**Clinical question.**

*In adult and pediatric patients with out-of-hospital cardiac arrests (P), does transport to a specialist cardiac arrest centre (I) compared with no such directed transport (C), improve outcome (eg. survival) (O)?*

Is this question addressing an intervention/therapy, prognosis or diagnosis? **INTERVENTION**

State if this is a proposed new topic or revision of existing worksheet: **NEW**

**Conflict of interest specific to this question**

Do any of the authors listed above have conflict of interest disclosures relevant to this worksheet?

JS - No relevant conflicts

GN -

NHLBI Bethesda, MD Grantee, co-PI, Resuscitation Outcomes Consortium Data Coordinating Center Canadian Institutes of Health Research, Medtronic Inc. Ottawa, Canada, and Minneapolis, MN Grantee, Coinvestigator, Resynchronization in Advanced Failure Trial (RAFT)

Asmund S Laerdal Foundation for Acute Medicine Stavanger, NO Principal Investigator, Randomized Trial of CPR Training Aid in Community Laerdal Inc. Equipment donation of training aids for overseas medical mission (2006)


Northfield Laboratories Evanston, IL Consultant (2008)

Paracor Medical Inc. Sunnyvale, CA Consultant (2007)

Innercool Therapies Inc. Travel expenses (Single trip, 2006)

Radiant Medical Inc. Travel expenses (Single trip, 2006)

Medic One Foundation, Seattle, WA. Member of Board of Directors Member of the AHA Writing Group on Regional Systems of Care for Cardiac Arrest

**Search strategy (including electronic databases searched).**

GN:


JS:
Search term:
Cardiac arrest centers OR cardiac arrest centres

Looked at key papers
(Langhelle, Tyvold et al. 2003; Lurie, Idris et al. 2005; Sunde, Pytte et al. 2007; Nichol, Thomas et al. 2008) and who had cited them in Scopus

Look at related articles and references
Search Medline, Embase, PsychINFO, CINAHL, Cochrane, Google Scholar, AHA EndNote Library, Science Direct, Scopus

GN also looked at Trauma/MI/Stroke care papers

Trauma

Stroke

Myocardial Infarction

• State inclusion and exclusion criteria

Inclusion:
Any study that has looked at indicators of regionalization of care
All age groups
Regionalisation for Trauma, MI and Stroke studies also included for extrapolation

Exclusion
As this is a new topic with few relevant studies no exclusion
Abstract only studies

- **Number of articles/sources meeting criteria for further review:**

  JS

  12 Jan 2009

  Cochrane – No relevant reviews

  Medline, Embase, PsychINFO, CINAHL

  (cardiac AND arrest AND center).ti,ab  790
  (cardiac AND arrest AND centre).ti,ab  233

  Combined with duplicates 1015

  ((cardiac arrest center*) OR (cardiac arrest centre*)).ti  36

  Without duplicates  20

  1 Lurie et al 2005

  The Lurie paper (Lurie, Idris et al. 2005) is an editorial about cardiac arrest centres.

  Search Scopus citation manager to find papers referencing Lurie et al 2005 gave 6 further papers

  Searching through reference lists of key papers identified 6 further articles

  Review of AHA ReSS 2008 identified 2 abstract only presentations

  AHA EndNote library did not identify any new papers

  14 papers including the 2 ReSS 2008 abstracts included in review – 1 (Callaway 2010 e published) subsequently published

  **Update after Osaka ILCOR discussion:**

  Identified 4 additional papers regarding package of post resuscitation care

  Removal of 1 study (Nichol G et al. 2008)

  GN

  CA 5 five LOE 3 (retrospective controls)
  T 20 LOE 5 (extrapolation from another clinical disorder- 2 prospective controls, 18 retrospective controls)
  MI 10 LOE 5 (extrapolation from another clinical disorder- 6 RCTs, 3 prospective controls, 1 retrospective controls)
  S 2 LOE 5 (extrapolation from another clinical disorder- 1 systematic review, 1 retrospective controls)

  **SEARCHES UPDATED for CARDIAC ARREST STUDIES 20 Jan 2010**

  1 new study – Callaway 2010 epub
2 position papers (these were not included in evidence review but were checked for source of other studies)

Nichol 2010

Mechem 2010

5 additional trauma centre studies also identified from AHA policy statement.

Final studies included in WS based on 20 January 2010 search

16 Cardiac arrest studies

And extrapolation from:

27 Trauma studies
10 MI studies
2 Stroke studies
# Summary of evidence

## Evidence Supporting Clinical Question

<table>
<thead>
<tr>
<th>Good</th>
<th>Evidence Supporting Clinical Question</th>
<th>Level of evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Oddo 2006 1865 D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sunde 2007 29 D E3 E6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Callaway 2010 epub C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vermeer 1999 426 C</td>
<td>MI</td>
</tr>
<tr>
<td></td>
<td>Widimsky 2000 823 C</td>
<td>MI</td>
</tr>
<tr>
<td></td>
<td>Widimsky 2003 94 C</td>
<td>Trauma</td>
</tr>
<tr>
<td></td>
<td>Culica 2007 SR9 C</td>
<td>Trauma</td>
</tr>
<tr>
<td></td>
<td>Mackenzie 2006 366 C</td>
<td>Trauma</td>
</tr>
<tr>
<td></td>
<td>Sampalis 1995 232 C</td>
<td>Trauma</td>
</tr>
<tr>
<td></td>
<td>Sampalis 1997 288 C</td>
<td>Trauma</td>
</tr>
<tr>
<td>Fair</td>
<td>Le May 2008 231 C</td>
<td>MI</td>
</tr>
<tr>
<td></td>
<td>Lamonte 2008 319 C</td>
<td>Stroke</td>
</tr>
<tr>
<td></td>
<td>Stroke Unit Trials Collaboration 2007</td>
<td>Stroke</td>
</tr>
<tr>
<td></td>
<td>Liberman 2004 1330 C</td>
<td>Trauma</td>
</tr>
<tr>
<td></td>
<td>Mann 2001 1111 C</td>
<td>Trauma</td>
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<tr>
<td></td>
<td>Mullins 1996 536 C</td>
<td>Trauma</td>
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<tr>
<td></td>
<td>Mullins 1998 609 C</td>
<td>Trauma</td>
</tr>
<tr>
<td></td>
<td>Mullins 1994 1919 C</td>
<td>Trauma</td>
</tr>
<tr>
<td></td>
<td>Nathens 2000 25 C</td>
<td>Trauma</td>
</tr>
<tr>
<td></td>
<td>Nicholl 1997 1349 C</td>
<td>Trauma</td>
</tr>
<tr>
<td>Poor</td>
<td>Davis 2007 44 C E1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Engdahl 2000 201 C E5 E6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Herlitz 2006 25 E2</td>
<td></td>
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<tr>
<td></td>
<td>Liu 2008 339 C</td>
<td></td>
</tr>
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<td></td>
<td>Keenan 2007 836 C, E7</td>
<td></td>
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<tr>
<td></td>
<td>Langhelle 2003 247 D E3</td>
<td></td>
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<tr>
<td></td>
<td>Spaite 2008 61 C E1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spaite 2009 248 C E1</td>
<td></td>
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<tr>
<td>Poor</td>
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</table>

### Level of evidence

<p>| | | | | |</p>
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<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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</table>

A = Return of spontaneous circulation  
C = Survival to hospital discharge
### Evidence Neutral to Clinical question

<table>
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<tr>
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<tbody>
<tr>
<td></td>
<td>Andersen 2003 773C</td>
</tr>
<tr>
<td></td>
<td>Bonnefoy 2002 825 C</td>
</tr>
<tr>
<td></td>
<td>Grines 2002 1713 C</td>
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<tr>
<td></td>
<td>Trauma</td>
</tr>
<tr>
<td></td>
<td>De Jongh 2008 1007 C</td>
</tr>
<tr>
<td>Fair</td>
<td>MI</td>
</tr>
<tr>
<td></td>
<td>Henry 2007 721 C</td>
</tr>
<tr>
<td></td>
<td>Ting 2007 729 C</td>
</tr>
<tr>
<td></td>
<td>Trauma</td>
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<tr>
<td></td>
<td>Boyd 1975 25 C</td>
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<tr>
<td></td>
<td>Goldberg 1981 547 C</td>
</tr>
<tr>
<td></td>
<td>Hulka 1997 514 C (children)</td>
</tr>
<tr>
<td></td>
<td>Kane 1992 576 C</td>
</tr>
<tr>
<td></td>
<td>Norwood 1995 240 C</td>
</tr>
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<td></td>
<td>Young 1998 88 C</td>
</tr>
<tr>
<td>Poor</td>
<td>MI</td>
</tr>
<tr>
<td></td>
<td>Jollis 2007 2371 C</td>
</tr>
</tbody>
</table>

### Level of evidence

1 | 2 | 3 | 4 | 5

**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>
<thead>
<tr>
<th>Good</th>
<th>Trauma</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reilly 2004 C</td>
</tr>
<tr>
<td>Fair</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor</td>
<td></td>
</tr>
</tbody>
</table>

### Level of evidence

1 | 2 | 3 | 4 | 5

**A** = Return of spontaneous circulation  
**B** = Survival of event  
**C** = Survival to hospital discharge  
**D** = Intact neurological survival  
**E** = Other endpoint  
*Italics = Animal studies*
The rationale for cardiac arrest centres and regionalization of care for cardiac arrest centres is the subject of a recent supportive AHA policy statement (Nichol 2010 epub Circulation).

There are no randomised studies to test this and it is unlikely they will take place. Therefore we need to look at studies that we can extrapolate data from:

1. Is there variation in outcomes between hospitals served by the same EMS systems?
2. Transport interval from scene to resuscitation centre – i.e. is it safe to by bypass closer hospitals to go to a designated cardiac arrest centre?
3. Effect of patient volume or hospital characteristics on survival of OHCA patients admitted to the centre.
4. Specific post resuscitation care interventions offered by centre (e.g. therapeutic hypothermia, percutaneous coronary intervention).
5. Can we extrapolate from other emergencies i.e., Trauma, MI and stroke systems of care where specialist centres and regionalization are already an established?

Transport interval (scene to hospital)/Transport mode

Three LOE 4 Studies:

Davis DP et al (Davis, Fisher et al. 2007) showed in an observational study that for urban OHCA in one US city EMS, nearly all survivors had ROSC at scene and transport time to hospital did not impact survival to hospital discharge. Study carried out in 2001-2002. Mean transport times from scene to ED were similar for those who died in ED (8.3 min) died after admission (7.8 min) and survived to discharge (8.5 min). The ranges are not reported. This suggests feasible to take all ROSC patients to single urban centre. These transport times are relatively short. The high scene ROSC rate will depend on the EMS system, time at scene. It is not clear how many hospitals were involved and how hospital factors influenced outcome.

Spaite DW et al (Spaite, Bobrow et al. 2008) showed in an observational study that in a number of EMS in Arizona during 2004-2006 transport time did not impact survival to hospital discharge in patients with ROSC in the field. Mean transport time 6.9 min (95% CI 6.7-7.1 min). Transport time data was missing in 38% of cases. It is not clear how hospital factors influenced these outcomes. It is difficult to interpret the results of this study since response times were missing in a high proportion of patients.

Spaite DW et al (Spaite, Stiell et al. 2009) studied observational data for 15,559 patients from the Ontario Prehospital Advanced Life Support Study (OPALS) collected between 1991 and 2002. The mean transport interval was 4 min for survivors and 4.2 min for non-survivors to hospital discharge. 19% of the data is missing. Transport interval with a multisystem EMS did not impact survival. It is difficult to extrapolate the results of this study to other settings since the overall survival was low.

The above studies with very short transport times [median (25 to 75 quartile); Davis = 7 (5 to 11) min; Spaite 2008 = 6 (4 to 9) min; Spaite 2009 = 4.2 (3.0 to 6.2) min] suggest it is feasible to bypass a hospital after ROSC achieved but not how long a safe journey time is. This requires further study.

Variation between hospitals/regions

Engdahl J et al (Engdahl, Abrahamsson et al. 2000) in an observational study in Goteberg, Sweden showed that hospital interventions impact survival. They studied approximately a 1000 patients with ROSC after OHCA between 1980 and 1996. There was a difference in survival to discharge between two hospitals served by the same EMS (44% versus 33%, P<001) despite pre-hospital and patient factors being similar. Patients in the hospital with better outcomes had a higher rate of interventions (coronary angiography, echocardiography, exercise testing, cardiac electrophysiology, Holter recording, and coronary angioplasty. The hospital with worse outcomes had patients of a lower socio-economic status. This is a relatively small study, there is a lot of missing information and there may be unmeasured confounders.
Langhelle A et al (Langhelle, Tyvold et al. 2003) observed outcomes in OHCA patients with ROSC (459 patients) admitted to Hospitals in 4 regions in Norway between 1995 and 1999. This study showed variation in hospital factors (after correcting for other factors) that effected survival and neurological status up to 1 year. This study did not however compare specific in hospital interventions.

Herlitz J et al (Herlitz, Engdahl et al. 2006) using data from the Swedish OHCA registry showed 1 month survival in OHCA patients served by 21 EMS systems and admitted to 21 hospitals after ROSC varied between 14 and 42%. Differences between hospitals remained after correcting for patient and pre-hospital factors. It was speculated that some of this difference was due to differences in post resuscitation care although hospital care was not formally assessed.

Keenan SP et al (Keenan, Dodek et al. 2007) studied 31 Canadian ICUs showed a large variation in ICU length of stay in non-survivors that was independent of hospital size. This study cannot specify what factors influenced this.

Carr BG et al (Carr, Goyal et al. 2008) studied 109, 739 hospital patients resuscitated after cardiac arrest in the US between 2000 and 2004. This includes both in and out of hospital cardiac arrests. In hospital mortality was lowest for urban, teaching and large hospitals (OR 0.58, 0.63, 0.55 respectively). This study did not adjust for case mix and cannot say which factors in hospital influenced outcome. Does support the fact that the hospital makes a difference for patients with OHCA or IHCA.

Liu JM et al (Liu, Yang et al. 2008) observed variation in OHCA survival to discharge between hospitals (29-42%) served by the Milwaukee County EMS (1995-2005). The main correlating factor for survival was beds to nurse ratio.

Carr BG et al (Carr, Kahn et al. 2009) showed in an observational study of 39 US hospitals that ICUs dealing with higher patient volumes had improved survival to hospital discharge. The study could not say if the 44% of the 4674 ICU admissions from the ED were out of hospital cardiac arrests or not. Age and illness adjusted survival varied between 46 and 68%. Hospitals that treated more than 50 cardiac arrests/year had a lower mortality than those who treated less than 20/year (OR 0.62, 95% CI 0.45-0.86). This study supports there is variation between hospitals. It is difficult to extrapolate the results of this study to management of OOHCA since inclusion of ICU patients only is subject to selection bias, and the study included patients with OOHCA as well as IHCA.

Callaway C et al 2010 observed a risk unadjusted improved survival to discharge, after OHCA in 9 US and Canadian regions (254 hospitals, 3644 OHCA, 2005-2007), in large hospitals with cardiac catheter facilities compared with smaller hospitals with no cardiac catheter facilities. Large hospital (>400 beds) with cardiac catheter facilities had fewer deaths (OR 0.71, 95% CI 0.54-0.93). The study did not show any significant differences between CATH and Non–CATH hospitals or high/low volume (40 cut-off) after risk adjustment. The study does not list whether patients actually had cardiac catheterization and volume of patients attending hospitals. The hospital size and presence of catheter facilities is inferred to be a surrogate marker for improved post resuscitation care.

These studies show variation in survival from cardiac arrest between hospitals and regions.

**Hospital treatments – 5 LOE 3 studies comparing with historical controls summarised in Table 1**

Studies of systems for Trauma and MI are summarized in Table 2 and 3. These Tables based on Nichol at al. Regional Systems of Care for Out-of-Hospital Cardiac Arrest. A Policy Statement From the American Heart Association. Circulation. Epub.
<table>
<thead>
<tr>
<th>Author</th>
<th>Design</th>
<th>Population</th>
<th>Intervention</th>
<th>Comparator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oddo 2006</td>
<td>Historical case-</td>
<td>Proportion VF</td>
<td>Hypothermia, PPCI, Goal directed therapy; glucose control not stated (n=55)</td>
<td>Standard care (n=54)</td>
</tr>
<tr>
<td></td>
<td>control LOE3</td>
<td>79%</td>
<td>CPC 1 or 2 at discharge 20 (37%)</td>
<td>CPC 1 or 2 at discharge 6 (11%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>p=0.004</td>
</tr>
<tr>
<td>Sunde 2007</td>
<td>Historical case-</td>
<td>Prop. VF 90%</td>
<td>Hypothermia, PPCI, Goal directed therapy; glucose control (n=61)</td>
<td>Standard care (n=58)</td>
</tr>
<tr>
<td></td>
<td>control LOE3</td>
<td></td>
<td>CPC 1 or 2 at discharge 56%</td>
<td>CPC 1 or 2 at discharge 26%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>p=0.001</td>
</tr>
<tr>
<td>Knafelj 2007</td>
<td>Historical case-</td>
<td>ST-elevation MI</td>
<td>Hypothermia, PPCI; Goal directed therapy, glucose control not stated (n=40)</td>
<td>Standard care (n=32)</td>
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<td></td>
<td>control LOE3</td>
<td>Prop. VF 100%</td>
<td>CPC 1 or 2 at discharge 53%</td>
<td>CPC 1 or 2 at discharge 19%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>p=0.001</td>
</tr>
<tr>
<td>Wolfrum 2008</td>
<td>Historical case-</td>
<td>ST-elevation MI</td>
<td>Hypothermia, PPCI; Goal directed therapy, glucose control not stated (n=16)</td>
<td>Standard care (n=17)</td>
</tr>
<tr>
<td></td>
<td>control LOE3</td>
<td>Prop. VF 100%</td>
<td>CPC 1 or 2 at discharge 69%</td>
<td>CPC 1 or 2 at discharge 47%</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>p=0.3</td>
</tr>
<tr>
<td>Gaieski 2009</td>
<td>Historical case-</td>
<td>Prop. VF 50%</td>
<td>Hypothermia, PPCI, Goal directed therapy; glucose control (n=20)</td>
<td>Standard care (n=18)</td>
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<tr>
<td></td>
<td>control LOE3</td>
<td></td>
<td>CPC 1 or 2 at discharge 8 (40%)*</td>
<td>CPC 1 or 2 at discharge 4 (22%)</td>
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<td></td>
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<td></td>
<td></td>
<td>p=0.12</td>
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Table 1 – Hospital treatments
<table>
<thead>
<tr>
<th>Author/Reference Design</th>
<th>Population</th>
<th>Intervention</th>
<th>Comparator</th>
<th>Alternative Comparator</th>
<th>Alternative Comparator</th>
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<tbody>
<tr>
<td>Abernathy 2002 Retrospective cohort study of administrative data</td>
<td>Patients from 6 counties in Alabama transported by EMS and admitted to level 1 trauma center from April 1995 to March 1998</td>
<td>Implementation of voluntary regional trauma system</td>
<td>Before implementation</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>n=1 718</td>
<td>Mortality 65 (3.8%)</td>
<td>ISS ≥16 342 (20%)</td>
<td>Adjusted OR or RR not reported</td>
</tr>
<tr>
<td></td>
<td></td>
<td>n=1 306</td>
<td>Mortality 77 (5.9%), P=0.0002</td>
<td>ISS ≥16 276 (21%)</td>
<td></td>
</tr>
<tr>
<td>Boyd 1975 Retrospective cohort study of hospital-based trauma registries</td>
<td>Patients with motor vehicle–related injuries from 14 counties in Region 13A, Illinois, from July 1970 to December 1972</td>
<td>Implementation of regional trauma program</td>
<td>Before implementation</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td></td>
<td></td>
<td>n=15 061</td>
<td>ISS not reported</td>
<td>Mortality 2.5%</td>
<td>Adjusted OR or RR not reported</td>
</tr>
<tr>
<td></td>
<td></td>
<td>n=13 459</td>
<td>ISS not reported</td>
<td>Mortality 2.7%</td>
<td></td>
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<tr>
<td>Culica 2007 Retrospective cohort study of administrative data</td>
<td>Injured patients hospitalized in trauma centers in Texas from 1999 to 2000</td>
<td>Admitted to level 1 (n=35 878)</td>
<td>Admitted to level 2 (n=15 300)</td>
<td>Admitted to level 3/4 (n=31 669)</td>
<td>N/A</td>
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<tr>
<td></td>
<td></td>
<td>Mortality 1514 (57.4%)</td>
<td>Mortality 603 (22.9%)</td>
<td>Mortality 520 (19.7%)</td>
<td>Reference group, P&lt;0.0001</td>
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<tr>
<td></td>
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<td>Adjusted OR&lt;sup&gt;a&lt;/sup&gt; 0.31 (95% CI 0.27, 0.36)</td>
<td>Adjusted OR&lt;sup&gt;a&lt;/sup&gt; 0.47 (95% CI 0.4, 0.55)</td>
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<tr>
<td>de Jongh 2008 Retrospective cohort study of regional trauma registry</td>
<td>Trauma admissions, dead on arrival, or died in ED at 12 EDs in Netherlands from 2000 to 2006</td>
<td>Transferred from another hospital to trauma center (n=69)</td>
<td>Direct admissions to nontrauma center (n=448)</td>
<td>Direct admissions to trauma center (n=382)</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ISS, median (IQR) 25 (17, 26)</td>
<td>ISS, median (IQR) 19 (16, 25)</td>
<td>ISS, median (IQR) 25 (17, 30)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mortality 21.7%</td>
<td>Mortality 13.6%</td>
<td>Mortality 28.8%</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Referent group</td>
<td>Adjusted OR&lt;sup&gt;b&lt;/sup&gt; 1.5 (95% CI 0.7, 3.4)</td>
<td>Adjusted OR&lt;sup&gt;b&lt;/sup&gt; 1.9 (95% CI 0.9, 4.1)</td>
<td></td>
</tr>
</tbody>
</table>

EMS indicates emergency medical services; ISS, Injury Severity Score; N/A, not applicable; ED, emergency department; IQR, interquartile range; ICD, implantable cardioverter-defibrillator; FARS, Fatality Analysis Reporting System; MVC, motor vehicle collision; CRAMS, Circulation, Respiraion, Abdomen, Motor, Speech; and ICD-9, International Classification of Diseases version 9.

<sup>a</sup>Adjusted for age, race, insurance status, hospital stay >1 wk, emergency admission, severity of injury, and risk of mortality.
Adjusted for age, ISS, Glasgow Coma Scale score, and severe neurological trauma.

### Table 2 – Trauma Studies continued - ALL LOE 5 EXTRAPOLATIONS

<table>
<thead>
<tr>
<th>Author/Reference Design</th>
<th>Population</th>
<th>Intervention</th>
<th>Comparator</th>
<th>Alternative Comparator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hannan 2005</td>
<td>Injured, age &gt;13 y identified in prehospital care reports, &gt;1 trauma triage criterion, transported directly to hospital Excluded patients with flat vital signs on arrival at ED. From 1996 to 1998</td>
<td>Level 1 trauma center (n=2 218) ISS not reported Mortality 46.8% Referent group Unadjusted OR 0.79 (95% CI 0.65, 0.95)</td>
<td>Level 2 trauma center or nontrauma center (n=2 525) ISS not reported Mortality 53.2% Referent group</td>
<td>N/A</td>
</tr>
<tr>
<td>Harrington 2005</td>
<td>Trauma patients admitted to single level 1 trauma hospital from 2001 to 2003</td>
<td>Direct transfer from field (n=3 227) ISS 11 ± 0.2 Mortality 7% OR or RR not reported</td>
<td>Transfer from nontrauma center (n=280) ISS 17.5 ± 0.8 Mortality 10%</td>
<td>N/A</td>
</tr>
<tr>
<td>Liberman 2004</td>
<td>Major trauma treated at hospital, including ≥1 death as result of injury, admission with hospital stay ≥3 d, admission to intensive care or interhospital transfer during 1992-1993 (before) and 2001-2002 (after)</td>
<td>After designation of level 1 trauma centers, triage, and transfer protocols (n=1 884) ISS not reported Mortality 8.6% OR or RR not reported</td>
<td>Before implementation of regional trauma care (n=3 823) ISS not reported Mortality 51.8%</td>
<td>N/A</td>
</tr>
<tr>
<td>MacKenzie</td>
<td>Injured patients age 18 to 84 y with ISS &gt;15 treated at hospital in 15 contiguous Metropolitan Statistical Areas (n=5 191) Excluded patients dead on arrival or within 30 min</td>
<td>Level 1 trauma centers Observed in-hospital mortality 8% North American National Database</td>
<td>Nontrauma centers that treated &gt;25 patients with trauma annually Observed in-hospital mortality 5.9%</td>
<td>N/A</td>
</tr>
<tr>
<td>Mann 2001</td>
<td>Age &gt;65 y discharged from acute care hospital who had ≥1 injury-related ICD-9 discharge diagnosis in Washington from</td>
<td>After implementation of statewide trauma system (n=46 424) ISS 7.1 ± 4.2</td>
<td>Before implementation (n=30 712) ISS 6.8 ± 4.4</td>
<td>N/A</td>
</tr>
<tr>
<td>Author/Reference Design</td>
<td>Population</td>
<td>Intervention</td>
<td>Comparator</td>
<td>Alternative Comparator</td>
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<tr>
<td>Mullins 1996 Retrospective cohort study of hospital discharge data linked with death index</td>
<td>Patients discharged from acute care hospital who had ≥1 injury-related ICD-9 discharge diagnosis in Oregon (n=27 633) from 1985 to 1987 (before) and 1991 to 1993 (after)</td>
<td>After implementation of regional trauma system Adjusted OR for mortality(^d) 0.82 (0.73, 0.92)</td>
<td>Before implementation</td>
<td>N/A</td>
</tr>
<tr>
<td>Mullins 1998 Retrospective cohort study of hospital discharge data linked with death index</td>
<td>Patients discharged from acute care hospital who had ≥1 injury-related ICD-9 discharge diagnosis in Oregon and Washington from 1990 to 1993</td>
<td>Regional trauma system in Oregon (n=11 879) Adjusted OR for mortality(^e) 0.80 (0.70, 0.91)</td>
<td>Regional trauma system in Washington (n=17 369)</td>
<td>N/A</td>
</tr>
<tr>
<td>Mullins 1994 Retrospective cohort study of hospital discharge data and hospital trauma registry</td>
<td>Patients discharged from acute care hospital who had ≥1 injury-related ICD-9 discharge diagnosis in 4 counties in Oregon (n=27 633) from 1984 to 1985 (before), 1986 to 1987 (during), and 1990 to 1991 (after)</td>
<td>After implementation of regional trauma system Level 1 center (n=7 238) Applicant trauma hospitals (n=4815) Nontrauma hospitals (n=9 753) ISS not reported All hospitals adjusted OR for mortality(^f) 0.94 (0.82, 1.07) compared with reference period</td>
<td>During implementation of regional trauma system Level 1 center (n=5 017) Applicant trauma hospitals (n=6 691) Nontrauma hospitals (n=11 691) ISS not reported All hospitals adjusted OR for mortality(^f) 1.01 (0.88, 1.16) compared with reference period</td>
<td>Before implementation of regional trauma system Level 1 center (n=4 239) Applicant trauma hospitals (n=6 812) Nontrauma hospitals (n=14 094) ISS not reported</td>
</tr>
</tbody>
</table>

\(^d\)Adjusted for age, gender, multiple injuries, AIS score, and preexisting conditions.

\(^e\)Adjusted for age, gender, anatomic site, severity of injury, and preexisting conditions.

\(^f\)Adjusted for age, injury severity, and comorbidity.
Adjusted for age, gender, AIS score, and preexisting conditions.

Table 2 – Trauma Studies continued - ALL LOE 5 EXTRAPOLATIONS

<table>
<thead>
<tr>
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<th>Alternative Comparator</th>
<th>Alternative Comparator</th>
</tr>
</thead>
</table>
| **Mullner 1978**
Retrospective cohort study of sample from Department of Transportation records of motor vehicle–related trauma | Patients with severe or fatal trauma in Region 5, Illinois, during and 1970 to 1973 (after) | Implementation of regional trauma system Regional trauma hospitals (n=958) ISS not reported Mortality 8.5% Nontrauma hospitals (n=1676) ISS not reported Mortality 11.4% OR or RR not reported | Before implementation Regional trauma hospitals (n=992) ISS not reported Mortality 11.5% | Mullner(134) Retrospective cohort study of sample from Department of Transportation records of motor vehicle–related trauma | Patients with severe or fatal trauma in Region 5, Illinois, during and 1970 to 1973 (after) |
| **Nathens 2000**
Retrospective cohort study of National Center for Health Statistics data, FARS database, and census data | Deaths associated with unintentional injury or injury purposely inflicted by other persons FARS motor vehicle–related deaths during 1995 | States with functional trauma systems Deaths per 100 000 population All injuries 26.5 ± 16.0 Incident rate ratio 0.91 (95% CI 0.89, 0.92) MVC-related injuries 17.3 ± 10.2 Incident rate ratio 0.82 (95% CI 0.81, 0.84) | States without functional trauma systems Deaths per 100 000 population All injuries 29.2 ± 17.2 MVC-related injuries 14.2 ± 8.8 | Nathens(135) Retrospective cohort study of National Center for Health Statistics data, FARS database, and census data | Deaths associated with unintentional injury or injury purposely inflicted by other persons FARS motor vehicle–related deaths |
| **Nathens 2003**
Retrospective cohort study of regional trauma registry | Trauma patients age ≥16 y injured in King County, Wash, from 1995 to 1998 Included if length of stay >2 d; ICD injury-related code; dead on arrival or died in hospital; interhospital transfer; or trauma team activation | Field triage to level 1 trauma hospital by medics (n=4439) ISS 11.7 ± 12.9 Mortality 10% | Field triage to level 3 or 4 trauma hospital by medics, then transfer to level 1 hospital after initial assessment (n=281) ISS 8.9 ± 7.0 Mortality 5% Adjusted RR for mortalityf 1.05 (0.61, 1.80) compared with reference period | N/A | N/A |
Table 2 – Trauma Studies continued - ALL LOE 5 EXTRAPOLATIONS

<table>
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<tr>
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<th>Alternative Comparator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nicholl 1997 Prospective before-after study using individual patient data</td>
<td>Trauma patients with ISS &gt;15 brought directly to ED by ambulance or other means, whether or not vital signs present on arrival from 1990 to 1993</td>
<td>Implementation of regional trauma system in northwest Midlands with 1 central hospital and on-site neurosurgery, 6 regional hospitals, 1 EMS agency</td>
<td>No change in trauma care in Lancashire with 1 central hospital and on-site neurosurgery but not cardiothoracic surgery, 5 regional hospitals, 3 EMS agencies</td>
<td>No change in trauma care in Humberside with 1 central hospital and on-site neurosurgery but not cardiothoracic surgery, 3 regional hospitals, 1 EMS agency</td>
<td>N/A</td>
</tr>
<tr>
<td>Potoka 2000 Retrospective cohort study of state trauma registry</td>
<td>Trauma patients age ≤16 y treated at accredited trauma center from 1993 to 1997 Excluded injuries due to burns</td>
<td>Transported to pediatric trauma center (n=5189) ISS &gt;15 11.9% Mortality Blunt 11.3% Penetrating 21.3%</td>
<td>Transported to level 1 adult trauma center with additional qualifications (n=3636) ISS &gt;15 12.4% Mortality Blunt 11.4% Penetrating 28.1%</td>
<td>Transported to level 1 adult trauma center (n=1207) ISS &gt;15 21.6% Mortality Blunt 13.0% Penetrating 46.3%</td>
<td>Transported to level 2 adult trauma center (n=3319) ISS &gt;15 16.2% Mortality Blunt 14.1% Penetrating 40.9%</td>
</tr>
<tr>
<td>Reilly 2004 Retrospective cohort study of hospital discharge data</td>
<td>Adult trauma patients discharged from New York City hospital from 1998 to 2000 (n=103 659) Excluded injuries due to burns</td>
<td>Hospitalized at level 1 trauma hospital (n=50 021) ISS not reported Mortality 2.6% Adjusted odds of mortality in trauma hospital ( \hat{h} ) 1.8 (95% CI 1.7, 2.0)</td>
<td>Hospitalized at other hospitals (n=53704) ISS not reported Mortality 1.9%</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

\(^{a}\)Adjusted for age, ISS, severity of head injury, maximum AIS score, shock, and payer status.

\(^{b}\)Adjusted for age, gender, and severity of injury.
### Table 2 – Trauma Studies continued - ALL LOE 5 EXTRAPOLATIONS

<table>
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<tr>
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<th>Alternative Comparator</th>
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</tr>
</thead>
</table>
| Sampalis 1995 Retrospective cohort study of hospital discharge data | Trauma patients transported by EMS and admitted to hospital during 1987 and 1993 | Designation of receiving hospitals as level 1 trauma center (n=288) 
ISS 15.5 ± 11.6 
Mortality 10% 
Adjusted odds of mortality before designation\(^1\) 3.3 (95% CI 1.6, 6.5) | Before designation (n=158) 
ISS 15.0 ± 12.3 
Mortality 20% | N/A | N/A |
| Young 1998 Retrospective cohort study of hospital trauma registry | Adult trauma patients with ISS >15 admitted to trauma center | Direct transfer to level 1 trauma center (n=165) 
ISS 24 ± 8 
Mortality before discharge 21% 
Adjusted odds of mortality not reported | Transfer from another hospital (n=151) 
ISS 23 ± 7 
28 
Mortality before discharge 18.5% | N/A | N/A |
| Clemmer 1985 Retrospective cohort study of regional trauma registry | Trauma patients transported by EMS with field CRAMS score ≤6 
Excluded patients transported for >15 min or interfacility transports | Transported to level 1 trauma center (n=57) 
Mortality before discharge 46% 
Adjusted odds of mortality not reported | Transported to local hospital (n=33) 
Mortality before discharge 61% | N/A | N/A |
| Goldberg 1981 Retrospective cohort study of hospital discharge data | Trauma patients hospitalized in Illinois outside Chicago with selected injuries during 1973 and 1974 | Hospitalized at trauma system hospitals (n=4 560) 
Mortality before discharge 2.9% 
Adjusted odds of mortality not reported | Hospitalized at nontrauma hospitals (n=5465) 
Mortality before discharge 2.7% | N/A | N/A |

\(^1\)Adjusted for age, ISS, and mechanism of injury
### Table 2 – Trauma Studies continued - ALL LOE 5 EXTRAPOLATIONS

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Hulka 1997 Retrospective cohort study of hospital discharge data</td>
<td>Children age ≤18 y with acute injury hospitalized in Oregon from 1985 to 1993</td>
<td>Before (n=14 082, 1985 to 1987) and after (n=8981, 1991 to 1993) implementation of statewide trauma system in Oregon</td>
<td>Before (n=18 525, 1985 to 1987) and after (n=12 991, 1991 to 1993) No implementation of statewide trauma system in Washington</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Kane 1992 Retrospective cohort study of hospital discharge data</td>
<td>Injured &lt;48 h before ED admission, ISS &gt;15, admitted to or died at acute hospital in Los Angeles County from 1982 to 1984 Excluded injuries limited to drowning, smothering, strangulation, choking, hanging, electrical shock, asphyxiation, or spontaneous pathological fracture</td>
<td>After (n=766, 1984) implementation of countywide trauma system</td>
<td>Before (n=658, 1982) implementation of countywide trauma system</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Mullner 1978 Retrospective cohort study of state trauma registry</td>
<td>Patients injured in motor vehicle collision in southern Illinois from 1970 to 1973</td>
<td>After implementation of regional trauma system at trauma hospitals (n=958) and other hospitals (n=1 676)</td>
<td>Before implementation of regional trauma system at trauma hospitals (n=992) and other hospitals (n=1 866)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Table 2 – Trauma Studies continued - ALL LOE 5 EXTRAPOLATIONS

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<thead>
<tr>
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<th>Alternative Comparator</th>
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</thead>
<tbody>
<tr>
<td>Norwood 1995 Retrospective cohort study of regional trauma registry</td>
<td>Injured patients who underwent surgery, died in ED, or were admitted to level 2 trauma hospital in east Texas from 1987 to 1992</td>
<td>After implementation of level 2 designation at trauma hospital (n=699)</td>
<td>Before implementation of level 2 designation at trauma hospital (n=862)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mortality 7.7% Adjusted odds of mortality not reported</td>
<td>Mortality 8.0% Adjusted odds of mortality not reported</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sampalis 1997 Retrospective cohort study of hospital discharge data combined with census data</td>
<td>Patients with acute injury treated at tertiary trauma centers in Quebec from 1993 to 1995</td>
<td>Field transfer to tertiary trauma hospitals (n=2,756)</td>
<td>Transfer from lower-level hospital to tertiary trauma hospital (n=1,608)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mortality 4.8%</td>
<td>Mortality 9.8% Adjusted odds of mortality compared with field transfer 1.57 (95% CI 1.17, 2.11)</td>
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</tr>
</tbody>
</table>

*Adjusted for age, gender, hypotension, status of head injury, and mechanism of injury.
### TABLE 3: EFFECT OF REGIONALIZATION OF CARE FOR PATIENTS WITH ST-ELEVATION MYOCARDIAL INFARCTION - ALL LOE 5 EXTRAPOLATIONS

<table>
<thead>
<tr>
<th>Author/Reference Design</th>
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<th>Intervention</th>
<th>Comparator</th>
<th>Alternative Comparator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vermeer 1999</td>
<td>AMI, presenting at hospitals not capable of PPCI</td>
<td>Transfer for PPCI (n=75)</td>
<td>Fibrinolytic in non-PCI hospital (n=75)</td>
<td>Fibrinolytic with transfer, rescue PCI if indicated (n=74)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Symptoms to therapy 240 ± NR</td>
<td>Symptoms to therapy 135 ± NR</td>
<td>Symptoms to therapy 255 ± NR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Door to balloon NR</td>
<td>Door to balloon NR</td>
<td>Door to balloon NR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Death&lt;sup&gt;a&lt;/sup&gt; 5 (7)</td>
<td>Death&lt;sup&gt;a&lt;/sup&gt; 5 (7)</td>
<td>Death&lt;sup&gt;a&lt;/sup&gt; 6 (8)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Recurrent infarct&lt;sup&gt;a&lt;/sup&gt; 1 (1)</td>
<td>Recurrent infarct&lt;sup&gt;a&lt;/sup&gt; 7 (9)</td>
<td>Recurrent infarct&lt;sup&gt;a&lt;/sup&gt; 4 (5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stroke&lt;sup&gt;a&lt;/sup&gt; 2 (3)</td>
<td>Stroke&lt;sup&gt;a&lt;/sup&gt; 2 (3)</td>
<td>Stroke&lt;sup&gt;a&lt;/sup&gt; 3 (4)</td>
</tr>
<tr>
<td>Widimsky 2000</td>
<td>AMI, presenting within 6 h of symptom onset at hospitals not capable of PPCI</td>
<td>Immediate transfer for PPCI (n=101)</td>
<td>Fibrinolytic therapy in non-PCI hospitals (n=99)</td>
<td>Fibrinolytic therapy during transport for PCI (n=100)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Symptoms to therapy 215 ± NR</td>
<td>Symptoms to therapy 132 ± NR</td>
<td>Symptom to therapy 220 ± NR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Door to balloon NR</td>
<td>Door to balloon NR</td>
<td>Door to balloon NR</td>
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<tr>
<td></td>
<td></td>
<td>Death&lt;sup&gt;b&lt;/sup&gt; (7)</td>
<td>Death&lt;sup&gt;b&lt;/sup&gt; (14)</td>
<td>Death&lt;sup&gt;b&lt;/sup&gt; (12)</td>
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<tr>
<td></td>
<td></td>
<td>Recurrent infarct&lt;sup&gt;b&lt;/sup&gt; (1) &lt;i&gt;P&lt;/i&gt;&lt;0.03</td>
<td>Recurrent infarct&lt;sup&gt;b&lt;/sup&gt; (10)</td>
<td>Recurrent infarct&lt;sup&gt;b&lt;/sup&gt; (7)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stroke&lt;sup&gt;b&lt;/sup&gt; (0)</td>
<td>Stroke&lt;sup&gt;b&lt;/sup&gt; (1)</td>
<td>Stroke&lt;sup&gt;b&lt;/sup&gt; (3)</td>
</tr>
<tr>
<td>Andersen 2003</td>
<td>AMI with ST elevation presenting at hospital not capable of PPCI</td>
<td>Transfer for angioplasty within 3 h (n=567)</td>
<td>Fibrinolysis at referral hospital (n=562)</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Symptoms to therapy 227± NR</td>
<td>Symptoms to therapy 150 ± NR</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Door to balloon 26</td>
<td>Door to therapy NR</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Death&lt;sup&gt;b&lt;/sup&gt; 37 (7)</td>
<td>Death&lt;sup&gt;b&lt;/sup&gt; 48 (9)</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Recurrent infarct&lt;sup&gt;b&lt;/sup&gt; 11 (2)</td>
<td>Recurrent infarct&lt;sup&gt;b&lt;/sup&gt; 35 (6)</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Stroke&lt;sup&gt;b&lt;/sup&gt; 16 (2)</td>
<td>Stroke&lt;sup&gt;b&lt;/sup&gt; 11 (2)</td>
<td></td>
</tr>
<tr>
<td>Grines 2002</td>
<td>High-risk AMI with ST elevation or presumed new left bundle branch block &lt;12 h</td>
<td>Transfer for PPCI (n=71)</td>
<td>Fibrinolytic therapy (n=66)</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Symptoms to therapy NR</td>
<td>Symptoms to therapy NR</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Door to balloon 174± 80</td>
<td>Door to therapy 63 ± 39</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Death&lt;sup&gt;b&lt;/sup&gt; 6 (8)</td>
<td>Death&lt;sup&gt;b&lt;/sup&gt; 8 (12)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Recurrent infarct&lt;sup&gt;b&lt;/sup&gt; 1 (1)</td>
<td>Recurrent infarct&lt;sup&gt;b&lt;/sup&gt; 0 (0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stroke&lt;sup&gt;b&lt;/sup&gt; 0 (0)</td>
<td>Stroke&lt;sup&gt;b&lt;/sup&gt; 3 (4)</td>
<td></td>
</tr>
</tbody>
</table>

AMI indicates acute myocardial infarction; PPCI, primary percutaneous coronary intervention; and NR, Not reported.
Outcomes at 42 d, not hospital discharge.  
Outcomes at 30 d, not hospital discharge.

**Table 3 MI studies (Continued) - ALL LOE 5 EXTRAPOLATIONS**

<table>
<thead>
<tr>
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</tr>
</thead>
</table>
| Bonnefoy 2002 | Patients with STEMI presenting to EMS within 6 h of symptom onset | Primary PCI (n=421)  
Symptoms to therapy NR  
Death\(^b\) 20 (5)  
Recurrent infarct\(^b\) 7 (2)  
Stroke\(^b\) 0 (0) | Prehospital fibrinolysis (n=419)  
Symptoms to therapy NR  
Death\(^b\) 16 (4)  
Recurrent infarct\(^b\) 15 (4)  
Stroke\(^b\) 4 (1) | N/A |
| Widimsky 2003 | Patients with STEMI within 12 h of symptom onset presenting to non-PCI-capable hospital | Immediate transfer for primary PCI (n=429)  
Symptoms to therapy 203 ± NR  
Death\(^b\) 29 (7)  
Recurrent infarct\(^b\) 6 (1)  
Stroke\(^b\) 1 (0) | Fibrinolytic in community hospital (n=421)  
Symptoms to therapy 185 ± NR  
Death\(^b\) 42 (10)  
Recurrent infarct\(^b\) 13 (3)  
Stroke\(^b\) 9 (2) | N/A |
| Ting 2007 | Patients with STEMI within 12 h of symptom onset  
Presented at non-PCI capable hospital and transferred for PCI (n=258)  
Symptoms to therapy 278 (171, 601)  
Door to balloon 116 (102, 137)  
In-hospital death 6 (5.7)  
Recurrent infarct 3 (2.9)  
Stroke 1 (1.0) | Presented at PCI-capable hospital and underwent PCI (n=105)  
Symptoms to therapy 188 (124, 389)  
Door to balloon 71 (56, 90)  
In-hospital death 17 (6.6)  
Recurrent infarct 4 (1.6)  
Stroke 2 (0.8) | Presented at non-PCI hospital <3 h from symptom onset and given fibrinolytic (n=131)  
Symptoms to therapy 103 (61, 145)  
In-hospital death 4 (3.1)  
Recurrent infarct 8 (6.1)  
Stroke 2 (0.8) |
| Henry 2007 | Patients with STEMI or new left bundle branch block within 24 h of symptom onset | Transfer for PCI at PCI-capable hospital (n=621)  
Symptoms to therapy 203 (147, 325)  
Door to balloon 95 min (82, 116)  
In-hospital death 24 (3.8)  
Recurrent infarct 5 (0.8)  
Stroke 6 (1.0) | Transfer for facilitated PCI at PCI-capable hospital\(^c\) (n=421)  
Symptoms to therapy 214 (167, 326)  
Door to balloon 120 min (100, 145)  
In-hospital death 22 (5.2), \(P=0.48\)  
Recurrent infarct 1 (0.2), \(P=0.02\)  
Stroke 5 (1.2), \(P=0.84\) | Primary PCI at PCI-capable hospital (n=297)  
Symptoms to therapy 171 (118, 307)  
Door to balloon 65 min (47, 84)  
In-hospital death 11 (3.7)  
Recurrent infarct 7 (2.4)  
Stroke 4 (1.3) |

\(^a\)Outcomes at 30 d, not hospital discharge.  
\(^b\)Outcomes at 30 d, not hospital discharge.  
\(^c\)Half-dose of tenecteplase given to fibrinolytic-eligible patient before transfer.
### Table 3 MI studies (Continued) - ALL LOE 5 EXTRAPOLATIONS

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</tr>
</thead>
</table>
| Jollis 2007             | Patients with STEMI | After implementation of statewide system for reperfusion (n=404 non-PCI; n=585, PCI)  
Presentation to PCI hospital 74  
Transferred to PCI hospital 128  
Door-to-needle in non-PCI 29  
Door-in door-out non-PCI 71  
Nonreperfusion in non-PCI hospital 15%  
Nonreperfusion in PCI hospital 11%  
Death in PCI hospital 6.2% | Before implementation  
Control (n=518 non-PCI; n=579 PCI)  
Presentation to PCI hospital 85 (P<0.001)  
Transferred to PCI hospital 165 (P<0.001)  
Door-to-needle in non-PCI 35 (P=0.002)  
Door-in-door-out non-PCI 120 (P<0.001)  
Nonreperfusion in non-PCI hospital 15% (P not significant)  
Nonreperfusion in PCI hospital 23% (P not stated)  
Death in PCI hospital 7.5% (P=0.38) | N/A |
| Le May 2008             | Patients with STEMI | Referral from field by paramedics for PPCI (n=135)  
Symptoms to balloon 158 (116, 207)  
Death 4 (3.0)  
Recurrent infarct 2 (1.5)  
Stroke 1 (0.7) | Referral from ED by physicians for PPCI after interhospital transfer (n=209)  
Symptoms to balloon 230 (173, 351)  
In-hospital death 12 (5.7)  
Recurrent infarct 2 (1.0)  
Stroke 3 (1.4) | N/A |
Knowledge Gaps

What treatments should a cardiac arrest centre offer?
What is a safe journey time for a patient with ROSC at scene?
Is secondary transport from receiving hospital to a regional centre an option?
Should all cardiac arrests be taken to a cardiac arrest centre or are there specific criteria e.g. ROSC at scene?
Is it ethical to do a randomised controlled trial comparing standard care versus sending patients to a cardiac arrest centre? Observational work as part of quality improvement may show this as being beneficial rather than randomised studies.
Are cardiac arrest centres only worthwhile in areas where the other links in the chain of survival are optimized?

Cost effectiveness of intervention

Acknowledgements:

GN Acknowledges the members of the AHA writing group on Regional Systems of Care for Cardiac Arrest

Citation List

Abstracts

Cardiac arrest studies


LOE 4, Fair, Supportive of large hospitals treating post cardiac arrest patients – retrospective cohort observational study using a large data set. Patients identified by diagnostic codes. How reliable these are is difficult to say. Mix of both in and out of hospital cardiac arrests. No case mix adjustment. If we believe larger hospitals (teaching, tertiary etc) have sickest patients this study may underestimate the improved survival in these hospitals. Patients transferred from other hospitals were excluded. The study can only speculate on what factors determine improved outcome.

LOE4, Fair, Supportive of inter-hospital variability – retrospective cohort observational study of ICU APACHE IV database serving 39 hospitals. Both in and out of hospital cardiac arrests. Case mix adjusted outcomes reported. Excluded 215 patients in 18 very low volume hospitals, resulting in 39 hospitals in the final sample. The hospitals in the dataset are all committed to benchmarking – this may not be a true representation of all ICUs. The study cannot comment on which hospital interventions make a difference. The implication is large volume centres offer a more comprehensive package of care.


LOE 4 good, weakly supporting good quality multicentre observational study from North America (ROC group). Shows improved survival to discharge in centers with cath labs and greater than 40 patients admitted per year had improved outcomes. There was however no difference in risk adjusted outcomes. WE also do not know what interventions the patient’s actually had.


LOE4, poor, supporting – prospective observational study. This study suggests that in patients with ROSC transport time does not influence survival – note the transport time is relatively short. Study implies that could bypass a closer hospital for a ‘cardiac arrest centre’. Relatively old data - 18-month period from January 2001 through June 2002. Predates hypothermia studies. It is not clear how many hospitals were involved and how hospital factors influenced outcome.


LOE4, poor, supporting differences between two hospitals served by the same EMS. Retrospective observational study of data from the EMS database and hospital records. Difference may be due to increased number of interventions available in more successful hospital. This hospital however had more patients needing ongoing CPR on arrival. Cannot rule out socio-economic factors. Relatively small numbers of patients. Large amount of missing data. Predate recent work on post resuscitation care, e.g., hypothermia.


LOE 3, fair neutral, shows feasibility of goal directed therapy and care bundle but not powerful enough to show statistically significant improvement – small numbers.


LOE4, poor, supporting – retrospective observation study based on Swedish cardiac arrest registry data. Shows variation in survival between hospitals. Weaknesses - missing information. Cannot say which hospital factors make a difference. Predates hypothermia.

LOE4, poor, supporting. Observation study of ICU database (1998-2002. Thirty-one Canadian ICUs, all but one being members of the Critical Care Research Network. In and out of hospital cardiac arrests. Admitting hospital remained independently and strongly associated with length of ICU stay after controlling for age, gender, APACHE II score, GCS score (the latter two in separate analyses), and hospital size. Data suggest that decisions on how long to support these patients is determined, in part, by where patients are treated (hospital site), not solely by patient characteristics. Data from before when therapeutic hypothermia benefits known. Do not know what proportion of cardiac arrest survivors were not admitted to an ICU. Some ICUs may just no admit them.


LOE 3, fair supporting – shows benefit of post cardiac arrest care package V historical control.


LOE4, poor, supporting- retrospective observation study showing difference in performance between hospitals. This study showed variation in hospital factors (after correcting for other factors) that effected survival and neurological status up to 1 year. This study did not however compare specific in hospital interventions. Predates work on hypothermia.


LOE 4, poor, supporting – retrospective, observational study shows variability between hospitals –due to bed:nurse ratio? Is this the result of a data trawl or a real factor.


Editorial on need for cardiac arrest centres.


LOE 3, good , supporting – Shows benefit of TH and other interventions after ROSC in single centre V historical control group. Does not directly answer PICO.

LOE 4, poor, supporting – prospective observational cohort study. Transport time data was missing in 38% of cases. The transport times were short. It is not clear how hospital factors influenced these outcomes. (October 2004 through December 2006).


LOE4, poor, supporting. Large data base but before therapeutic hypothermia. 19% of data missing. Short (4-5 min) transport times. Suggests transport time does not effect survival.


LOE3, good, supporting – observational study with historical control group showing improvement in outcomes with comprehensive post resuscitation care package. Small numbers. Supports concept of standardised care protocols improving survival


LOE3, fair, neutral. Study shows improvement with care package V historical control group that is not statistically significant as underpowered- small numbers. LOE5 as not directly answering question.

Non – cardiac arrest studies all LOE 5

MI Studies


LOE5, neutral, good. Individual randomized trial in Denmark


LOE5, neutral, good. Individual randomized trial in France

LOE5, neutral, good Individual randomized trial in US and Europe


LOE5, neutral, fair. Prospective cohort in 3 US states


LOE5, neutral, poor. Before-after year-long implementation in 1 state


LOE5, supporting, fair. Prospective cohort study in 1 city


LOE5, neutral, fair. Prospective cohort in 3 US states up to 150 mi from PCI-capable hospital


LOE5, supporting, good. Individual randomized trial in 1 province, Netherlands

Widimsky P et al. Multicentre randomized trial comparing transport to primary angioplasty vs immediate thrombolysis vs combined strategy for patients with acute myocardial infarction presenting to a community hospital without a catheterization laboratory. The PRAGUE study. Eur

LOE5, supporting good. Individual randomized trial in 1 province, Czech Republic


LOE5 supporting, good. Individual randomized trial in Czech Republic

Stroke Studies


LOE5 – observational data from another study, supporting, fair.


LOE5 – meta-analysis – supporting, fair

Trauma Studies


LOE 5 Retrospective cohort study of administrative data, supporting poor.


LOE 5 Retrospective cohort study of hospital-based trauma registries, neutral fair.


LOE5 Retrospective cohort study of regional trauma registry, supporting, poor.

LOE5 Retrospective cohort study of administrative data, supporting good.


LOE5 Retrospective cohort study of regional trauma registry, neutral, good,


LOE5 Retrospective cohort study of hospital discharge data, neutral, fair.


LOE5 Retrospective cohort study of state trauma registry, supporting poor


LOE5 Retrospective cohort study of hospital trauma registry, supporting, poor.


LOE 5 Retrospective cohort study of hospital discharge data, neutral fair.


LOE5 Retrospective cohort study of hospital discharge data, neutral fair.

LOE5 Retrospective cohort study of hospital trauma registry, supporting, fair.


LOE5 Prospective stratified sample of cases and controls using medical record review and patient interview, supporting good.


LOE5 Retrospective cohort study of hospital discharge data linked with death index, supporting, fair.


LOE5 Retrospective cohort study of hospital discharge data linked with death index, supporting, fair.


LOE5 Retrospective cohort study of hospital discharge data linked with death index, supporting, fair.


LOE5 Retrospective cohort study of hospital discharge data and hospital trauma registry, supporting fair.


LOE5 Retrospective cohort study of sample from Department of Transportation records of motor vehicle–related trauma, supporting, poor.


LOE5 Retrospective cohort study of state trauma registry, supporting, poor.

LOE5 Retrospective cohort study of National Center for Health Statistics data, FARS database, and census data, supporting, fair.


LOE5 Retrospective cohort study of regional trauma registry, supporting, poor.


LOE5 Prospective before-after study using individual patient data, supporting, fair.


LOE5 Retrospective cohort study of regional trauma registry, neutral, fair


LOE5 Retrospective cohort study of state trauma registry, supporting, poor.


LOE5 Retrospective cohort study of hospital discharge data, opposing, fair.


LOE5 Retrospective cohort study of hospital discharge data, supporting good.


LOE5 Retrospective cohort study of hospital discharge data combined with census data, supporting, good.

LOE5 Retrospective cohort study of hospital trauma registry, neutral, fair.

References


References – Stroke Studies


References - MI Studies


References - Trauma Studies


