PENETRATING CARDIAC INJURIES
Juan A. Asensio MD FACS  FCCM  FRCS (England) KM
Professor and Chief
Division of Trauma Surgery, Surgical Critical Care, Acute Care Surgery
Director of Trauma Institute
Director of Trauma Center and Trauma Program
Department of Surgery Creighton University

Creighton University
Medical Center
INCISIONS
Descending Thoracic Aorta Crafoord-DeBakey Clamp
Aortic Cross-Clamping
Crafoord-DeBakey Clamp
Descending Thoracic Aorta
Aortic Cross-Clamping
Crafoord-DeBakey Clamp
Inflow-Occlusion Cross-Clamping Intrapericardial SVC and IVC
Pulmonary hilar Cross-Clamping
Crafoord-DeBakey Clamp
Air embolus (in coronary vein)
PENETRATING CARDIAC INJURIES

Complex and combined cases

- Cardiac injuries plus thoracic injuries
- Cardiac injuries plus thoracic vascular injuries
- Cardiac injuries plus abdominal injuries
- Cardiac injuries plus abdominal vascular injuries
- Cardiac injuries plus peripheral vascular injuries
PENETRATING CARDIAC INJURIES

THE CASES
Penetrating Cardiac Wounds: Prospective Study of Factors Influencing Initial Resuscitation

Buckman RF, Badellino MM, Mauro LH, Asensio JA, Caputo C, Gass J, Grosh JD.

J Trauma 1993; Vol 34, No. 5, pp 717-725
Penetrating Cardiac Wounds:

- **Prospective Study**
  - 66 consecutive patients – 27 months
- **Patients stratified**
  - Injury mechanism
  - Physiologic scoring CVRS/TS
Penetrating Cardiac Wounds:

**Data**

1. Pre-hospital
2. CVRS and TS
3. Electrocardiographic Rythm
4. Entry point
   - Precordial
   - Non precordial
5. Tamponade
6. Surgical Procedure
   - ED thoracotomy
   - OR thoracotomy
7. Autopsy
Penetrating Cardiac Wounds - CVRS

<table>
<thead>
<tr>
<th>CVRS</th>
<th>BP</th>
<th>Resp. Rate</th>
<th>Resp. Effort</th>
<th>Cap. Refill</th>
</tr>
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<tbody>
<tr>
<td>11</td>
<td>&gt;90</td>
<td>10-24</td>
<td>Normal</td>
<td>Normal</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Absent</td>
<td>Absent</td>
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</table>
Penetrating Cardiac Wounds - Results

- 66 patients
  - Ages 5 – 78
  - Male 59
  - Female 7

- Etiology
  - GSW 44 (70%)
  - SW 20 (30%)

- Procedures
  - ED thoracotomy 47 (71%)
  - OR thoracotomy 19 (29%)
Penetrating Cardiac Wounds - Results

- Physiologic Condition
  - SW 30% CVRS=0
  - GSW 72% CVRS=0

- Cardiac Rhythm
  - SW 10% Asystole
  - GSW 54% Asystole
Penetrating Cardiac Wounds - Results

- **Site of entry**
  - SW 16/20 (80%) Precordial
  - GSW 21/46 (46%) Extraprecordial

- **Anatomic Severity**
  - SW 1/20 (5%) Multiple/irreparable wounds
  - GSW 31/46 (67%) Multiple/irreparable wounds

- **Chambers injured**
  - SW 0/20 (0%) Multiple
  - GSW 24/46 (52%) Multiple
Penetrating Cardiac Wounds - Results

Overall Survival
- Early <24° - 24/66 (36%)
- Late >24° - 18/66 (27%)

Early Survival by Etiology
- SW - 16/20 (80%)
- GSW - 9/46 (20%)
Penetrating Cardiac Wounds - Conclusions

1. Prospective physiologic scoring CVRS – helpful in predicting outcomes
2. GSW/Asystole/CVRS=0 Predicts survival
3. SW/Asystole/CVRS=0 Cannot predict survival
4. Tamponade – Not a critical independent factor in survival
5. Absence of exsanguinating hemorrhage and severe degree of tamponade – real predictor of survival
6. Increase in survival – related to means of transport
7. Alcohol/cocaine – role unknown.
Penetrating Cardiac Injuries:
Prospective One Year Preliminary Report
An analysis of variables predicting outcome

Asensio JA, Murray J, Demetriades D, Berne J, Cornwell E, Velmahos G, Gomez H, Berne TV.

One Hundred Five Penetrating Cardiac Injuries: A Two Year Prospective Evaluation


J Trauma 1998; Vol. 44, No. 6, pp 1073-1082
One Hundred and Five Penetrating Cardiac Injuries
A Two Year Prospective Evaluation

I. Introduction

Penetrating Cardiac Injuries

- Leading causes of death Urban Trauma Centers
- Rapid Transport
- Patients “in extremis”
- “One hundred years ago”
One Hundred and Five Penetrating Cardiac Injuries
A Two Year Prospective Evaluation

I. Introduction

Series in the literature

- Retrospective
- Institutions dealing with few cases/years
- Overlapping
- Not uniformity
- No data on physiological status
One Hundred and Five Penetrating Cardiac Injuries
A Two Year Prospective Evaluation

I. Introduction

- Design: Prospective
- Setting: Urban Level I Trauma Center
- Intervention: Thoracotomy for Resuscitation and definitive repair
One Hundred and Five Penetrating Cardiac Injuries
A Two Year Prospective Evaluation

I. Introduction

Objectives

• Analyze physiological parameters
• CVRS
• Mechanism and anatomical site of injury
• Tamponade and cardiac rhythm
• AAST-OIS Cardiac Injury Grading
One Hundred and Five Penetrating Cardiac Injuries
A Two Year Prospective Evaluation

II. Patients and Methods

• 24 month study (12/94 – 11/96)
• 105 patients
• Protocols
• Prospective data collected in cardiac injury registry
• No patients excluded
II. Patients and Methods

- Mechanism
- Anatomical site of injury
- Thoracotomy specific parameters
- Tamponade
- Cardiac Rhythm
II. Patients and Methods

Statistical analysis

- Relative risk of mortality
- 95% Confidence Intervals
- \( P < 0.05 \) - significant
One Hundred and Five Penetrating Cardiac Injuries
A Two Year Prospective Evaluation

Characteristics of Patient Population

<table>
<thead>
<tr>
<th>Variables</th>
<th># of patients</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Range</th>
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</thead>
<tbody>
<tr>
<td>Age</td>
<td>97</td>
<td>27.8</td>
<td>10.91</td>
<td>0 – 58</td>
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<tr>
<td>RTS</td>
<td>103</td>
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<td>GCS</td>
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<td>5.13</td>
<td>3 – 15</td>
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<td>103</td>
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<td>4.41</td>
<td>0 – 11</td>
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<tr>
<td>ISS</td>
<td>96</td>
<td>36.3</td>
<td>21.93</td>
<td>1 - 75</td>
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</table>
One Hundred and Five Penetrating Cardiac Injuries
A Two Year Prospective Evaluation

Mortality, Demographics and Injury Characteristics

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Sub-group</th>
<th>#Died/#cases</th>
<th>Mortality Rate (%)</th>
<th>Relative Risk</th>
<th>95% Confidence Interval</th>
<th>p-Value</th>
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<tbody>
<tr>
<td>Gender</td>
<td>Female</td>
<td>12/13</td>
<td>92.3</td>
<td>1.46</td>
<td>1.02, 2.10</td>
<td>0.037</td>
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<td></td>
<td>Male</td>
<td>58/92</td>
<td>63.0</td>
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<td>Revised Trauma Score</td>
<td>0</td>
<td>57/64</td>
<td>89.1</td>
<td>2.90</td>
<td>2.05, 4.08</td>
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<td></td>
<td>1+</td>
<td>12/39</td>
<td>30.8</td>
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<tr>
<td>GCS</td>
<td>&lt;=8</td>
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<td>83.8</td>
<td>3.07</td>
<td>2.07, 4.56</td>
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<td></td>
<td>&gt;8</td>
<td>9/33</td>
<td>27.3</td>
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<tr>
<td>CVRS</td>
<td>0-3</td>
<td>57/64</td>
<td>89.1</td>
<td>2.90</td>
<td>2.05, 4.08</td>
<td>0.001</td>
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<tr>
<td></td>
<td>4-11</td>
<td>12/39</td>
<td>30.8</td>
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<tr>
<td>ISS</td>
<td>&gt;=15</td>
<td>61/88</td>
<td>69.3</td>
<td>1.39</td>
<td>0.78, 2.47</td>
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<td>&lt;15</td>
<td>4/8</td>
<td>50.0</td>
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<td>Mechanism of injury</td>
<td>Gunshot</td>
<td>57/68</td>
<td>83.8</td>
<td>2.39</td>
<td>1.70, 3.35</td>
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<td></td>
<td>Stab</td>
<td>13/37</td>
<td>35.1</td>
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</table>
# One Hundred and Five Penetrating Cardiac Injuries

## A Two Year Prospective Evaluation

### Mortality, Surgical Findings and Outcome upon opening Pericardium

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Sub-group</th>
<th>Died/#cases</th>
<th>Mortality Rate (%)</th>
<th>Relative Risk</th>
<th>95% Confidence Interval</th>
<th>P Value</th>
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<tbody>
<tr>
<td>Sinus Rhythm</td>
<td>No</td>
<td>59/67</td>
<td>88.1</td>
<td>3.26</td>
<td>2.25, 4.71</td>
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<tr>
<td></td>
<td>Yes</td>
<td>10/37</td>
<td>27.0</td>
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<tr>
<td>Active Bleeding</td>
<td>No</td>
<td>25/31</td>
<td>80.7</td>
<td>1.34</td>
<td>1.01, 1.78</td>
<td>0.045</td>
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<td></td>
<td>Yes</td>
<td>44/73</td>
<td>60.3</td>
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<tr>
<td>Aorta Clamped</td>
<td>No</td>
<td>20/49</td>
<td>40.8</td>
<td>0.46</td>
<td>0.34, 0.62</td>
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<td></td>
<td>Yes</td>
<td>49/55</td>
<td>89.1</td>
<td></td>
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<tr>
<td>Organized Rhythm restored</td>
<td>No</td>
<td>50/50</td>
<td>100.0</td>
<td>2.58</td>
<td>1.95, 3.42</td>
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<td>Yes</td>
<td>19/49</td>
<td>38.8</td>
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<td>Measurable blood Restored</td>
<td>No</td>
<td>53/54</td>
<td>98.2</td>
<td>3.01</td>
<td>2.21, 4.10</td>
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<td></td>
<td>Yes</td>
<td>15/46</td>
<td>32.6</td>
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One Hundred and Five Penetrating Cardiac Injuries
A Two Year Prospective Evaluation

Results

- 105 patients
  - GSW 68 65%
  - SW 37 35%
- ISS mean 36
- Multiple Chambers 23/105 22% Injured
# One Hundred and Five Penetrating Cardiac Injuries
## A Two Year Prospective Evaluation

## Mortality and Wounded Chambers

<table>
<thead>
<tr>
<th>Chambers wounded</th>
<th># of deaths/ # of patients</th>
<th>Mortality Rate</th>
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<tbody>
<tr>
<td>None or chamber unknown</td>
<td>2/4</td>
<td>50.0%</td>
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<tr>
<td>RA</td>
<td>5/8</td>
<td>62.5%</td>
</tr>
<tr>
<td>RV</td>
<td>19/39</td>
<td>48.7%</td>
</tr>
<tr>
<td>LA</td>
<td>4/5</td>
<td>80.0%</td>
</tr>
<tr>
<td>LV</td>
<td>20/26</td>
<td>76.9%</td>
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</tbody>
</table>
One Hundred and Five Penetrating Cardiac Injuries
A Two Year Prospective Evaluation

Results

Survival

Overall Survival 35/105 33%
GSW 11/68 16%
SW 24/37 65%
One Hundred and Five Penetrating Cardiac Injuries
A Two Year Prospective Evaluation

- Stepwise Logistic Regression Analysis Identified:
  - GSW
  - Exsanguination
  - Restoration of BP
- Most Predictive Variables of Mortality
- Max-rescaled $R^2 = 0.81$
- Concordance = 95%
One Hundred and Five Penetrating Cardiac Injuries
A Two Year Prospective Evaluation

<table>
<thead>
<tr>
<th>AAST-OIS</th>
<th># of injuries</th>
<th>% of Total</th>
<th>Mortality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>1</td>
<td>0.9</td>
<td>0</td>
</tr>
<tr>
<td>II</td>
<td>2</td>
<td>1.9</td>
<td>50</td>
</tr>
<tr>
<td>III</td>
<td>3</td>
<td>2.85</td>
<td>66</td>
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<td>IV</td>
<td>50</td>
<td>47.6</td>
<td>56</td>
</tr>
<tr>
<td>V</td>
<td>38</td>
<td>36.2</td>
<td>76</td>
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<tr>
<td>VI</td>
<td>11</td>
<td>10.5</td>
<td>91</td>
</tr>
</tbody>
</table>
One Hundred and Five Penetrating Cardiac Injuries
A Two Year Prospective Evaluation

Results

ED Thoracotomy

71/105 68%
10/71 14% Survivors
One Hundred and Five Penetrating Cardiac Injuries
A Two Year Prospective Evaluation

Results

*Survival by CVRS*

<table>
<thead>
<tr>
<th>CVRS</th>
<th>Patients</th>
<th>% Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>50/53</td>
<td>94%</td>
</tr>
<tr>
<td>0-3</td>
<td>57/64</td>
<td>89%</td>
</tr>
<tr>
<td>4-11</td>
<td>12/39</td>
<td>31%</td>
</tr>
</tbody>
</table>
III. CONCLUSIONS

- Significant predictors of outcome in penetrating cardiac injuries
  - Physiological condition
  - CVRS
  - Mechanism of injury
  - Initial rhythm
  - AAST – OIS Cardiac Injury Grade
PENETRATING CARDIAC INJURIES

ROLE OF EMERGENCY DEPARTMENT THORACOTOMY
A Surgeon Needs to Have:

- The wisdom of Aristotle
- The courage of a lion
- The gentle hands of a lady

Lord George Andrew Berkeley
Moynihan of Leeds