ongoing ischemia needing potential re-intervention. For NSTEMI or STEMI post PCI, following troponins are predictive of future events, but do not change our therapeutic choices.[2,3] Troponins in the post-revascularization setting are more reassuring that we are consistent with guidelines and that post STEMI care is in accordance with recommended quality standards. ■

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— Sam Butman, MD

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Disclosures: Dr. Morton Kern reports he is a consultant for Abiomed, Abbott Vascular, Philips Volcano, ACIST Medical, and Opsens Inc.

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