# Section II: Interventions at the disaster field

## II.6: Fluids and urine volume monitoring early after extrication

### TYPE OF FLUIDS in CRUSH-RELATED AKI

#### 1. Volume resuscitation, 2. Alkalinization, 3. Other targets

<table>
<thead>
<tr>
<th>Solution (1000 ml)</th>
<th>Advantages</th>
<th>Drawbacks</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isotonic saline</td>
<td>Effective</td>
<td>Hypervolemia, Hypertension</td>
<td>Preferred solution</td>
</tr>
<tr>
<td>Isotonic saline + 5% Dextrose</td>
<td>Provides calories</td>
<td></td>
<td>Hard to find</td>
</tr>
<tr>
<td></td>
<td>Attenuates hyperkalemia</td>
<td></td>
<td>Preferred, if available</td>
</tr>
<tr>
<td>Hypotonic saline + HCO3</td>
<td>Improves acidosis</td>
<td>Complicated prep. Symp. alkalosis</td>
<td>Good for small scale disasters</td>
</tr>
<tr>
<td></td>
<td>Attenuates hyperkalemia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mannitol-alkaline solution (Basal sol.: Hypotonic saline)</td>
<td>Plasma expander</td>
<td>Hypervolemia, CHF Nephrotoxicity</td>
<td>Contraindicated in anuria</td>
</tr>
<tr>
<td></td>
<td>Diuresis, plugs, antioxid. Compartment syndrome</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Albumin</td>
<td>Expansion of intravascular volume</td>
<td>Hard to find, side effects, expensive</td>
<td>Not preferred</td>
</tr>
<tr>
<td>Hydroxyethylstarch (HES)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Brown et al. J Trauma 2004

Preventing Renal Failure in Patients with Rhabdomyolysis: Do Bicarbonate and Mannitol Make a Difference?

Carlos Y. R. Brown, MD, Peter Kline, MD, MPH, Lindon K. Kelly, Evans, MS, Demetrios Demetriades, MD, PhD, and George C. Rizk, MD, PhD.

The Journal of TRAUMA® Injury, Infection, and Critical Care

No consensus among workgroup regarding mannitol administration!

Adult trauma ICU (1997-2002)

- 1771 patients with abnormal CK
- 154 received, 228 did not receive MAN / BIC

No difference in AKI, dialysis or mortality

Tendency toward improved outcome if CK > 30,000 UL

(Most suggest assessing response to a test dose)
Section II: Interventions at the disaster field

II.6: Fluids and urine volume monitoring early after extrication

OVERALL VOLUME and RATE of FLUIDS

AFTER EXTRICATION

(no fluids could be given before rescue) (was receiving isotonic saline during rescue)

Initiate isotonic saline Continue isotonic saline

Administer overall 3-6 L of fluid (subject to change depending on several variables)

(Monitor for 6hrs. since initiation of fluids)

Anuria

IV fluid* (0.5 - 1 L/d + all presumed losses of the previous day)

Urine output (+)

close monitoring impossible

IV fluid* (3 - 6 L/d)
close monitoring possible

IV fluid* (more than 6 L/day)
**BINGOL (TURKEY) EARTHQUAKE**

- 16 victims; 12 male; mean age: 23 ± 13 yr.

<table>
<thead>
<tr>
<th>Fluids and urinary output</th>
<th>Dialysis (-) (n:12)</th>
<th>Dialysis (+) (n:4)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluids (L/d.)</td>
<td>21.8±2.7</td>
<td>11±2.5</td>
<td>0.002</td>
</tr>
<tr>
<td>Ur. vol. (L/d.)</td>
<td>8.8±2.3</td>
<td>1.8±2.4</td>
<td>0.002</td>
</tr>
</tbody>
</table>

- Mean time under the rubble: 10.3 ±7 (3 to 24) h.
- Duration between rescue and fluid resuscitation:
  - Nondialyzed: 3.7±3.3 h. vs dialyzed: 9.3±1.7 h.  \( p<0.03 \)

Gunal et al. JASN, 2004;15:1862-7
# THERAPEUTIC INTERVENTIONS

## MEDICAL

- Renal replacement therapy (dialysis)
- Blood and blood product transfusions
- Treatment of infections and other complications

## SURGICAL

- Management of traumatic wounds, amputations
- Fasciotomy
Dialysis application is problematic!

<table>
<thead>
<tr>
<th>Location</th>
<th>Clinics Reported as Katrina-affected</th>
<th>Clinics Closed for 10 days or Longer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Louisiana</td>
<td>55(^a)</td>
<td>37 (67%)</td>
</tr>
<tr>
<td>Mississippi</td>
<td>30</td>
<td>7 (23%)</td>
</tr>
<tr>
<td>Alabama</td>
<td>9</td>
<td>1 (11%)</td>
</tr>
<tr>
<td>Total</td>
<td>94</td>
<td>45 (48%)</td>
</tr>
</tbody>
</table>

\(^a\) Forty of these clinics were located in the New Orleans metropolitan area.

Dialysis supply is inadequate for chronic patients!

Kutner et al, KI, 76, 760-766, 2009
There is a disparity between demand and supply.

Dialysis supply is inadequate for chronic patients!

Even

5137 EXTRA dialysis sessions for crush cases

Renal replacement therapies in the aftermath of the catastrophic Marmara earthquake

Mehmet S. Sever, Ekrem Erek, Raymond Vanholder, Birsen Yurugan, Guray Kantarcı, Murat Yavuz Hurv, Emre Semza, Bozhidarov

There is a disparity between demand and supply.
All modalities have:

- Logistic and medical advantages

and drawbacks
# Intermittent Hemodialysis

<table>
<thead>
<tr>
<th>Medical</th>
<th>Advantages</th>
<th>Drawbacks</th>
</tr>
</thead>
</table>
|         | - High clearance rate of low molecular weight solutes  
|         | - Possibility to dialyze without anticoagulation | - Priming volume may induce hypotension  
|         | | - Risk of dialysis disequilibrium syndrome |

<table>
<thead>
<tr>
<th>Logistic</th>
<th>Advantages</th>
<th>Drawbacks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Possibility to treat several pts. per day at the same position</td>
<td>- Need for experienced personnel and infrastructure</td>
</tr>
</tbody>
</table>

# Slow Continuous Therapy

<table>
<thead>
<tr>
<th>Medical</th>
<th>Advantages</th>
<th>Drawbacks</th>
</tr>
</thead>
</table>
|         | - Better volume control  
          | - Gradual removal of solutes, Disequilibrium synd. | - Need for continuous anticoagulation  
          |                                      | - Low removal capacity for small solutes (i.e. $K^+$) |
| Logistic| - Can be established rapidly | - Ability to treat only one pt. per machine per day  
          |                                      | - Need for experienced personnel, electricity  
          |                                      | - Excessive amounts of substitution fluid |

# Peritoneal Dialysis

<table>
<thead>
<tr>
<th>Medical</th>
<th>Advantages</th>
<th>Drawbacks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- No need for vascular access, simpler technique</td>
<td>- Low clearance of small molecules (i.e. K⁺)</td>
</tr>
<tr>
<td></td>
<td>- Less hemodynamic instability</td>
<td>- Difficult to perform in patients with trauma and in some complications</td>
</tr>
<tr>
<td></td>
<td>- Initiated rapidly, no risk of disequilibrium synd.</td>
<td></td>
</tr>
<tr>
<td>Logistic</td>
<td>No need for water and electricity</td>
<td>- Difficulty in maintaining sterile technique</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Need for large quantities of dialysate</td>
</tr>
</tbody>
</table>

Dialysis support in 477 (74.6%) patients

IHD: 462, SCT: 34, PD: 8

HD sessions: 11.1 ± 8.0
Days on HD: 13.4 ± 9.0

5137 sessions of IHD

Sever et al. Kidney Int 2002
BLOOD and BLOOD PRODUCT TRANSFUSIONS
(The Marmara earthquake experience)

Blood: 2981 u.
FFP: 2837 u.
H. alb.: 2594 u.

8500 units

- Medical concerns
- Logistic concerns

Sever et al. Nephron 2002
FASCIOTOMY

**Advantages**
- Decompression $\Rightarrow$ necrotic muscle mass
- Distal ischemia / necrosis can be prevented
- Irreversible neurologic damage prevented

**Disadvantages**
- A closed wound $\Rightarrow$ open wound $\Rightarrow$ infection
- Higher risk of amputation (infection)
- Long term sensory / motor losses

Szewczyk. J Trauma 1998
Matsuoka et al. J Trauma 2002
FASCIOTOMIES in the Marmara E.

397 fasciotomies in 323 patients

**Sepsis:**
- Fasc. (+): 25%
- Fasc. (-): 13%

**Mortality:**
- Sepsis (+): 27%
- Sepsis (-): 12%

Sever et al. NDT 2002

Fasciotomies ⇒ objective criteria

Better et al. KI 2003;63:1155-1157
RENAL 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
LOGISTICS

- Procurement
- Maintenance
- Distribution
- Replacement

Personnel / material

Vital in disasters due to chaotic conditions
Support is offered, if needed

Inform RDRTF Branch Chairman (international support)
Inform local authorities (national support)

Anticipation of the needs for support (i.e. medications, blood products)

US Geological services - earthquake detection

Initial estimation of number of crush syndrome victims

Advance scouting nephrologic team

Local key person

Reporting local conditions / assessing magnitude of the problem

Sever, Vanholder, Lameire. NEJM 2006
LOCAL LOGISTIC INTERVENTIONS

I. Severity assessment

II. Providing health care
- Rescue activities
- Evacuation of the victims
- Logistic planning in hospitals

III. Medical support

IV. Other logistic issues
- Global logistic needs
- Managing chr. patients
- Medical records
THE INCIDENCE

Many factors effective!

- Intensity of the disaster
- Population density of the region
- Structural characteristics of buildings
- Timing (moment) of disaster
- Efficacy of rescue activities

Noji et al., 1990; Nadjafi et al., 1997

Gujarat Earthquake:
Death: 19,727; Cr.: 35

Bam Earthquake:
Death: 25,000; Cr.: 160 (Dx+)

September 11 terrorism
Death: >3,000; Cr.: 1

Viroja et al, WCN Abstracts, 2001
Hatamizadeh et al.
AJKD 2006; 3:428-38
RENAL DISASTER / CRUSH SYNDROME

- Introduction
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LOGISTIC ISSUES

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

CONCLUSIONS

- Rescue Activities
- Evacuation of the victims
- Logistic planning in hospitals
People living in disaster prone regions should consider that they are needed as "rescuers" in the case of a disaster.

Noji et al. 1993

De Bruycker et al., 1985
Rescue activities within the first 2 days are of vital importance

Sever et al, Crit Care Med 2002
Non-survivors vs. survivors: (p=0.26)

Dialyzed: 10±10 hrs.
Not dialyzed: 16±23 hrs.

p<0.001

Only the victims with mild trauma can survive under the rubble for longer periods

CONCLUSIONS

• Disasters and subsequent "renal disasters" will continue to be major causes of death in the future.

• Number of deaths due to crush s. (renal disaster victims) can be decreased by appropriate management.

• Medical practice during disasters differ considerably as compared to routine medical applications.

• National / international disaster preparedness and logistic planning can be helpful to decrease post-disaster chaos and provide effective health care.