Management of Crush Victims in Mass Disasters

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CONTENTS

RENNAL DISASTER / CRUSH SYNDROME
- Introduction
- Etiology / pathogenesis
- Clinical / lab. findings
- Prophylactic / therapeutic interventions

LOGISTIC ISSUES
- Severity assessment
- Providing health care
- Medical support
- Other logistic issues

CONCLUSIONS
GLOBAL SEISMIC HAZARD MAP

EARTHQUAKES: A WORLDWIDE PROBLEM
The Marmara Earthquake: One of the most catastrophic disasters of the World in the 20th Century

- 17 August, 1999
- 7.4 (Richter scale)
- 45 sec
- Deaths: 17,480
- Injured: 43,953
The Marmara Earthquake
Patients with renal problems: 639
Patients requiring dialysis: 477

The Hanshin-Awaji (Kobe) Earthquake
Patients with AKI: 202
Patients requiring Dialysis: 123

The largest “renal disaster” documented so far!

Sever et al. Kidney Int 2001
Oda et al. J Trauma 1997
Dialysis for acute renal failure due to crush injuries after the Armenian earthquake


N T Richards, J Tattersall, M McCann, A Samson, T Mathias, A Johnson

On 7 December 1988 an earthquake measuring all patients develop acute renal failure at the same time,

“RENAL DISASTER”


Kidney Int 1993; 44: 479-83

INVITED CONTRIBUTION

International dialysis aid in earthquakes and other disasters


University of Alberta Hospitals, 5B4.02 W.C. MacKenzie Health Sciences Centre, Edmonton, Alberta, Canada; Guy’s Hospital, London.
• 80% die instantly
• 10% minor injuries
• 10% major injuries

Crush syndrome

2nd most frequent cause of deaths
(following direct effect of trauma)

“RENAL DISASTER”

Ron et al. Arch Intern Med 1984

Ukai. Ren Fail 1997
Cush syndrome is a life-threatening disorder!

Mortality in crush syndrome:
- Overall: 24.8% (50/202)
- Dialyzed: 41% (50/123)

Mortality rates in dialyzed crush victims:
- Marmara: 17%
- Taiwan: 17%
- Pakistan: 19%
- Iran: 13%

Hwang et al. 2001; Sever et al 2004; Van der Tol et al. 2008; Hatamizadeh et al AJKD 2006
Crush: injury due to pressure between opposing elements

Crush syndrome: systemic manifestations of crush injury-induced rhabdomyolysis

**SURGICAL**
- Local findings of trauma
- Compartment syndrome

**MEDICAL**
- Hypovolemic shock
- Hyperkalemia
- Infections
- Acute renal failure
Rhabdomyolysis

Disintegration of striated muscles resulting in release of muscular cell contents

- lactic acid
- thromboplastin
- creatin kinase

- nucleic acids
- phosphate
- creatine

- Myoglobin
- Potassium

into the extracellular fluid
TERMINOLOGY - II

- **Compartment**: space restricted by the rigid fasciae surrounding the muscles.

**Compartment syndrome**

- increased pressure in the compartments due to traumatic tissue swelling.

Disrupts perfusion / hinders muscle function.
**Fasciotomy**
- Surgical incision through the fasciae to reduce intracompartmental pressure

**Decompressive intervention**
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ETIOLOGY of RHABDOMYOLYSIS

Non-traumatic
- Metabolic myopathies
- Drugs and toxins
- Infections
- Electrolyte abnormalities
- Endocrine disorders
- Polymyositis, dermatomyositis

Traumatic
- Traffic or working accidents
- Prolonged immobilization
- Vessel clamping
- Strainful exercise of muscles
- Electrical current
- Hyperthermia
- Disasters

vanholder et al. JASN 2000
PATHOGENESIS of TRAUMATIC RHABDOMYOLYSIS

Better et al. Miner Electrolyte Metab 1990; Better and Stein. NEJM 1990; Abassi et al. AJKD 1998
PATHOGENESIS of RHABDOMYOLYSIS-INDUCED AKI

~ 30–50% of rhabdomyolysis ⇒ AKI

Rhabdomyolysis ⇒ a frequent cause of AKI (5 - 20%)

Better and Stein. NEJM 1990
Vanholder et al. JASN 2000
Pathogenesis of rhabdomyolysis-induced AKI

Thromboplasatin

Hyperphosphatemia

Hypocalcemia

Myoglobinemia

Myoglobinuria

Potassium

Endotoxin/cytokines

Renal hypoperfusion/ischemia

Cast formation

Tubular damage

Luminal stasis

Uric ac.

Lactic ac.

NO scavenging

Hyperphosphatemia

Fe loading

Free radicals

CaPO₄ salts

DIC

Better and Stein, NEJM 1990
Zager, Kidney Int 1996
Vanholder et al., JASN 2000
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CLINICAL FINDINGS in CRUSH SYNDROME

Local findings in the traumatized muscles

1. Pain
2. Pressure
3. Paresthesia
4. Paresis or paralysis
5. Pallor
6. Pulselesness

(6 “P”s)

Systemic manifestations of rhabdomyolysis (C.S.)

- Hypovolemic shock
- AKI
- Hyperkalemia
- Heart failure
- ...............
TRÁUMA PATTERN in the MARMARA EARTHQUAKE CRUSH VICTIMS

No. of traum. Extremities

<table>
<thead>
<tr>
<th>No.</th>
<th>Extremities</th>
<th>Thoracic</th>
<th>Abdominal</th>
<th>Skull</th>
<th>Multiple</th>
<th>Others</th>
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<td>Global</td>
<td>790</td>
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</tbody>
</table>

Multivariate analysis:

- Thoracic (p=0.001, o.r.=2.8)
- Abdominal (p<0.0014, o.r.=3.8)

Victims with thoracic / abdominal traumas should be referred from the field as soon as possible

Sever et al, NDT, 2002
## Laboratory Findings in Crush Syndrome

<table>
<thead>
<tr>
<th>Urinary Findings</th>
<th>Biochemistry</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Myoglobinuria</td>
<td>- Muscle enzymes</td>
</tr>
<tr>
<td>- Other findings</td>
<td>- Creatinine / BUN</td>
</tr>
<tr>
<td></td>
<td>- Acidosis</td>
</tr>
<tr>
<td></td>
<td>- Hyperphosphatemia</td>
</tr>
<tr>
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<td>- Hyperuricemia</td>
</tr>
<tr>
<td></td>
<td>- Hypocalcemia</td>
</tr>
<tr>
<td></td>
<td>- Hypoalbuminemia</td>
</tr>
<tr>
<td></td>
<td>- Abnormal blood count</td>
</tr>
<tr>
<td></td>
<td>- Hyperkalemia</td>
</tr>
</tbody>
</table>
SERUM POTASSIUM
(The Marmara Earthquake Experience)

Serum potassium: 5.3±1.3 (2.4 - 13.3) mmol/L

Many patients died at the field, during transportation or on admission to hospitals due to fatal hyperkalemia!

Sever et al, Clin Nephrol 2003
Marmara E.: 10% of the patients were receiving K+ containing solutions on admission.

This was certainly can be called nothing less than malpractice.

Resulted in many patient deaths?

K+ containing solutions should NEVER be administered empirically!
• Rescued victims who were seemingly well under the rubble, deteriorated or even died as soon as they were extricatied!

Ashkenazi et al. Prehosp Disast Med 2005
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Treatment of rhabdomyolysis-induced AKI

- Myoglobinemia
- Hyperphosphatemia
- Hypocalcemia
- Myoglobinuria

Thromboplastin
Potassium
Endotoxin/cytokines
Renal hypoperfusion/ischemia

HCO₃⁻

Lactate
Uric acid

Cast formation
Luminal stasis
Tubular damage

MANN.

FLUIDS

DIC
Better and Stein, NEJM 1990,
Zager, KI 1996,
Vanholder et al. JASN 2000

Myoglobinuria

Fe loading
Free radicals

CaPO₄ salts

Myoglobinemia

Primary importance
Secondary importance
Tertiary importance

Section II: Interventions at the disaster field

II.3: Intervention before / during extrication

A victim is detected under the rubble

BEFORE EXTRICATION

(A vein is sought in one of the limbs)

No vein can be found → No fluid is given → Initiate isotonic saline (1 L/h) → A vein is found

DURING EXTRICATION

(Continue isotonic saline 1 L/h)

Duration of extrication process >2h → Reduce isotonic saline (0.5 L/h or even less)