

Acute Kidney Injury DURING DISASTERS

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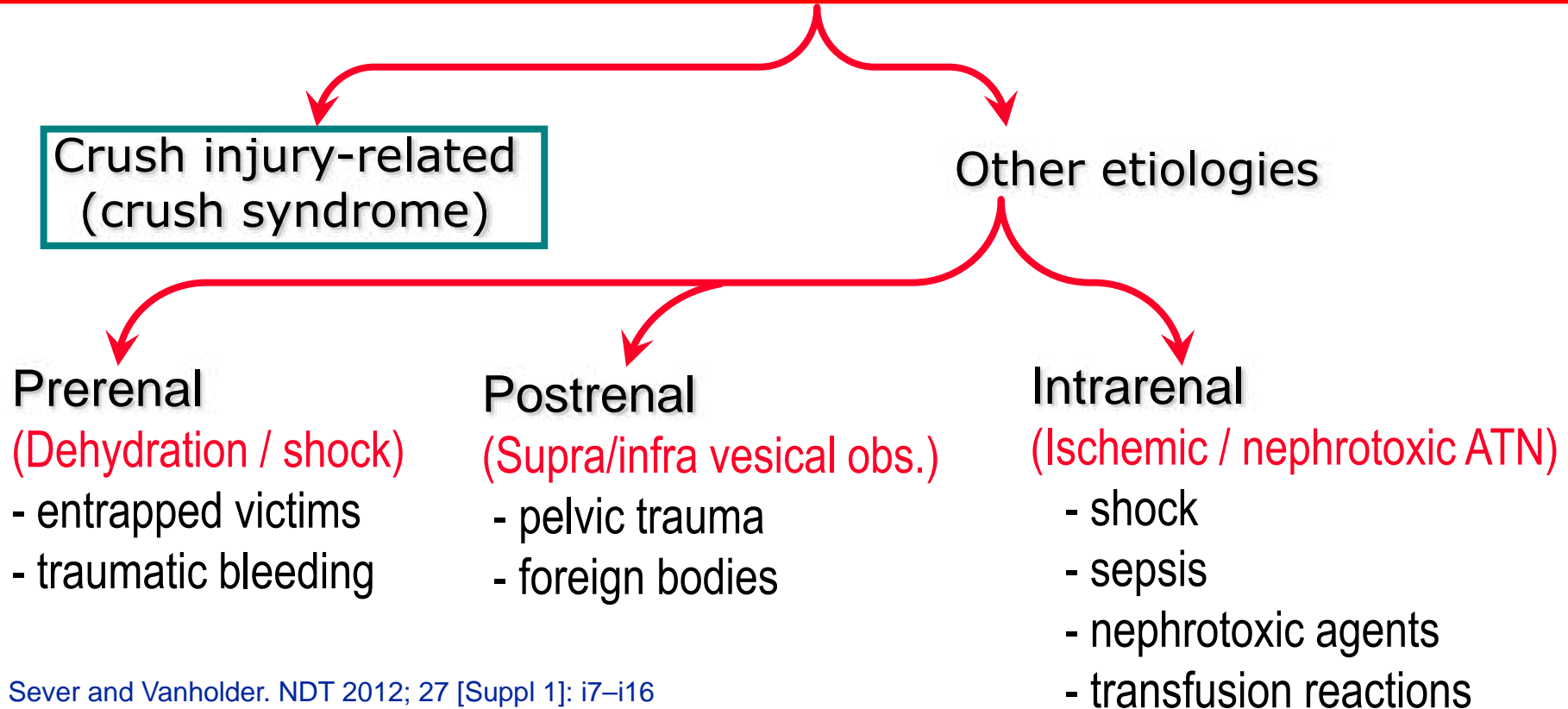
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CONTENTS

- **Introduction**
- Pathophysiology
- Clinical and laboratory features
- Prophylaxis and treatment

SPECTRUM of AKI after DISASTERS



THE CRUSH SYNDROME

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
- AKI

UNDERLYING PATHOLOGY → RHABDOMYOLYSIS

Crush syndrome is frequent !

- Incidence of crush syndrome:
→ 2 - 3% of all casualties

Sheng ZY. J Trauma 1987;27:1130; Sever MS et al. Kidney Int 2001;60:1114-23

- Haiti E. (2010)→ Deaths: 220.000; injured: 300.000

Vanholder et al. Nephron Clin Pract 2011;117: c184–197

Crush syndrome is fatal !

Mortality rates in dialyzed crush victims:

- **Marmara: 17%**

(Sever et al. Nephron 2002; 92: 64-71)

- **Taiwan: 17%**

(Hwang et al. NDT 2001; Suppl 5: 78-82)

- **Pakistan: 19%**

(Vanholder et al. Kidney Int 2007; 71: 17-23)

- **Iran: 13%**

(Hatamizadeh et al AJKD 2006; 47: 428-38)

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PATHOGENESIS of CRUSH-RELATED AKI

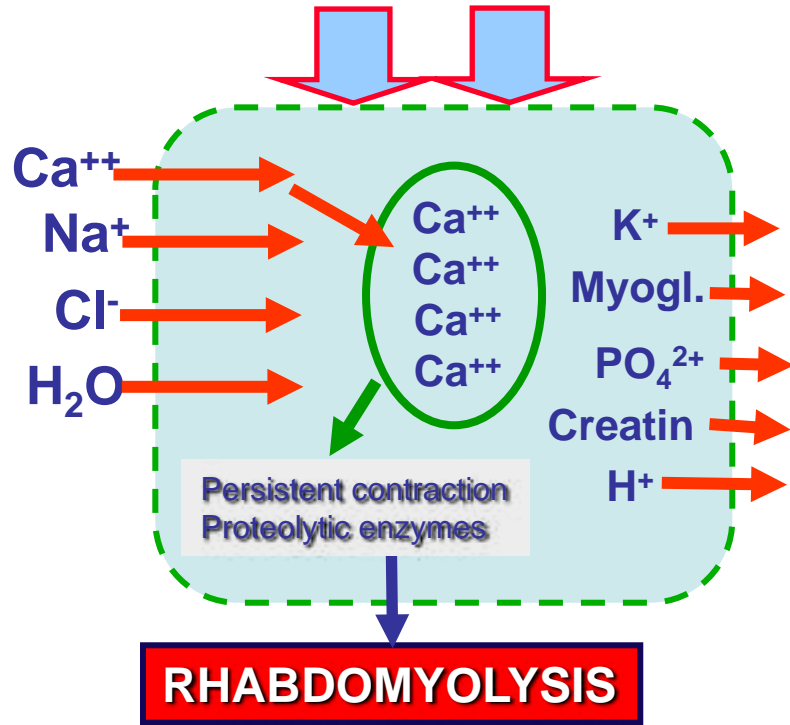
I. Traumatic rhabdomyolysis

II. Rhabdomyolysis-induced AKI

~30 - 50% of rhabdomyolysis \Rightarrow AKI

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

PATHOGENESIS of TRAUMATIC RHABDOMYOLYSIS

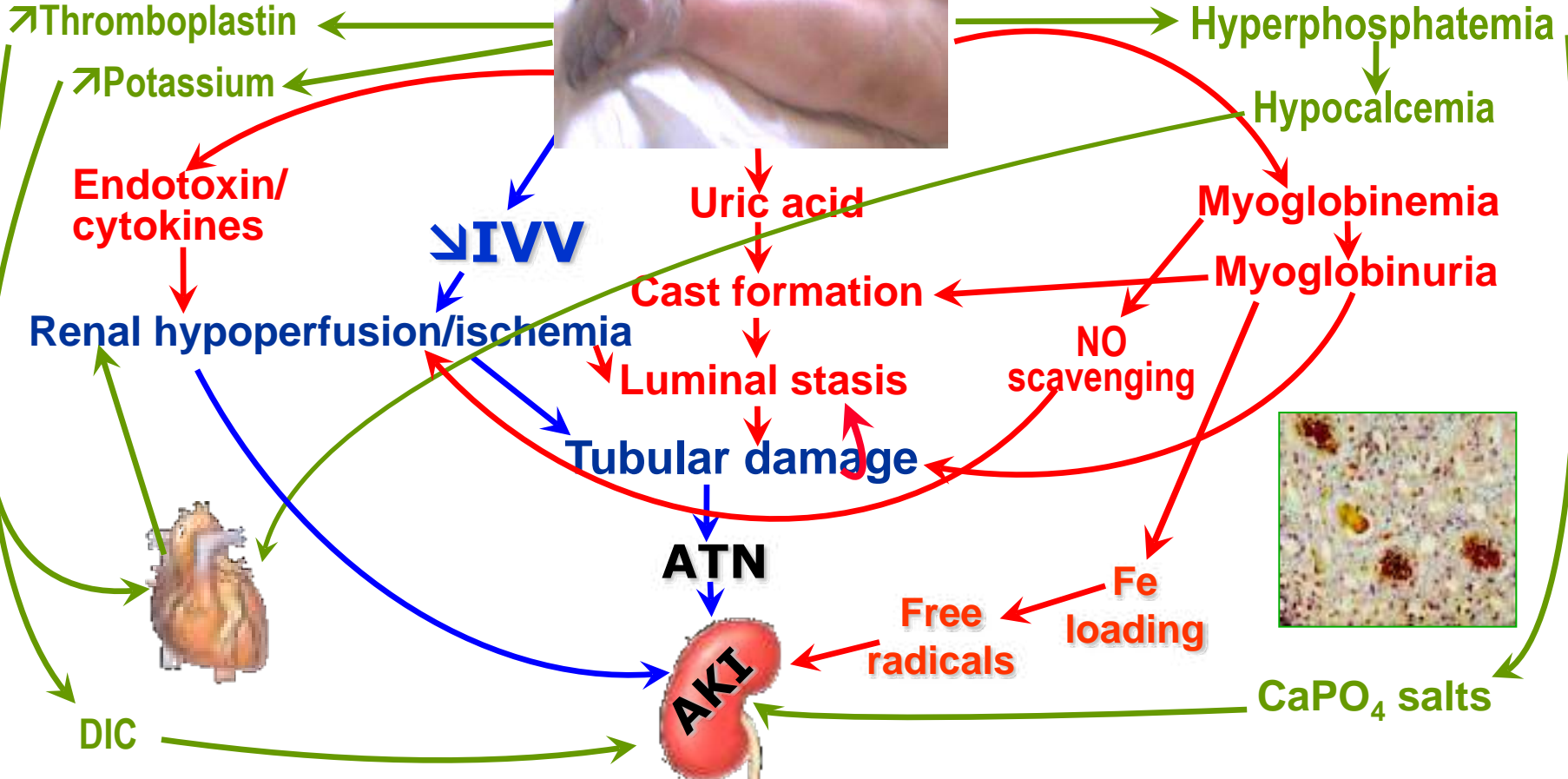


COMPARTMENT SYNDROME

Primary importance

Secondary importance

Tertiary importance



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CLINICAL FINDINGS in CRUSH-RELATED AKI

Local findings in the traumatized muscles

- Pain
- Pressure
- Paresthesia
- Paresis or paralysis
- Pallor
- Pulselessness

(6 "P"s)



Systemic manifestations of the crush injury

- AKI
- Hypovolemic shock
- Hyperkalemia
- Infections
-

VERY RISKY

LABORATORY FINDINGS

Urinalysis

- Myoglobinuria
- Other findings



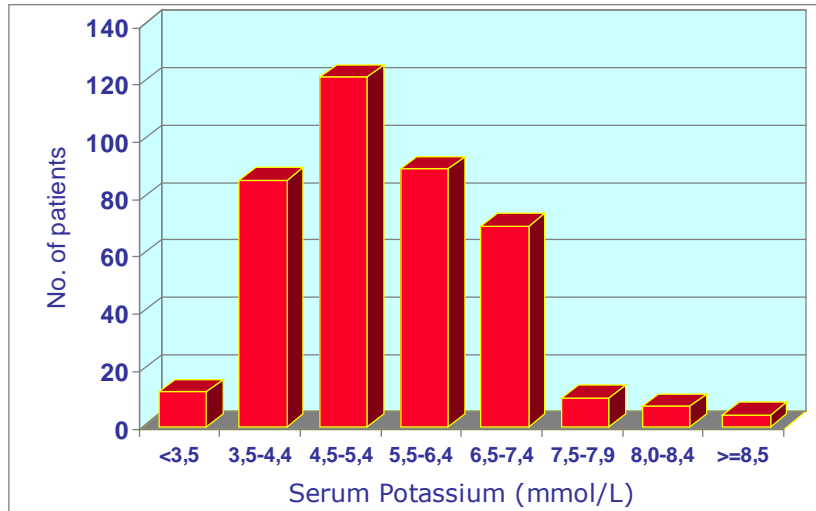
Blood chemistry

- \nearrow muscle enzymes
- \nearrow urea, creatinine
- Acidosis
- Hyperphosphatemia
- Hypoalbuminemia
- **Hyperkalemia**

Serum potassium in the crush syndrome victims of the Marmara disaster

M.S. Sever¹, E. Ereke², R. Vanholder³, G. Kantarci⁴, M. Yavuz⁵, A. Turkmen¹,

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



Cum. No. of the pts.	Potassium (mmol/L)
176	≥ 6.0
116	≥ 6.5
70	≥ 7.0
6	≥ 8.5

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

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Öğren-özet-Pekiştir (ÖÖP) yayınıdır
Volume 37 Supplement 1 April 2012

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NEPHROLOGY DIALYSIS TRANSPLANTATION
Basic and clinical renal science

RECOMMENDATIONS FOR THE MANAGEMENT OF CRUSH VICTIMS IN MASS DISASTERS



Work Group Co-Chairs: Mehmet Sukru Sever and Raymond Vanholder

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(SHORT FOLD VERSION)

Treatment of Disaster Crush Victims

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graph TD; Root[Treatment of Disaster Crush Victims] --> Disaster[Disaster field]; Root --> Transportation[Transportation]; Root --> Hospitals[Hospitals];
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Disaster field

- Rescue
- Triage
- Primary survey
- Stabilization
- Basic surgical int.
- **Fluids**
- Other interventions

Transportation

- Triage
- Primary survey
- Stabilization
- **Fluids**
- Other interventions

Hospitals

- Triage
- Prim./ sec. surveys
- Surgical interv.
- Medical interv.
 - **Fluids**
 - Blood / products trans.
 - **Dialysis**
 - Other interventions

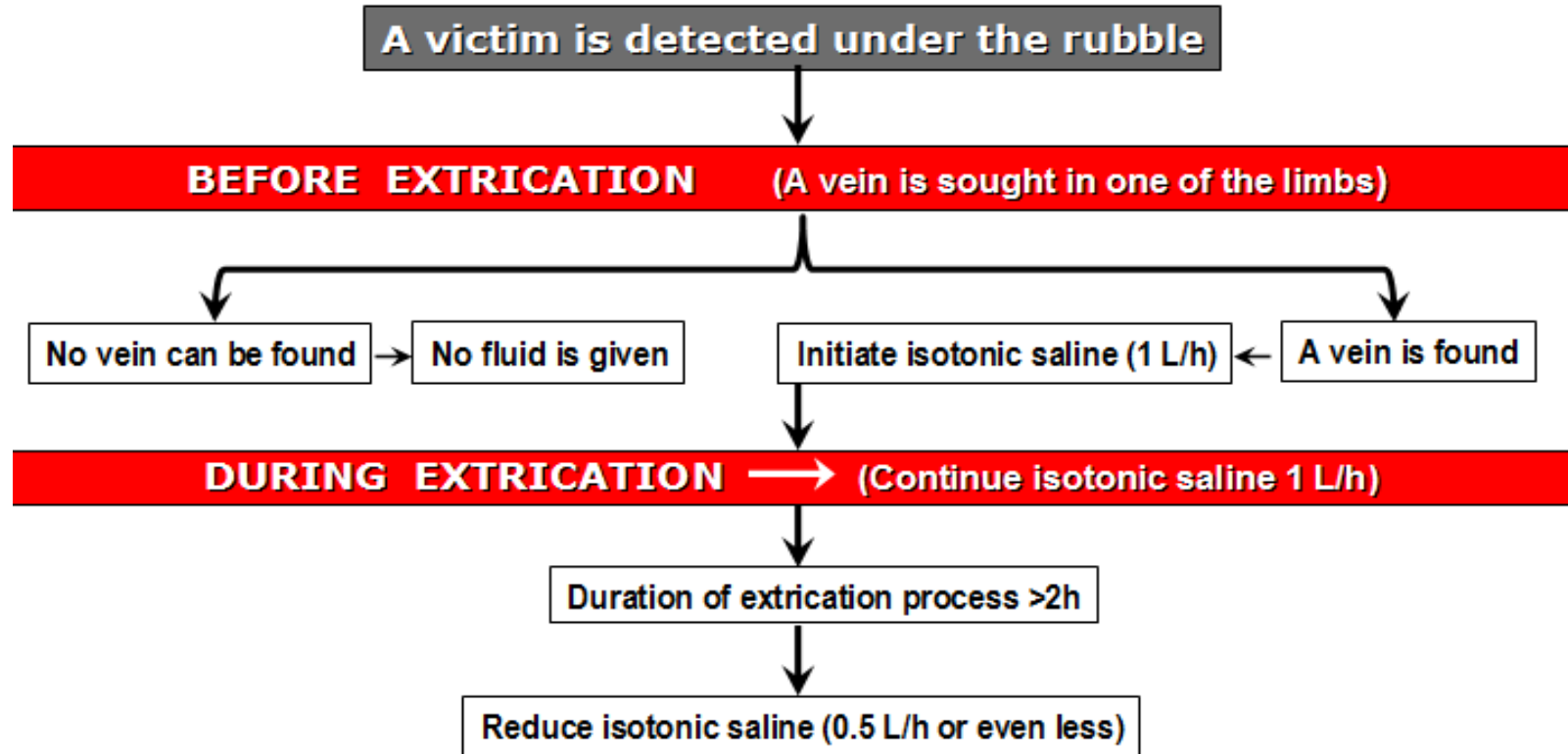
TYPE OF FLUIDS in CRUSH-RELATED AKI

MEDICAL: Bicarbonated hypotonic NaCl

LOGISTICS: Isotonic NaCl

Colloids	Albumin Hydroxyethylstarch (HES)	Expansion of intravascular volume	Hard to find, side effects, expensive	Not preferred
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FLUID TREATMENT POLICY IN CRUSH VICTIMS -I



FLUID TREATMENT POLICY IN CRUSH VICTIMS -II

VARIABLES TO BE CONSIDERED

- Age
- Body weight
- Trauma pattern
- Duration of extrication
- Urine production
- Amount of overall estimated fluid losses
- Ambient temperature
- Logistic circumstances (severity of the disaster, availability of medical items..)

Other Measures at the Disaster Field

<i>Complication</i>	<i>Treatment</i>	<i>Comments</i>
<i>Airway obstruction</i>	- Jaw thrust, Mayo canula providing free airway, aspiration of secretions, administration of oxygen, tracheal intubation	- Should be considered as a first-line measure because of its life-saving capacity.
<i>Pain</i>	- Narcotics, ketamine	- Morphine should be given IV since the response to IM morphine is unpredictable and may lead to respiratory depression. - NSAIDs should not be used for analgesia.
<i>Hyperkalemia</i>	- Potassium binding resins; i.e. kayexalate Na ⁺ or Ca ⁺⁺ - Transferring the patients as soon as possible for dialysis	- Side effects of kayexalate: nausea, vomiting, hypocalcemia, hypokalemia and rarely intestinal necrosis. - Na-kayexalate is preferred; Ca- kayexalate should be avoided

ECG; iSTAT[®] point-of-care device

<i>Hypertension</i>	or blood products, treatment of ischemic heart disease, electrolyte abnormalities and infection(s)	Need for fluids may be considerably high in such cases because of sequestration in the tissues.
<i>Hypertension</i>	- Calcium antagonists and nitrates - Diuretics in victims with urine production	- Excessive fluids is to be avoided in oligoanuric victims. - Psychologic support can be helpful in case of severe stress.
<i>Myocardial ischemia and infarction</i>	- Relief of pain, treatment of hypertension and anxiety, administration of short acting nitrates, oxygen inhalation	- Transport of the patients to a hospital at the earliest occasion.
<i>Cardiac failure</i>	- Short acting nitrates, diuretics, oxygen inhalation	- Patients should be placed in a sitting position. - Application of intermittent venous tourniquets may be useful.

Renal Replacement Therapy in Crush-Related AKI -I

Dialysis indications:

- Clinical symptoms
(hypertension, volume overload, nausea...)
- Biochemical abnormalities
(severe uremia, hyperkalemia, acidemia..)

Prophylactic dialysis

- High risk for hyperkalemia



Consider the broader clinical context, the presence of conditions that can be modified with RRT, and trends of laboratory tests—rather than single BUN and creatinine thresholds alone—when making the decision to start RRT. (Not Graded)

Renal Replacement Therapy in Crush-Related AKI -II

	<i>Medical Advantages</i>	<i>Medical Drawbacks</i>
IHD	<ul style="list-style-type: none">- High clearance rate of low molecular weight solutes- Dialyzing without anticoagulation	<ul style="list-style-type: none">- Priming volume may induce hypotension- Risk of disequilibrium syndrome
CRRT	<ul style="list-style-type: none">- Better volume control- Lower risk of disequilibrium syndrome- Administering more calories	<ul style="list-style-type: none">- Continuous heparinization- Low removal capacity for small solutes like potassium
PD	<ul style="list-style-type: none">- No need for vascular access- Less hemodynamic instability- No need for water and electricity	<ul style="list-style-type: none">- Low clearance rate- Difficulty in maintaining sterile technique- Difficult application in some pts.

Renal Replacement Therapy in Crush-Related AKI -III

	<i>Logistic Advantages</i>	<i>Logistic Drawbacks</i>
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IHD is the most practical RRT modality in disaster crush victims.

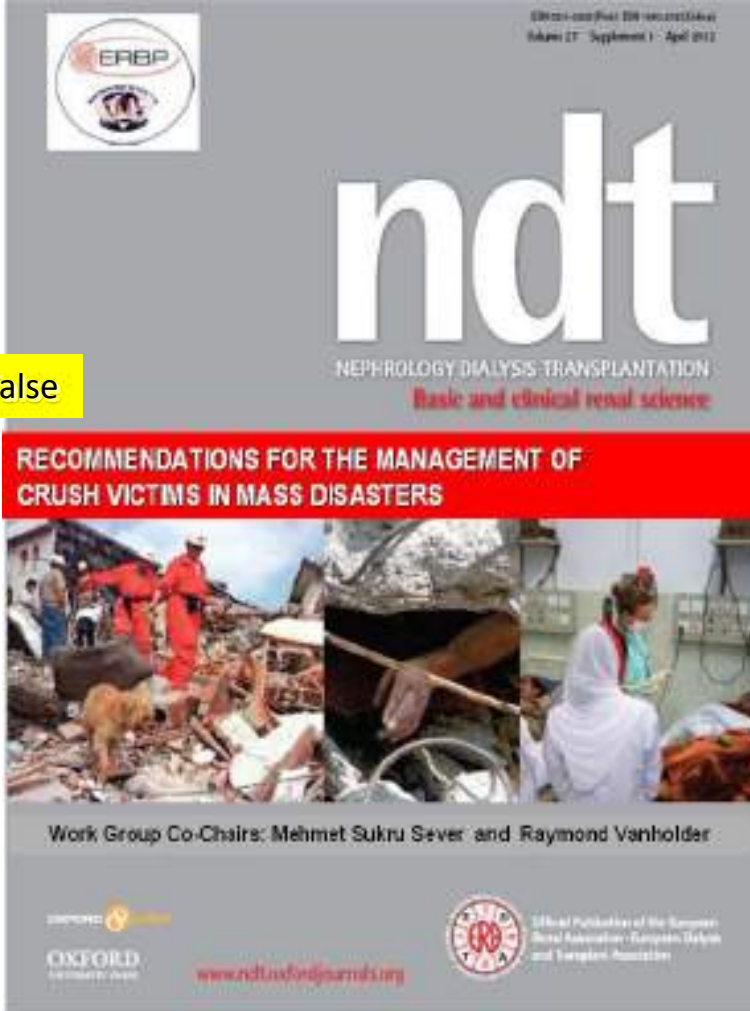
PD	- No need for water and electricity.	- Transportation of fluid bags to the disaster area.
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CONCLUSIONS

- Crush syndrome is the most important cause of AKI after disasters. It was / is (will continue to be) a major cause of death after earthquakes.
- Early, fluid administration is the most pragmatic intervention for prophylaxis of crush syndrome.
- Treatment strategies may differ considerably because of medical and logistic circumstances.
- Deaths due to crush-related AKI can be decreased by appropriate medical and logistic management.

for further information:

https://academic.oup.com/ndt/article/27/Suppl_1/i1/1818526?login=false



The image shows the cover of the journal *Nephrology Dialysis Transplantation* (ndt). The cover is primarily grey with a red banner across the middle. At the top left is the ERBP logo. The title 'ndt' is in large white letters, with 'NEPHROLOGY DIALYSIS TRANSPLANTATION' and 'Basic and clinical renal science' in smaller text below it. The red banner contains the text 'RECOMMENDATIONS FOR THE MANAGEMENT OF CRUSH VICTIMS IN MASS DISASTERS'. Below the banner is a photograph of a disaster relief scene with people in orange uniforms and a dog. At the bottom, it lists the 'Work Group Co-Chairs: Mehmet Sukru Sever and Raymond Vanholder'. Logos for Oxford Journals and the European Renal Association-Eurodialysis and Transplant Association are at the bottom.

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