# WORKSHEET for Evidence-Based Review of Science for Emergency Cardiac Care

## Worksheet author(s)
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Michael Christopher Kurz MD MS-HES  

## Date Submitted for review:
Jan 1, 2009

## Clinical question.
In patients with suspected ACS (P), do any specific techniques (I), improve STEMI system or process of care compared with standard management (C), to improve time to treatment and clinical outcome (O)?

This topic has never been reviewed.

## Conflict of interest specific to this question
The author (MCK) has received non-significant honorarium (<$2000) from Zoll Medical Corporation in the last year.

The author (TRC) has no relevant conflicts.

## Search strategy (including electronic databases searched).

<table>
<thead>
<tr>
<th>Search strategy</th>
<th>PubMed search terms</th>
<th>EMBase search terms</th>
<th>Google Scholar search terms</th>
<th>Cochrane database</th>
<th>SCOPUS search terms</th>
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<td>1. Emergency physician activation of the catheterization lab</td>
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<td>2. Having a single call to a page operator to activate the catheterization lab</td>
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</table>
• State inclusion and exclusion criteria

The following criteria were used for inclusion of citations for evaluation. The article:
1) Must be a study (instead of an opinion, letter to the editor, book review, contemporary educational review, etc.)
2) Could not be an abstract only

The following studies were excluded (266 studies eliminated):
1) Duplications
2) Editorials
3) Abstract only
4) Educational program
5) Review
6) Topic not related

Total number of articles excluded: 368

• Number of articles/sources meeting criteria for further review (38 reviewed):

37 articles reviewed
1 pending ILL
5 need translation

Summary of evidence

Evidence Supporting Clinical Question

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<tr>
<th>Good</th>
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<tr>
<td>Brown 2008 C,E 3</td>
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<tr>
<td>Markel 1996 E 6</td>
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<tr>
<td>Khot 2007 E 1</td>
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<td>Zarich 2004 C,E 1</td>
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<td>Caputo 1997 E 8</td>
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<td>Huang 2008 C,E 1,4,6</td>
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<td>Jacoby 2005 E 1</td>
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<td>Bradley 2006 (NEJM) E 1-6</td>
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Level of evidence

A = Return of spontaneous circulation  C = Survival to hospital discharge  E = Other endpoint
B = Survival of event  D = Intact neurological survival  Italics = Animal studies

In the table above, the outcome measured by each study is noted with letters A – E. Some articles provide evidence for more than one technique in improving STEMI systems of care. Additional notations are made to identify which specific technique(s) (1 – 8) each study investigates.
1. Emergency physician activation of the catheterization lab
2. Single call activation of the catheterization lab
3. Pre-hospital activation of the catheterization lab
4. Having the catheterization lab ready in 20 minutes
5. Having the attending cardiologist always at the hospital
6. Providing real-time data feedback
7. Senior management commitment
8. Team based approach

**Evidence Neutral to Clinical question**

<table>
<thead>
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Larson 2007 E 1
Gibson 2008 C.E

**Level of evidence**

A = Return of spontaneous circulation  
B = Survival of event  
C = Survival to hospital discharge  
D = Intact neurological survival  
E = Other endpoint

**Evidence Opposing Clinical Question**

<table>
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Level of evidence

A = Return of spontaneous circulation  
B = Survival of event  
C = Survival to hospital discharge  
D = Intact neurological survival  
E = Other endpoint

**REVIEWER’S FINAL COMMENTS AND ASSESSMENT OF BENEFIT / RISK:**

The specific techniques to improve STEMI process of care are diverse. Since it was determined that D2B correlates with mortality, there have been a wide range of processes implemented to improve time to reperfusion. These have been put into practice by hospitals across the nation with variable success. The first studies to examine time to treatment in STEMI were performed by Lewis, Sharkey and Kereiakes [Lewis, 1982, 123; Sharkey, 1989, 3174; Kereiakes, 1990, 773]. Sharkey demonstrated that the longest delays were door time to ED ECG [Sharkey, 1989, 3174]. Bradley (NEJM) provides the most comprehensive list of the potential techniques to improve the process of treatment of STEMI [Bradley, 2006, 2308]. In this article, interviews with 365 hospitals revealed the effectiveness of 28 strategies. Of these 28, only 6 were shown to have a significant association with decreased D2B time. The same study shows a clear association between the number of strategies in place and having a lower D2B time. Hospitals that employed 4 or more specific techniques to improve STEMI treatment had a D2B of 79 minutes or less (p < 0.001). Bradley reviewed the literature available supporting these strategies [Bradley, 2007, 91].
To systematically evaluate the wide range of specific techniques, this worksheet focuses on these 6 techniques that have been associated with decreased D2B. Each strategy will be assessed separately.

1. Emergency physician activation of the catheterization lab
2. Single call activation of the catheterization lab
3. Pre-hospital activation of the catheterization lab
4. Having the catheterization lab ready in 20 minutes
5. Having an attending cardiologist always at the hospital
6. Providing real-time data feedback

Also included are two additional strategies suggested by the D2B Alliance [Krumholz, 2008, 97].
7. Senior management commitment
8. Team based approach

Many of the studies involve strategies that are implemented concomitantly. In these circumstances, it is impossible to determine which strategy is responsible for the improvement in D2B. Additionally, a number of the studies are part of a larger quality improvement initiative. For these projects, the Hawthorne effect is significant and must be considered when interpreting the results.

**Emergency physician activation**

The specific technique with the greatest impact on time to treatment of STEMI is emergency physician (EP) activation of the catheterization lab. The data that supports this is both qualitative and quantitative. Qualitative data is provided in two publications by Bradley [Bradley, 2005, 1236; Bradley, 2006, 1079]. In these articles, the authors identified specific techniques to improve STEMI process of care through interviews with top performing hospitals. EP activation was proposed and an association is suggested. The authors demonstrate that hospitals which implement EP activation had lower D2B times by 8.2 minutes with a statistical significance of p = 0.01 [Bradley, 2006, 2308]. However, causality is not established.

There are 10 studies that provide direct evidence supporting EP activation as a direct cause of decreased D2B [Huang, 2008, 46; Jacoby, 2005, 154; Khot, 2007, 67; Kraft, 2007, 520; Kurz, 2007, 527; Lee, 2008, 414; Lipton, 2006, 29; Singer, 2007, 538; Thatcher, 2003, 693; Zarich, 2004, 191]. Of these, the range of improvement in D2B is from 20 – 68 minutes. The earliest study of this strategy to improve D2B was performed by Thatcher [Thatcher, 2003, 693]. Limitations of this study are that it was completed while the hospital was undergoing the transition from thrombolitics to PCI.

Since that time, there is literature that provides direct evidence of the positive impact of EP activation [Huang, 2008, 46; Jacoby 2005, 154; Khot, 2007, 67; Kraft, 2007, 520; Kurz, 2007, 527; Lee, 2008, 414; Lipton, 2006, 29; Singer, 2007, 538; Thatcher, 2003, 693; Zarich 2004], limiting the ability to attribute the decrease in D2B solely to EP activation. Two of the studies did not mention if other initiatives were started at the same time [Jacoby, 2005, 154; Khot, 2007, 67]. Only 2 studies implemented EP activation in isolation without any additional specific techniques to improve STEMI treatment [Kraft, 2007, 520; Kurz, 2007, 520]. In these studies, a decrease in D2B of 40 minutes was realized. In all of the studies, EP activation had a remarkable and significant impact on D2B.

When EP activation is implemented, false positive activation of the catheterization lab becomes a concern. Of the studies that investigate EP activation, the false activation rate that is reported ranges from 0% to 1% [Jacoby, 2005, 154; Khot, 2007, 67; Kraft, 2007, 520; Kurz, 2007, 527; Lee, 2008, 414]. The remaining studies do not report a false activation rate [Huang, 2008, 46; Lee, 2008, 414; Lipton, 2006, 29; Singer, 2007, 538; Zarich 2004], limiting the ability to attribute the decrease in D2B solely to EP activation. Larson conducted a study of false positive activation of the catheterization lab when activated by EP [Larson, 2007, 2754]. The false positive rate detected by this study was remarkably higher than the studies mentioned above. Of all EP activations of the catheterization lab, 14% had no culprit artery on catheterization, 9.5% had no CAD, and 11.2% had negative cardiac enzymes.

**Single call to a central page operator**

The most effective method of activating the catheterization team is suggested by Bradley (NEJM) [Bradley, 2006, 2308]. The hospitals that enforce a single call to a central page operator have significantly lower D2B times by 13.2 minutes. There are a number of studies that utilize this method of catheterization lab activation [Afolabi, 2007, 588; Gross, 2007, 1360; Lipton, 2006, 29; Singer, 2007, 538]. None of these studies implement this specific technique in isolation. Consequently, there is little data to confirm causality between this specific technique and decreased D2B times.

**Pre-hospital activation of the catheterization lab**

Another method of catheterization lab activation occurs before the patient arrives in the hospital and while they are en route via emergency medical services (EMS). Pre-hospital activation of the catheterization lab is a specific technique that has been studied in the literature and proposed as a measure to decrease D2B [Afolabi, 2007, 588; Bradley, 2006, 2308; Brown, 2008, 158; Gross,
2007, 1360; Le May, 2008, 231; Swor, 2006, 374; Van de Loo, 2006, 112]. This particular intervention is distinct from the pre-hospital ECG which is assessed by another worksheet (ACS-026). Bradley (NEJM) established the association between D2B and pre-hospital activation [Bradley, 2006, 2308]. In this study, the hospitals that perform pre-hospital activation of the catheterization lab have lower D2B times by 15.2 minutes (p = 0.001).

The remaining studies demonstrate the positive effect of implementation of pre-hospital activation of the catheterization lab on D2B time. The studies are variable in their application and this makes comparison more challenging. Each study approaches the implementation of pre-hospital activation differently [Afolabi, 2007, 588; Brown, 2008, 158; Gross, 2007, 1360; Le May, 2008, 231; Swor, 2006, 374; Van de Loo, 2006, 112]. Pre-hospital activation may require transmission of a positive pre-hospital ECG [Afolabi, 2007, 588] (which has been shown to have an impact on D2B and is answered by a separate worksheet). In some studies, pre-hospital evaluation is utilized to triage the patient to a primary PCI center [Gross, 2007, 1360; Le May, 2008, 231]. The topic of regional systems of care and direct transport of patients with suspected ACS to a primary PCI center is addressed in detail in another worksheet (027A).

One study utilized pre-hospital activation to allow for bypass of the emergency department completely and direct transport of the patient to the catheterization lab on arrival to the hospital [Van de Loo, 2006, 112]. These studies evaluate D2B and found a decrease ranging from 22 to 69 minutes with pre-hospital activation of the catheterization lab. [Afolabi, 2007, 588; Brown, 2008, 158; Gross 2007, 1360; Le May, 2008, 231; Swor, 2006, 374; Van de Loo, 2006, 112]. Few of these studies are powered to evaluate mortality [Afolabi, 2007, 588; Brown, 2008, 158; Le May, 2008, 231; Swor, 2006, 374]. Only Gross found a significant mortality difference for those patients who were triaged by paramedics directly to PCI center compared to those that were transferred from an ED (0% vs. 4.3% p = 0.007). Pre-hospital activation had a positive impact on length of hospital stay (4 vs. 5 days, p = 0.007) [Le May, 2008, 231]. The data remains limited, however, and the true impact of this specific technique on D2B and mortality is uncertain. None of the studies investigate the percentage of false positive activation among these patients.

Expecting the catheterization lab to arrive in 20 minutes
Bradley (NEJM) established an association between hospitals that expect the catheterization team to arrive in 20 minutes and having decreased door to balloon time [Bradley, 2006, 2308]. A time savings of 14.2 minutes was recognized among hospitals that employ this technique (p <0.01). Two hundred eighty of the 365 hospitals that were interviewed already require that the catheterization staff arrive in the lab within 21 – 30 minutes of being paged. Only 39 hospitals require that the catheterization team is in the lab in less than 20 minutes. No studies have investigated the impact of implementing this specific technique in isolation on D2B time. Huang employed the expectation of catheterization team arrival within 30 minutes along with other techniques as part of a quality improvement initiative [Huang, 2008, 46]. The impact of the other techniques as well as the Hawthorne effect cannot be excluded. How much this specific technique improved the D2B time cannot be elucidated. Sadeghi conducted a prospective multicenter study of 2084 patients and compared the time to treatment and outcomes among patients who presented to the catheterization lab during peak vs. off peak hours [Sadeghi, 2004, 637]. They did observe a 21 minute improvement in D2B among those patients who presented when the catheterization lab was in house. However, they also found that outcomes were the same and there was no difference in mortality or left ventricular function.

Having an attending cardiologist always at the hospital
Bradley (NEJM) demonstrated an association between having an attending cardiologist always at the hospital and decreased door to balloon times of 8.2 minutes (p = 0.01) [Bradley, 2006, 2308]. Only 14 hospitals of 365 enforce this requirement. No studies have investigated the impact of implementing this specific technique on D2B time.

Real time data feedback
Four studies investigate the usefulness of real time data feedback on improving D2B. Evidence to support real time data feedback is provided by Bradley (NEJM) [Bradley, 2006, 2308]. Hospitals that employ real time data feedback, either from the hospital to ED staff or from the ED staff to EMS, recognize a time savings of 10 – 12 minutes (p < 0.001) [Bradley, 2006, 2308]. A before-and-after cohort study by Lipton assessed the value of providing quarterly feedback to cardiologists. This study has limitations in assessing the impact of real time feedback. Firstly, there was no feedback to the ED staff or EMS. While a D2B decrease of 39 minutes was observed, it is impossible to determine if this was secondary to the feedback to the cardiologists or the other measures implemented. Two studies implemented real time data feedback among other interventions to improve STEMI treatment [Huang, 2008, 46; Lipton, 2006, 29]. The third study did not perform real time data feedback [Ward, 2000, 336]. Instead, the authors performed an audit of D2B times and relevant time intervals and assessed areas of delay. While this is not a study of real time data feedback, this study clearly demonstrates a positive impact of an audit on D2B. A decrease of 54 minutes was realized (p <0.01). This study was significant in that no other measures were implemented during this time, strengthening the impact of this on D2B.

Senior management commitment
A qualitative study by Bradley (Circulation) provides insight into several measures that are necessary for achievement in decreasing D2B [Bradley, 2006, 1079]. Among the several strategies, senior management commitment is suggested. While thorough, it remains a qualitative study and there is no direct association provided between this specific strategy and any time savings in D2B.
Only one other study investigates the importance of physician leadership in STEMI [Holmboe, 2003, 289]. It is also qualitative and no direct causality or correlation is proven.

**Team based approach**

Bradley (Circulation) provides a qualitative study of systems improvements to decrease D2B [Bradley, 2006, 1079]. Among the several strategies, a team based approach is suggested. While thorough, it is remains a qualitative study and there is no causality provided between this specific strategy and any time savings in D2B.

Four studies investigate the implementation of a team based method to improve time to treatment of ACS. Pell evaluated the impact of a fast track protocol for patients suspected to have acute myocardial infarction [Pell, 1989, 83]. The results showed an decrease in time to treatment from 93 to 49 minutes (p < 0.001). The details of their fast track system included: 1) allowing all people who met STEMI criteria by history and EKG findings to bypass evaluation by the medical registrar and proceed directly back to the ED for treatment 2) requiring early establishment of IV access and 3) prompt consultation with a cardiac team. This study was one of the earliest studies on how to improve D2B. It laid the groundwork on methods to decrease D2B.

Markel confirmed the effectiveness of a quality improvement protocol in the reduction of time to treatment in STEMI [Markel, 1996, 685]. In this study, a significant decrease in time to treatment was recognized (22 minutes, p = 0.0001). The authors evaluated the efficacy of specific techniques designed to target the root causes of delays in treatment. While these techniques were not the 8 studied by this worksheet, it does establish the impact of hospital wide initiatives on improving time to treatment.

In two publications, Caputo demonstrates the positive impact of a quality improvement program at two different institutions [Caputo, 1997, 1159; Caputo, 2005, 428]. Significant D2B improvements are realized in both studies by Caputo (range of 20 to 95 minutes). In these studies, the multiple strategies employed include having an on-call schedule for the cardiologists, increasing teaching and awareness of STEMI treatment, specifying a protocol for activating interventional cardiology (not a single call system), expecting the catheterization lab to arrive in 30 minutes, and implementing PCI improvement strategies.

**Additional Studies**

Chen demonstrated that treatment of STEMI with PCI at a rural hospital in China was associated with remarkably long time from symptom onset to presentation (178 minutes) [Chen, 2007, 225]. The patients in this study also had mean D2B times of 169 minutes. The prolonged time to treatment resulted in higher mortality and longer hospital stays in this patient population. No studies to date study the impact of any of the 8 strategies investigated in this worksheet among rural hospitals that treat STEMI with PCI.

Outside of these 8 recommendations investigated above, there is clear evidence that remarkable improvements in D2B have been made over the last 16 years [Gibson, 2008, 1035]. In this review of the NRMI database, there has been demonstrated decreased use of fibrinolytics, increased use of PCI, decreased D2B and decreased mortality. Although no causality is established with the eight specific techniques described above, there is evidence of improvement.

Bradley published an update on the impact of D2B Alliance [Bradley, 2008, 23]. Among the 900 hospitals that participate in the D2B Alliance, 30% of the hospitals employed 4 of 5 key strategies. However, 9.3% continue to employ none of the key strategies to decrease D2B time. Their update on the progress of this project indicates there continues to be opportunities for continued improvement and increased participation among hospitals nationwide.

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**Acknowledgements:**

None

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**Citation List**

### I. Included or Reviewed References


LOE 2
Quality: Fair
Supportive
Key Study Supporting 2nd TR


LOE 5
Quality: Fair
Supportive


LOE 5
Quality: Fair
Supportive


LOE 5
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Supportive


LOE 5
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Supportive
Key Article For Determining Evidence Based Strategies.


LOE 5
Quality: Fair
Supportive


LOE 5
Quality: Fair
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LOE 2
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LOE 3

LOE 3
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LOE 2
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Supportive

References Pending Translation


II. Other References Reviewed


35. Drummond J, Jermy B, Muzaffar S. Time critical diagnosis system recommendations to advance emergency medical care for stroke and STEMI in Missouri. 2008 July.


