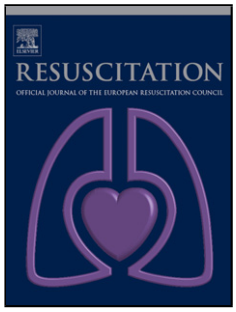

Title: Patients without ST elevation after return of spontaneous circulation may benefit from emergent percutaneous intervention: a systematic review and meta-analysis

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Title

Patients without ST elevation after return of spontaneous circulation may benefit from emergent percutaneous intervention: a systematic review and meta-analysis

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Running Title

Systematic review of the benefit of post cardiac arrest PCI

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Abstract

Introduction: The American Heart Association recommends that post-arrest patients with evidence of ST elevation myocardial infarction (STEMI) on electrocardiogram (ECG) be emergently taken to the catheterization lab for percutaneous coronary intervention (PCI). However, recommendations regarding the utility of emergent PCI for patients without ST elevation are less specific. This review examined the literature on the utility of PCI in post-arrest patients without ST elevation compared to patients with STEMI. Methods: A systematic review of the English language literature was performed for all years to March 1, 2015 to examine the

hypothesis that a percentage of post-cardiac arrest patients without ST elevation will benefit from emergent PCI as defined by evidence of an acute culprit coronary lesion. Results: Out of 1067 articles reviewed, 11 articles were identified that allowed for analysis of data to examine our study hypothesis. These studies show that patients presenting post cardiac arrest with STEMI are thirteen times more likely to be emergently taken to the catheterization lab than patients without STEMI; OR 13.8 (95% CI 4.9 - 39.0). Most importantly, the cumulative data show that when taken to the catheterization lab as much as 32.2% of patients without ST elevation had an acute culprit lesion requiring intervention, compared to 71.9% of patients with STEMI; OR 0.15 (95% CI 0.06 - 0.34). Conclusion: The results of this systematic review demonstrate that nearly one third of patients who have been successfully resuscitated from cardiopulmonary arrest without ST elevation on ECG have an acute lesion that would benefit from emergent percutaneous coronary intervention.

Keywords: cardiopulmonary arrest; return of spontaneous circulation; percutaneous intervention; systematic review; meta-analysis

Introduction

The American Heart Association (AHA) recommends that patients who have been successfully resuscitated from out-of-hospital cardiac arrest and have an initial electrocardiogram (ECG) that shows ST segment elevation myocardial infarction (STEMI) should undergo emergent cardiac catheterization with the intent to identify and re-vascularize the culprit lesion by percutaneous intervention (PCI) when clinically applicable.[1, 2] Since the largest group of patients with neurologically intact successful resuscitation present with ventricular fibrillation (VF), and patients with VF tend to have a positive prognosis when taken to PCI[3], this recommendation has been widely accepted.[1]

While it is well accepted to take a post-arrest patient with STEMI to emergent cardiac catheterization, the recommendations for performing emergent cardiac catheterization on post-arrest patients without ST elevation on ECG are less clear. Although the AHA guidelines specifically recommend that post-cardiac arrest patients with STEMI on the initial ECG should be taken to emergent catheterization[1], the most recent AHA guidelines also note that, "it may be reasonable," to perform emergent catheterization on select patients without STEMI.[2]
A recent study by Dumas, et al supports these guidelines demonstrating improved odds of survival for all post-arrest patients, including those without STEMI, that were emergently taken to PCI compared to delayed or no PCI.[4]

However, the AHA guidelines do not provide specific characteristics of patients who may benefit from emergent catheterization.[2] Retrospective studies show that a subset of patients who are post-cardiac arrest without ST elevation on ECG frequently have critical stenosis of coronary arteries.[4, 5] However, it is difficult to attribute the cause of the arrest to the diseased coronary artery especially in the absence of clearly distributed electrocardiographic findings. We hypothesized that the percentage of patients who would benefit from emergent PCI despite a lack of evidence of ST elevations is significant enough to warrant further study, develop clinical decision rules, and a potential change in practice towards bringing more of these patients to emergent catheterization. This in turn may lead to EMS agencies preferentially transporting patients who achieve ROSC to hospitals capable of performing cardiac interventions.

Therefore, the purpose of this scientific review is to help guide future therapy and scientific inquiry regarding the care of post-cardiac arrest patients that do not have a clear indication for emergent cardiac catheterization based on current clinical guidelines and practice patterns.

Understanding that the determination of clinical benefit is dependent on the defined clinical outcome, we kept our search broad to look for a number of possible benefits that included both disease-oriented outcomes (i.e. stentable lesion) and patient-oriented outcomes (i.e. mortality).

Methods

A systematic review of the literature was performed to address the following initial research question: What is the appropriate patient sub-group, of the overall patient population, that is post-cardiopulmonary arrest that should undergo emergent percutaneous coronary intervention (PCI)? Using a PICO format strategy our research question was reformatted to the following search strategy: ("out-of-hospital cardiac arrest" OR "cardiopulmonary arrest") AND ("percutaneous coronary intervention" OR "intensive care unit admission").

Following the guidelines from the PRIMSA statement[6], two reviewers independently performed a title, abstract and a full manuscript review, using PubMed, of the publicly-indexed English scientific literature for all years to June 3rd 2013 to determine manuscripts selected for analysis of data to address the study question. A third independent reviewer resolved discrepancies between the two reviewers throughout the review process.

Upon completion of the full manuscript review, study authors determined that further refinement of the search strategy was needed. This decision was made due to a large catchment of manuscripts that demonstrated a benefit to emergent cardiac catheterization for STEMI patients, as well as the established practice of sending post-arrest STEMI patients to the

catheterization lab. As our primary focus was on the role of emergent PCI for patients without ST elevation, a concentrated search was conducted to more narrowly define the study population. Specifically, we sought to examine the utility of referring post arrest patients without ST segment elevation to the catheterization lab. Further, it was determined that the hypothesis that a significant percentage of patients without STEMI will benefit from emergent PCI could more explicitly be addressed by searching for articles that specifically compared post-arrest patients without STEMI to those with STEMI. In this manner we hoped to demonstrate a comparative difference in outcomes with emergent cardiac catheterization for these two populations.

Therefore, study authors further developed the research question to the following: of patients that have been successfully resuscitated from cardiac arrest, is there a benefit to emergent cardiac catheterization for patients without STEMI on ECG versus those with STEMI? Using this refined research strategy two reviewers independently examined the manuscripts that were captured during the initial search strategy and identified manuscripts that specifically compared outcomes for patients that did not have STEMI on initial ECG to those who did have STEMI on initial ECG. Once again, a third independent reviewer resolved discrepancies between the two reviewers in the final determination of manuscripts chosen for final data analysis.

Study authors were then asked to abstract data from the identified manuscripts onto a standardized data abstraction sheet. Outcomes studied were: a decision was made to take the patient to emergent coronary angiography; the patient had emergent PCI with opening of a suspected culprit vessel and placement of a stent; the patient was given a diagnosis of acute myocardial infarction (AMI) based on identification of a culprit vessel from PCI or elevation of

cardiac biomarkers (i.e. cardiac troponin); survival; and good neurological outcome based on a cerebral performance category score of 1 or 2 or a modified Rankin score of 0, 1, or 2.

Once all data was abstracted from the relevant manuscripts a meta-analysis was then performed to aggregate results across the studies so as to calculate a summarized measurement of the association between STEMI status and: 1) emergent cardiac catheterization, 2) diagnosis of AMI, 3) PCI, and 4) survival. We entered raw data from each study into MetaXL version 4.0 to calculate the individual study and pooled effect sizes. Using a quality effects model, which adjusts for bias by accounting for heterogeneity of data and corrects for over dispersion by weighting each study based on sample size, we calculated odds ratios (OR) and confidence intervals (CI).[7] SAS 9.3 statistical software was then used to create forest plot figures to visually depict each study's effect size and the pooled effect size.

The manuscripts were also further reviewed to assess for biases using the Cochrane Review Bias Assessment Tool.[8] Finally, prior to data analysis the search strategy and review process was repeated on March 1st 2015 to update the literature review for new articles published since the initial search was performed.

Results

Our initial search strategy, which was performed on June 3, 2013, revealed 842 manuscripts, which was narrowed to 36 articles for full review by the study authors. On review of these articles, while they were all fairly homogeneous in the definition of cardiac cause of arrest, it was difficult to ascertain useful information due to the confounder of the effect of the specific ECG findings, i.e. STEMI versus no STEMI. Therefore, in order to specifically address our hypothesis regarding the utility of PCI for patients without STEMI we decided to further restrict

our search to only examine articles that compared the utility of emergent cardiac catheterization for post-cardiac arrest patients with STEMI to those without STEMI.

After further revision of the methods of our search strategy, eight manuscripts provided quantitative data to compare the clinical utility of cardiac catheterization for post arrest patients without STEMI vs. those with STEMI. Three additional articles were identified on a second run of the search, which was performed on March 1, 2015. In total, eleven articles that directly addressed the study hypothesis were incorporated into the final analysis.[3, 9-17] See Table 1 for details of the search strategy.

On review of these eleven articles we realized that one of the articles (Sideris et al 2014) included data from a previously published article (Sideris et al 2011). Therefore we elected to not include the article published in 2011 so as to minimize the chance of duplicate results biasing our study analysis. Further, we also determined that out of the eleven articles, ten articles focused on patients in out-of-hospital cardiac arrest, while only one article focused on patients that had in-hospital cardiac arrest. Therefore, in order to concentrate the study analysis solely on patients that had out-of-hospital cardiac arrest, with the expectation that these two conditions may represent different pathophysiological processes, we excluded the study from in-hospital arrests from our analysis (Merchant et al 2008).

Finally, two additional manuscripts were captured for study analysis outside of the formal search strategy process. The first manuscript was identified by one of the members of our project team (Kern et al 2015), and the second manuscript was identified during editorial review (Garcia et al 2016). After double author review we decided to include both of these studies in our data analysis. Therefore, we included eleven articles in our final data analysis that addressed our

hypothesis (Aurore 2011; Cronier 2011; Dumas 2010; Garcia 2016; Kern 2015; Radsel 2011; Sideris 2014; Spaulding 1997; Zanuttini 2012; Zanuttini 2013; and Zelias 2014)[3, 9-18]. See table 2 for a summary of the articles comparing post-arrest patients with STEMI to those without STEMI.

Overall, the eleven studies were quite heterogeneous in nature with sample sizes ranging from 84-754 patients. Most challenging was the variance in the methods used to determine the clinical value of emergent cardiac catheterization for post-arrest patients. Even the definition of acute myocardial infarction was heterogeneous, although most used some quantifiable method to gauge size of reduction in the diameter of the coronary artery lumen with some of the studies confirming there was an acute lesion by observation of an elevation of the troponin cardiac biomarker. In our search, no prospective randomized trials of PCI in post-cardiac arrest patients without STEMI were found, supporting the call by Miranda, et al for a randomized controlled trial of this population.[19]

Ultimately, we examined the data from these eleven studies to look for comparative evidence of the odds of an acute culprit lesion being identified during emergent PCI for patients with STEMI to those without STEMI. We were also interested in the likelihood that a patient would be taken to emergent catheterization and the odds of survival for these two groups.

Within the identified set of eleven articles, four provided data to examine the odds of post-arrest patients without ST-elevation going to the catheterization lab, compared to patients with STEMI. In these studies (Aurore et al, Cronier et al, Garcia et al, and Kern et al) 41.5% of patients without ST elevation were taken to emergent catheterization compared to 92.5% of those with STEMI.[3, 9]

In terms of the diagnosis of AMI, ten studies determined the presence of an AMI based on a subjective determination that a lesion identified on coronary angiography was the culprit cause of an ischemic trigger of cardiac arrest, with many of the studies objectively defining a critical lesion as one that has an acute reduction of greater than fifty percent luminal diameter of a coronary vessel. Within these ten studies, there was one patient without ST elevation diagnosed with AMI for every 10 STEMI patients diagnosed with AMI with 32.2% of patients without ST elevation (373/1159) being diagnosed with a culprit vessel in the catheterization lab compared to 71.9% of STEMI patients (665/925) being diagnosed with a culprit vessel. The overall odds ratio for a culprit vessel by PCI for patients without ST elevation compared to patients with STEMI was 0.15 (95% CI 0.06 - 0.34). See Figure 1 for a forest plot of the odds of AMI for patients without ST elevations versus those with STEMI based on cardiac catheterization findings.

In addition to the catheterization findings, two of the studies correlated the catheterization finding with elevations of troponin levels identifying that 54.7% of patients without ST elevation (220/402) had AMI diagnosed based on elevation of cardiac markers, while 87.0% (340/391) of STEMI patients were diagnosed with AMI (Dumas, et al, and Zelis, et al).

In terms of the odds of a patient having PCI with placement of a stent in a culprit lesion, 6 studies were included in the analysis. These six studies demonstrate that 37.7% of patients without ST elevation underwent PCI for a culprit lesion compared to 84.4% of STEMI patients, with an overall odds ratio of 0.14 (95% CI 0.06 - 0.30). These results are consistent with those findings for AMI as defined by angiographic findings and cardiac marker elevations.

Finally, in terms of survival, the combined data from three studies (Aurore et al, Garcia et al and Kern et al) showed that patients who were post-cardiac arrest that emergently went to the catheterization lab, including those with STEMI and those without evidence of STEMI on ECG, have 3.7 (95% CI 1.31 - 10.70) higher odds of survival.[9] Four studies (Cronier et al, Garcia et al, Kern et al and Sideris et al) showed that overall cardiac arrest patients who do not have ST elevation on ECG have 30% lower odds of survival compared to those presenting with STEMI (OR=0.69, 95% CI 0.55 - 0.87).[3, 12] Only two studies addressed neurological outcomes (Garcia et al, and Kern et al). These studies showed no difference in neurological outcomes between the two groups (OR=0.65, 95% CI 0.65 - 1.43).[17] See Figure 2 for a forest plot of the odds of survival for emergent PCI.

Discussion

In this systematic review and meta-analysis we examined the benefit of emergent cardiac catheterization for post cardiac arrest patients without clear evidence of ST elevation on ECG. As to be expected, these manuscripts demonstrate that when post-arrest patients are taken to emergent cardiac catheterization, those with STEMI have a significantly higher chance of having an acute coronary artery lesion (i.e. a “culprit lesion”) than patients without ST elevation. Still, these collective manuscripts demonstrate that almost one third of post-arrest patients without ST elevation on ECG will be found to have an acute culprit lesion causing AMI that could potentially benefit from emergent PCI. These data suggest that for a large percentage of cardiac arrest patients without ST elevation on ECG there could be significant diagnostic and therapeutic benefit to emergent cardiac catheterization.

It should be noted that these manuscripts do not provide the ability to analyze and differentiate those patients without ST elevation that may benefit from those that will not benefit from emergent catheterization. Therefore, one should be cautioned to not conclude from this review that all post-arrest patients without ST elevation should be taken to emergent cardiac catheterization, but rather conclude that the absence of ST elevation on ECG does not indicate a lack of underlying coronary disease in cardiac arrest patients. This study demonstrates that nearly one third of such patients will have a culprit lesion and could stand to benefit from emergent catheterization and PCI. Yet, there is a lack of data available to guide the decision about which post-arrest patients without ST elevation on ECG should go to emergent catheterization, indicating the need for further study.

The 2015 AHA guidelines on post-cardiac arrest care note that it is reasonable to perform emergent coronary angiography for patients who remain comatose after out-of-hospital cardiac arrest (OHCA) without ST elevation on initial ECG.[2] However, what are not known are the characteristics of those patients that will benefit versus those that will not benefit from emergent PCI. Certain groups have attempted to identify high-risk features that portend a poor outcome following cardiac arrest that can be used to identify patients who are unlikely to benefit from emergent cardiac catheterization.[20] However, these criteria have yet to be externally tested or validated and they have the potential to exclude patients who would otherwise be appropriate candidates for emergent PCI.

AHA guidelines suggest that individuals with persistent hemodynamic or electrical instability should be considered for early angiography.[2] With regards to risk stratification of patients with acute coronary syndrome who are not post cardiac arrest, patients with a higher Global Registry of Acute Coronary Events (GRACE) score have been shown to have a relative reduction in

death rates at six months when PCI was performed early versus late.[21, 22] Although the GRACE score has not been previously applied to patients that are post cardiac arrest without evidence of ST elevation, the application of a similarly type of scoring system may warrant further study.

Further research is needed to elucidate the specific attributes of patients resuscitated from OHCA without STEMI that may benefit from early PCI. Such research may have significant ramifications in the regionalization of cardiac arrest care, as has been done for stroke and trauma.[23, 24] Instead of prehospital emergency medical services (EMS) agencies transporting patients resuscitated from OHCA to the closest ED, it may be more appropriate to transport such patients to hospitals with immediate PCI-capability. A study in Japan, for example, demonstrated improved survival with good neurologic outcome for patients resuscitated from OHCA when transported to a PCI-capable hospital as opposed to a hospital without access to PCI.[25] Accordingly, the Maryland Medical Protocols recommend that all patients resuscitated from out of hospital cardiopulmonary arrest be transported to the closest appropriate cardiac intervention center (or hospital capable of performing emergent percutaneous coronary intervention).[26]

Care of patients with cardiac arrest requires a system-wide approach in order to improve patient outcomes. While timely bystander CPR and early access to defibrillation are often key components to surviving an out-of-hospital cardiac arrest, decisions regarding an appropriate destination facility and timing of PCI may also be consequential. This systematic review highlights the need for further study to determine which subset of patients resuscitated from OHCA who present without STEMI should be taken for emergent cardiac catheterization.

Our study suggests that what is truly needed is the development and external validation of a real time clinical decision instrument or checklist that clinicians can use to determine those patients that will benefit from emergent catheterization.

Limitations

Several limitations are implied within the context of this review. In addition to the usual drawbacks of a retrospective analysis, it should be noted that the eleven studies in this review are quite heterogeneous, which complicates this analysis, as there was a fair amount of selection and definition bias in the analysis of these results. In addition, it is difficult to concretely establish the link between a “culprit lesion” and a resultant cardiac arrest. The definition of a myocardial infarction was also subject to a measure of variability; despite a consistent pathophysiologic definition, the determination that an acute lesion was the culprit of an ischemic event causing cardiac arrest was to some extent subjective. Further, although the determination that a 50% reduction in luminal diameter was consistently applied by most of the studies as an objective measure of a culprit lesion, many would argue that a 50% lesion is not biologically a plausible cause of an acute myocardial infarction. Finally, the outcome of AMI based on identification of a culprit lesion or elevation of cardiac markers is a diseased-oriented outcome, which may or may not be directly linked to the patient-oriented outcomes of interest of survival and good neurological outcome, noting that only two studies in our review that examined neurological outcome did not find a difference in emergent catheterization for patients without evidence of STEMI.

The authors also acknowledge a significant amount of referral bias. In many studies, patients were brought preferentially to centers capable of PCI. Specialty cardiac arrest centers may have

a lower threshold for the practice of post-ROSC catheterization, and established clinical pathways for cardiac intervention may have biased results.

Finally, the clinical scenario that accompanies a post-arrest cardiac catheterization is somewhat unique. Post arrest patients are more hemodynamically labile, more likely to die, and are on the average more highly comorbid than their colleagues undergoing routine cardiac catheterization. Thus, the benefits of post arrest catheterization are readily confounded. Yet, this factor is balanced by the clear survival benefit for emergent cardiac catheterization in this post-arrest group.[9]

Conclusion

This systematic review of the literature demonstrates that nearly one third of post-cardiac arrest patients who do not have ST elevation on ECG will nevertheless have an acute culprit lesion and stand to benefit from emergent PCI. Further study is needed to identify those patients that will stand to benefit the most from emergent cardiac catheterization so that clinical guidelines may be developed.

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Conflicts of Interest

None to report

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Figure 1

Figure 1

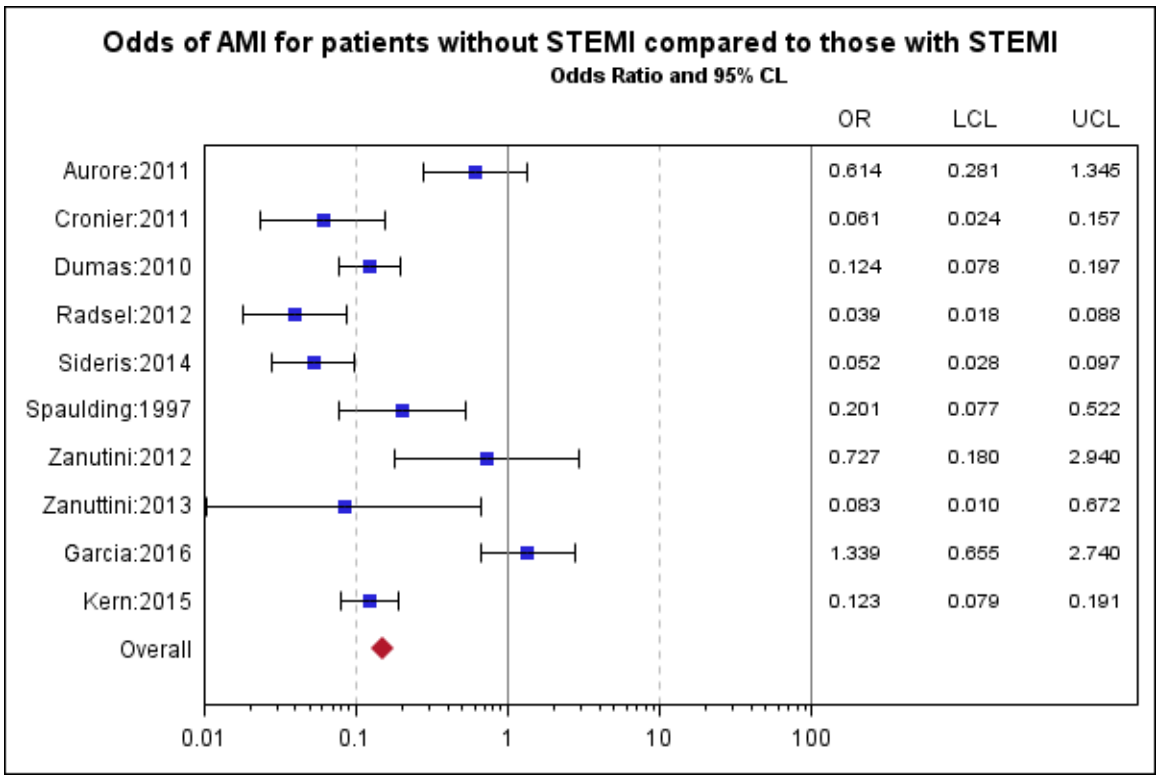

Figure 2

Figure 2

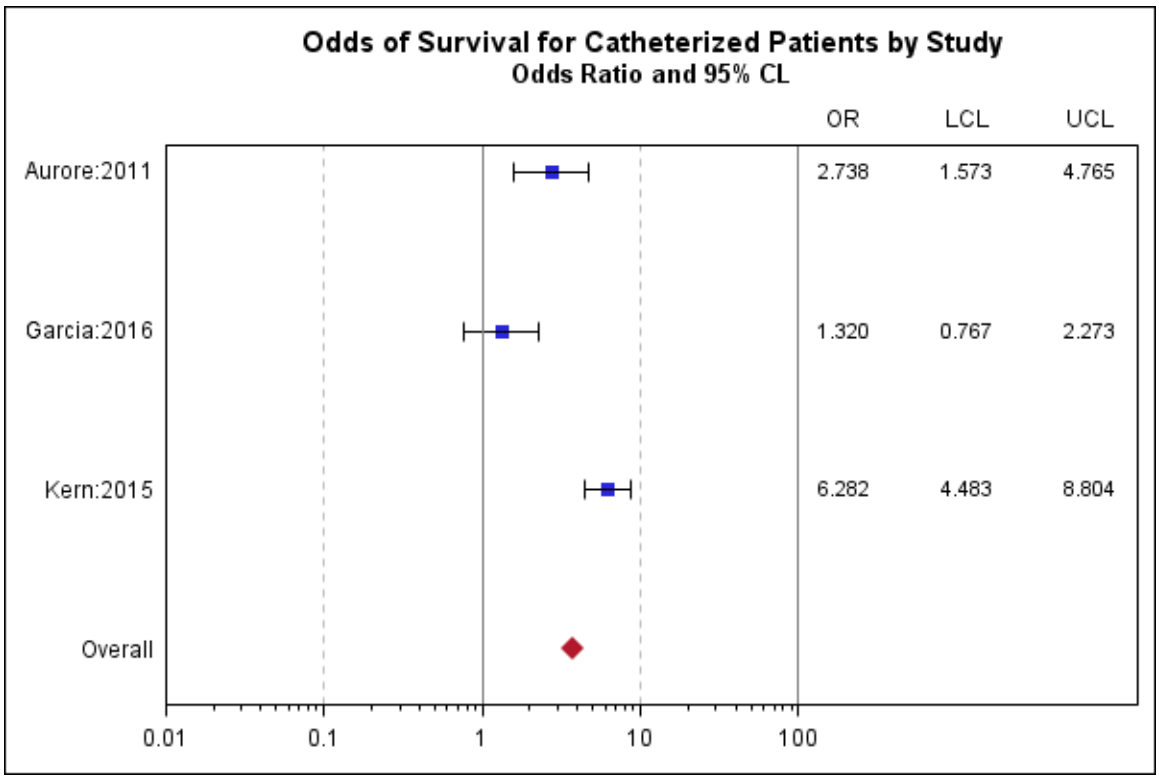

Table 1 – Search Strategy

Date of Search/Initiation of Review	Search Strategy	Articles from search	Study question	Articles after review	Final List
June 3, 2013 *(all years)*	("out-of-hospital cardiac arrest" OR cardiopulmonary arrest) AND (percutaneous coronary intervention OR intensive care unit admission)	842	What patient population that has been successfully resuscitated from cardiac arrest should be emergently taken to the cardiac catheterization lab?	36	
July 1, 2014			Of patients that have been successfully resuscitated from cardiac arrest is there a benefit to emergent percutaneous coronary intervention for patients with STEMI vs. without STEMI?	8	
June 1, 2013 – March 1, 2015		224	Of patients that have been successfully resuscitated from cardiac arrest is there a benefit to emergent percutaneous coronary intervention for patients with STEMI vs. without STEMI?	3	
August 8, 2016	Editorial recommendation for study published after last search included after review and agreement by two members of the study team			1	12

Table 2 – Summary of articles comparing NSTEMI to STEMI

Citation	Study design/description	N	Results	Assessment of Bias
Aurore, et al. Predictive factors for positive coronary angiography in out-of-hospital cardiac arrest patients. E. J of EM. 2011; 18: 73-76.	Retrospective study over 7-year period of all STEMI patients and select patients without STEMI successfully resuscitated from OHCA with emergent angiography within 2 hours of arrest.	Total=4,621 Analyzed=445 <u>Cath Lab</u> STEMI Yes = 65 No = 13 Not STEMI Yes = 68 No = 299	AMI = >50% reduction of lumen diameter STEMI = 65% Not STEMI = 11% OR=0.06 (0.04,0.11)	High risk of selection, performance, and detection bias
Cronier, et al. Impact of routine percutaneous coronary intervention after out-of-hospital cardiac arrest due to ventricular fibrillation. Crit Care. 2011; 15: R122.	Prospective study of all consecutive patients successfully resuscitated from OHCA. Patients had emergency coronary angiography prior to ICU admission.	Total=111 Analyzed=111 <u>Cath Lab</u> STEMI Yes = 47 No = 3 Not STEMI Yes = 44 No = 17	AMI = Occluded or stenotic vessel of suspected acute ischemia STEMI = 74% Not STEMI = 17% OR=0.06 (0.02,0.16)	High risk of performance and detection bias Low risk of selection bias
Dumas, et al. Immediate percutaneous coronary intervention is associated with better survival after out-of-hospital cardiac arrest: insights from the PROCAT Registry. Circ Cardiovasc Interv. 2010; 3: 200-207.	Retrospective review of prospectively collected data for PROCAT database. All successfully resuscitated OHCA patients of suspected cardiac cause admitted directly to the cath lab.	Total=714 Analyzed=435 <u>Cath Lab</u> STEMI Yes = 134 Not STEMI Yes = 301	AMI = At least one coronary artery with stenosis and elevated troponin level STEMI = 95% Not STEMI = 58% OR=0.07 (0.03,0.15)	High risk of performance bias Low risk of selection and detection bias
Garcia, et al. Early	Retrospective	Total = 431	AMI = PCI	High risk of

access to the cardiac catheterization laboratory for patients resuscitated from cardiac arrest due to a shockable rhythm: the Minnesota Resuscitation Consortium twin cities unified protocol. J Am Heart Assoc. 2016; DOI: 10.1161/JAHA.115.002670.	review of data from a prospectively collected state CARES database. All post arrest ROSC VF/VT patients included in the study.	Analyzed=315 <u>Cath Lab</u> STEMI Yes = 101 Not STEMI Yes = 130	with stent placement or emergent CABG STEMI = 75% Not STEMI = 46%	selection, performance, and detection bias. Low risk of attrition or reporting bias
Kern, et al. Outcomes of comatose cardiac arrest survivors with and without ST-segment elevation myocardial infarction. JACC: Cardiovascular Interventions.2015; 8: 1031-40	Retrospective review of prospectively collected data from the international cardiac arrest cardiology registry. All patients that survived to admission with patients chosen for coronary catheterization selected for study.	Total = 754 Analyzed=439 <u>Cath Lab</u> STEMI Yes = 192 Not STEMI Yes = 247	AMI = Findings on coronary angiography of a lesion thought to be the likely source of an ischemic trigger of cardiac arrest. STEMI = 80% Not STEMI = 33%	High risk of selection, performance, and detection bias Low risk of attrition and reporting bias
Radsel, et al. Angiographic characteristics of coronary disease and post-resuscitation electrocardiograms in patients with aborted cardiac arrest outside a hospital. Am J Cardiol. 2011; 108: 634-8.	Retrospective study of consecutive patients with OHCA of presumed cardiac origin. Decision for emergent angiography at the discretion of the treating physician.	Total=335 Analyzed=212 <u>Cath Lab</u> STEMI Yes = 158 Not STEMI Yes = 54 <u>No Cath Lab</u> Total = 123	AMI = >50% reduction of lumen diameter plus elevated troponin level STEMI = 89% Not STEMI = 26% OR=0.04 (0.02,0.09)	High risk of selection, performance bias Low risk of detection bias
Sideris, et al.	Retrospective	Total=439	AMI =	High risk of

Favourable 5-year postdischarge survival of comatose patients resuscitated from out-of-hospital cardiac arrest, managed with immediate coronary angiogram on admission. E HJ Acute Cardiovasc Care. 2014; 3: 183-91.	study of patients successfully resuscitated from OHCA with presumed cardiac cause. All patients transferred directly to the catheterization lab.	Analyzed=300 <u>Cath Lab</u> STEMI Yes = 108 Not STEMI Yes = 192	TIMI 0 or 1, or 2-3 vessels with ruptured plaque or fresh thrombus plus elevated troponin level STEMI = 68% Not STEMI = 10% OR=0.05 (0.03,0.09)	performance bias Low risk of selection and detection bias
Spaulding, et al. Immediate coronary angiography in survivors of out-of-hospital cardiac arrest. NEJM. 1997; 336: 1629-33.	Retrospective review of prospectively collected data for a cardiac arrest database. Study of patients successfully resuscitated from OHCA with presumed cardiac cause. All patients transferred directly to the catheterization lab.	Total=84 Analyzed=84 <u>Cath Lab</u> STEMI Yes = 49 Not STEMI Yes = 35	AMI = >50% reduction of lumen diameter, TIMI 0 or 1, or thrombus at site of occlusion STEMI = 63% Not STEMI = 26% OR=0.20 (0.08,0.52)	High risk of performance bias Low risk of selection and detection bias
Zanuttini, et al. Impact of emergency coronary angiography on in-hospital outcome of unconscious survivors after out-of-hospital cardiac arrest. Am J Cardiol. 2012; 110: 1723-28.	Retrospective study of patients successfully resuscitated from OHCA with presumed cardiac cause. Decision of emergent vs. delayed PCI at the discretion of the treating physician.	Total=93 Analyzed=48 <u>Emergent PCI</u> STEMI Yes = 28 Not STEMI Yes = 20 <u>No Emergent PCI</u> Total = 45	AMI = >50% reduction of lumen diameter STEMI = 79% Not STEMI = 80% OR=1.09 (0.26,4.51)	High risk of section, performance and detection bias
Zanuttini, et al.	Retrospective	Total=126	AMI = >50%	High risk of

Predictive value of electrocardiogram in diagnosing acute coronary artery lesions among patients with out-of-hospital-cardiac-arrest. Resuscitation. 2013; 84: 1250-54.	study of all STEMI patients and select patients without STEMI successfully resuscitated from OHCA of presumed cardiac cause.	Analyzed=91 <u>Cath Lab</u> STEMI Yes = 40 Not STEMI Yes = 36 <u>No Cath Lab</u> Total = 60	reduction of lumen diameter or acute thrombus STEMI = 85% Not STEMI = 65% OR=0.33 (0.10,1.09)	performance and detection bias. Low risk of selection bias.
Zelias, et al. Ten-year experience of an invasive cardiology centre with out-of-hospital cardiac arrest patients admitted for urgent coronary angiography. Kardiol Pol. 2014; 72: 687-99.	Retrospective review of patients with likely cardiac etiology of OHCA admitted to an invasive cardiology centre. Decision for emergent coronary angiography at the discretion of the treating physician.	Total=405 Analyzed=405 <u>Cath Lab</u> STEMI Yes = 273 Not STEMI Yes = 132 <u>No Cath Lab</u> Total = unknown	AMI = >50% reduction of lumen diameter plus elevated troponin level STEMI = 91% Not STEMI = 62% OR=0.16 (0.09,0.27)	High risk of selection and performance bias. Low risk of detection bias.

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