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Washington University Emergency Medicine Journal Club
Post-Arrest Cardiac Catheterization in Patients Without STEMI

Vignette

While on your EMS rotation, you ride along on a call for a 52-year old gentleman with cardiac arrest. On arrival to the patient's home, bystander CPR is underway. You learn that 10 minutes prior to your arrival, the patient was running on his treadmill when he suddenly clutched his left shoulder. He turned off the treadmill, told his wife and daughter he didn't feel well, and collapsed to the floor. His 17-year old daughter (a lifeguard) attempted to feel for a pulse while his wife called 911. The daughter was unable to palpate a pulse and began CPR.

The paramedics continue CPR while you attach the cardiac monitor. Seeing that the rhythm is ventricular fibrillation, you place the pads and defibrillate the patient with success on the first attempt. He now has a pulse, and his BP is 85/40 with a pulse of 115. After placing an IV and intubating the patient, you then transport him to the Barnes-Jewish ED. His ECG on arrival reveals sinus tachycardia with normal intervals and deep T-wave inversions in leads V1-3, with no ST elevation. His BP is now up to 110/60, and his pulse remains 115. The ED team begins placing an ICY line to induce mild therapeutic hypothermia, sends labs, and begins the process of admission to the ICU.

You feel fairly certain, based on the history provided by family, that the underlying cause of this patient's cardiac arrest was an acute myocardial infarction. Despite the lack of ST-elevation the ECG, you wonder if the patient would benefit from early cardiac catheterization to assess for significant acute coronary artery occlusion. You head to the offices on the 8th floor, find a computer, and begin a search to see what the literature says...

PICO Question
Population: Adults patients with out-of-hospital cardiac arrest who achieve return of spontaneous circulation without evidence of STEMI on the initial ECG (with ventricular arrhythmia vs. any rhythm).
Intervention: Early cardiac catheterization.
Comparison: Standard care, delayed cardiac catheterization, no cardiac catheterization.
Outcome: Findings of acute coronary artery occlusion, survival to hospital discharge, good neurologic recovery, quality of life.

Search Strategy

PubMed was searched using the strategy "(cardiac arrest) AND (early OR immediate) AND ((cardiac catheterization) OR (coronary angiography) OR (coronary intervention))" (**http://tinyurl.com/lke4so9**), resulting in 602 articles, from which the following 4 articles were chosen.

Article 1: Sideris G, Voicu S, Dillinger JG, Stratiev V, Logeart D, Broche C, Vivien B, Brun PY, Deye N, Capan D, Aout M, Megarbane B, Baud FJ, Henry P. Value of post-resuscitation electrocardiogram in the diagnosis of acute myocardial infarction in out-of-hospital cardiac arrest patients. Resuscitation. 2011 Sep;82(9):1148-53. Answer Key.

Article 2: Dumas F, Cariou A, Manzo-Silberman S, Grimaldi D, Vivien B, Rosencher J, Empana JP, Carli P, Mira JP, Jouven X, Spaulding C. Immediate percutaneous coronary intervention is associated with better survival after out-of-hospital cardiac arrest: insights from the PROCAT (Parisian Region Out of hospital Cardiac ArresT) registry. Circ Cardiovasc Interv. 2010 Jun 1;3(3):200-7. Answer Key.

Article 3: Larsen JM, Ravkilde J. Acute coronary angiography in patients resuscitated from out-of-hospital cardiac arrest--a systematic review and meta-analysis. Resuscitation. 2012 Dec;83(12):1427-33. Answer Key.

Article 4: Hollenbeck RD, McPherson JA, Mooney MR, Unger BT, Patel NC, McMullan PW Jr, Hsu CH, Seder DB, Kern KB. Early cardiac catheterization is associated with improved survival in comatose survivors of cardiac arrest without STEMI. Resuscitation. 2013 Aug 6. Answer Key.

Bottom Line

Less than one-third of patients with return of spontaneous circulation (ROSC) following out-of-hospital cardiac arrest (OHCA) survive to hospital discharge (Sasson 2010). While this data pre-dates the use of therapeutic hypothermia (Holzer 2005, Kim 2012), the data does suggest the need for improvements in the care of post-arrest patients. The 2010 American Heart Associations Guidelines for Post-Cardiac Arrest Care describe therapeutic hypothermia and "treatment of the underlying cause of cardiac arrest" as primary initiatives in post-arrest care. Acute myocardial infarction has been demonstrated to be the likely cause of arrest in anywhere from one-third (Spaulding 2007, Anyfantakis 2009) to 61% (Chelly 2012) of patients admitted to the hospital. In patients with ST-elevation myocardial infarction (STEMI) on ECG following ROSC, the International Liaison Committee on Resuscitation (ILCOR) recommends that reperfusion therapy be attempted. In patients without STEMI, ILCOR is less clear, though, and recommends only that one "consider immediate coronary angiography in all post-cardiac arrest patients in whom ACS is suspected."

One systematic review looked at studies on coronary angiography in OHCA (Larsen 2012). A meta-analysis of 10 studies in which coronary angiography was performed in select patients revealed an unadjusted odds ratio for survival of 2.78 (95% CI 1.89-4.10). While this finding suggests improved outcomes with coronary

angiography, selection bias likely made a large contribution given the observational nature of these studies. The authors also identified 5 studies that assessed the use of coronary angiography systematically in all survivors of OHCA without an obvious non-cardiac cause, and found that the presence of significant coronary artery disease was high, ranging from 59-71%, despite only 31-63% of included patients presenting with STEMI or presumed new LBBB. This suggests that a significant subset of patients without STEMI had significant coronary occlusion, and could potentially benefit from percutaneous coronary intervention (PCI). While this systematic review suggests that there is a subset of patients in whom coronary occlusion is the underlying cause for the arrest, but in whom STEMI is absent on the post-resuscitation ECG, it is unclear which patients will benefit from attempts at coronary reperfusion.

In the Parisian healthcare system, all patients successfully resuscitated from OHCA are transported immediately for coronary angiography (Laurent 2002, Dumas 2010, Chelly 2012). Dumas identified 435 patients with ROSC following OHCA without an obvious non-cardiac etiology. Among patients with STEMI, 96% had at least one significant coronary stenosis on angiography; in patients without STEMI, 58% had at least one significant coronary stenosis. While this latter number suggests that cardiac catheterization was necessary in the majority of such patients, only 26% of these patients underwent successful PCI. The authors primary outcome was survival in patients undergoing successful PCI compared to those with no or failed PCI; they found survival rates of 51% vs. 31% respectively ($p < 0.001$) for a relative risk of 1.62. The authors' conclusion, that "immediate PCI seems to offer survival benefit" (p. 206) fails to address one important concern: the difficulty in predicting successful PCI in non-STEMI patients prior to coronary angiography. A more accurate conclusion may be that if you are going to have a cardiac arrest, make sure you have a lesion amenable to PCI.

In an attempt to reduce the rates of unnecessary cardiac catheterization, another Parisian study attempted to identify ECG findings predictive of angiographically defined acute myocardial infarction (MI) in OHCA patients (Sideris 2011). They found that the combination of ST-elevation, ST-depression, left bundle branch block (LBBB), or nonspecific QRS widening had a sensitivity of 100%, a specificity of 47%, a positive predictive value of 52%, and a negative predictive value of 100%. Of 46 patients without ST-elevation who were positive by ECG criteria, only 7 (15%) had angiographically defined acute MI; the other 39 underwent an unnecessary cardiac catheterization. While the authors conclude that use of this rule would have resulted in 30% of the cohort avoiding unnecessary cardiac catheterization, use of such a rule in most US institutions would lead to a significant *increase* in cardiac catheterization rates. The benefit of such an increase would need to be verified prior to implementation in light of the increased cost and risks of the procedure.

Only one article was identified that looked specifically at cardiac catheterization in patients without STEMI (Hollenbeck 2013). In this retrospective, observational study of comatose patients resuscitated from OHCA due to ventricular tachycardia (VT) or ventricular fibrillation (VF), patients were assessed based on whether they

underwent cardiac catheterization (CC) early (< 24 hours after ROSC) or either underwent late CC or no CC during hospitalization. Overall survival to hospital discharge was higher in the early CC group compared to the control group: (65.6% vs. 48.6%, p = 0.017) with an adjusted odds ratio for death of 0.35 (95% CI 0.18-0.70). Surprisingly, among those in the early CC group, successful PCI itself was *not* associated with improvement in survival rates (60% for those with successful PCI vs. 68.3% for those without successful PCI, p = 0.386). This suggests that factors other than CC led to the improved outcomes. It is possible that the increased use of other interventions, such as anti-thrombin and antiplatelet agents, could have led to improved outcomes in the early CC group. Given the retrospective nature of the study, it seems more likely that selection bias played a significant role: patients suspected of having a better prognosis may have been referred for CC, whereas those in whom aggressive care was felt to be futile would be treated more conservatively. Additionally, certain important prognostic indicators were not addressed in this study. Baseline characteristics provided were primarily related to the arrest itself (witnessed arrest, bystander CPR, time to ROSC) and did not address prior history of coronary artery disease or the presence of pre-existing comorbidities, such as cancer, that could lead to the implementation of less aggressive care.

While it seems likely that coronary occlusion and acute MI is responsible for a significant proportion of patients with ROSC following OHCA, even in the absence of ST-elevation, the existing literature provides little direction as to which patients would benefit from cardiac catheterization. The data suggests that patients with conduction defects or ECG changes consistent with ischemia are more likely to have significant coronary obstruction; unfortunately, there is no evidence that performing routine catheterization in patients with such ECG findings improves overall outcomes. The data also does not currently support routine catheterization in patients with ventricular fibrillation or ventricular tachycardia, given the methodological flaws in the Hollenbeck paper. Consideration should still be given to selective catheterization in patients with a history concerning for acute MI preceding arrest, especially in the presence of ischemic ECG changes. Further studies will need to prospectively evaluate the use of angiography in a pre-defined population of patients without STEMI to assess its efficacy in subsets of this population.