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RECOMMENDATIONS FOR THE MANAGEMENT OF CRUSH VICTIMS IN MASS DISASTERS

(SHORT FIELD VERSION)

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PREFACE

Crush syndrome is a preventable cause of death after earthquakes. This short guide summarizes appropriate therapy in chaotic field conditions. The recommendations are based on expert judgment and retrospective analyses as no prospective trials have been conducted on treatment of crush victims. For the sake of simplicity and clarity, no rationale is provided. For additional details and rationale the reader is referred to the full text of these recommendations (Sever MS, Vanholder R and the workgroup on Recommendations for the Management of Crush Victims in Mass Disasters. *Nephrol Dial Transplant* 2012; 27 (Suppl 1), i1–i67.)

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SECTION I: INTERVENTIONS BEFORE AND DURING EXTRICATION

I.1. Personal safety

- Ensure safety of your own family prior to participation in relief operations.
- Do not participate in extrication of victims from partially or totally collapsed buildings, but focus on support and treatment of already rescued victims.

I.2. Intervention before extrication

- Begin medical evaluation as soon as contact is established, even before extrication, if possible.
- Early fluid administration is critical to prevent rescue death and crush syndrome; initiate intravenous isotonic saline through a large bore cannula in any accessible vein at a rate of 1000 ml/h in adults; 15–20 ml/kg in children (Fig. 1).
- Rate may need adjustment considering age (less in older victims); body weight (less in lighter patients); trauma pattern (less if affected muscle mass is small); ambient temperatures (less with cold climate); urinary volume (less in oligo-anuria) and duration of entrapment (less in extremely longer entrapped).
- Consider hypodermoclysis by isotonic saline at a rate of 1 ml/min, if no intravenous access is available.
- Avoid potassium-containing solutions.

I.3. Intervention during extrication

- Plan timing of extrication in collaboration with rescue workers.
- Continue isotonic saline infusion during extrication.
- Reevaluate victims during extrication process.
- If extrication time is >2 h reduce saline infusion rate to 500 ml/h, considering that the requirements may be influenced by victim condition, ongoing fluid losses, urine production and ambient temperature (Fig. 1).

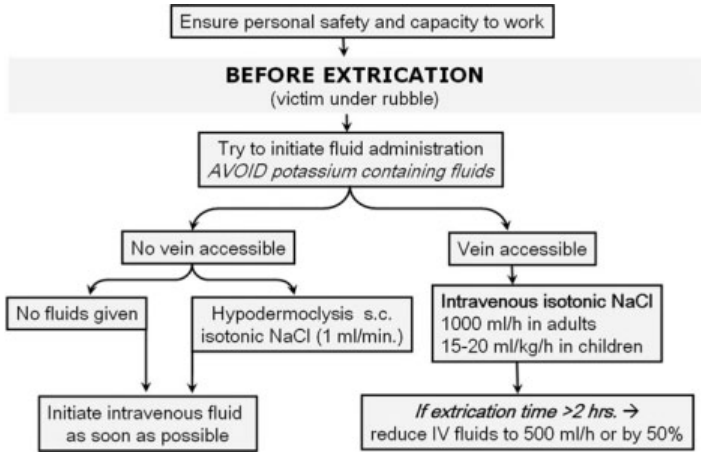

Fig. 1. Management of the victims while under the rubble.

SECTION II. INTERVENTIONS AFTER EXTRICATION

- Remove extricated victims away from site of structural collapse as quickly as possible.

II.1. Triage victims:

- If victim is alert, oriented and moving all extremities, conclude that the airway is patent, oxygenation is adequate, and there is no major central neurological injury.
- If the patient is unresponsive or has visible, potentially life-threatening trauma, consider prevailing logistic circumstances and medical factors to decide to *treat* or *not to treat on the spot*.
- Make maximum attempt to ensure victims with a low potential of survival triaged to non-active treatment.

These concerns are valid only for mass disasters; apply routine standards of care in small scale disasters, where problems can be coped with more easily.

- Apply principles of prehospital care (Table 1; Fig. 2).

Table 1. Treatment and evaluation of the victim by primary survey* at the disaster field

Primary survey	Problems to be taken into account	Intervention
Airway	- Consider that airway may be compromised	- Maintain airway patency; protect cervical spine
Breathing	- Consider that ventilation may be impaired secondary to dust or noxious gas inhalation and/or direct trauma	- Protect the patient from dust by applying a dust mask - Limitation of available space may interfere with safe intubation - Supplying oxygen may be limited by safety constraints - Analgesia may aid breathing in patients with broken ribs
Circulation	- Exclude dehydration - Assume the presence of crush injury unless definitely excluded - If the victim has been trapped for a long time and is still alive, assume there is probably no major active bleeding	- Control external bleeding - Assess volume status and then administer as much fluid as possible considering medical circumstances and logistic possibilities
Disability	- Consider neurologic examination may leave relevant lesions unrecognized	- Install or maintain spine protection
Exposure	- Consider the possibility of hypothermia - Expose body parts only if deemed absolutely necessary for saving life	- Cover, if exposed, to avoid hypothermia

**Primary survey* is a well-established protocol based on the mnemonic A.B.C.D.E., which allows for quick recognition of life-threatening injuries, and the prioritizing of treatment among victims encountered simultaneously.
Abbreviation. IV, intravenous.

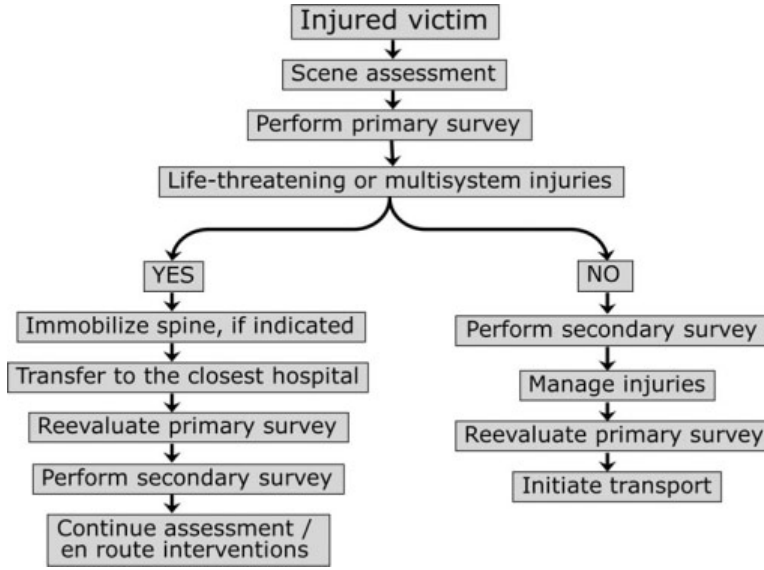

Fig. 2. Overview of prehospital care at the disaster field.
**Secondary survey* is a detailed evaluation of the trauma patient. At the disaster field, it consists of a quick but thorough check-up of the entire body to detect and treat any injuries overlooked during the primary survey.

II.2. General approach to victims early after extrication

- Perform *'primary survey'* to determine patient condition, injuries, urgent interventions required (Table 1).

II.3. Specific approach to crush victims after extrication

- Continue fluid resuscitation to prevent crush syndrome and acute kidney injury (AKI). Target of early fluid protocol is: 3–6 L of isotonic saline within the first 6 hours of victim contact (Fig. 3).
- When no urine flow is observed following appropriate fluid resuscitation, insert a Foley catheter if no contraindication is present (i.e. urethral laceration, characterized by bleeding from the meatus). Leave the catheter in place until good urine output has been ensured or oligoanuria is persistent. Ensure sterile insertion.
- Consider ambient temperature, time spent under the rubble, access to drinking water, and practical possibility for frequent re-assessment in determining ongoing fluid requirements.

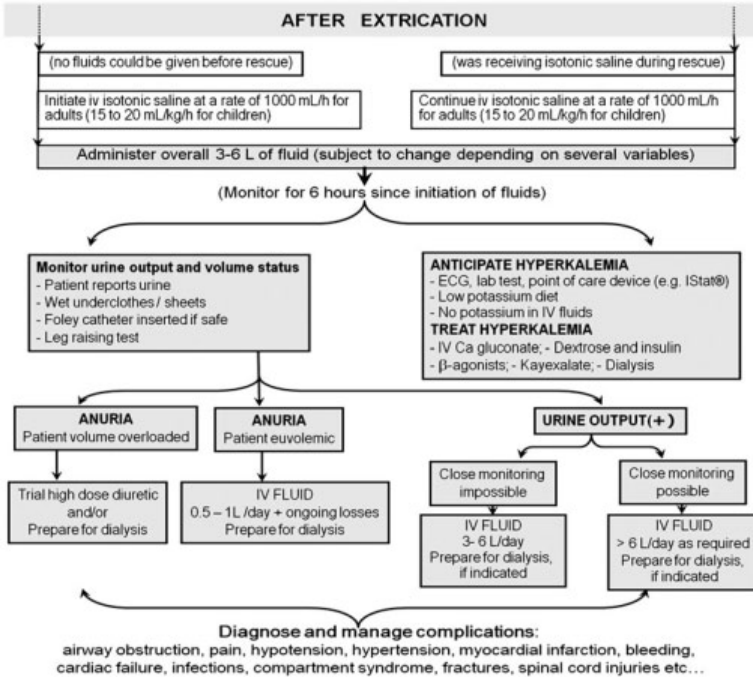

Fig. 3. Algorithm for specific approach to crush victims after extrication.

- Monitor hydration status by clinical examination. Check peripheral perfusion, blood pressure, heart rate, orthostasis, skin, lungs, edema and jugular venous pressure.
- Victims trapped for prolonged periods without hydration are at high risk of having established AKI. Re-evaluate fluid status frequently during hydration to avoid volume overload.
- Once AKI has been prevented, continue fluid administration until urine output and color normalizes.
- Adjust fluid composition if possible and appropriate (Table 2).

Table 2. Intravenous fluids that can be used in disaster crush victims

	Solution (1000 ml)	HCO3 to be added	Mannitol to be added	Advantages	Drawbacks	Notes
Crystalloids	Isotonic saline	N/A	N/A	- Very effective - Readily available	- Volume overload, hypertension, and acidosis	- Preferred solution
	Isotonic saline + 5% Dextrose	N/A	N/A	- Supplies calories - Attenuates hyperkalemia	- Similar to isotonic saline - Mostly not available	- Should be preferred, if available
	Half-normal saline + bicarbonate*	50 mmol to each liter	N/A	- Effective for alkalinizing the urine, correcting metabolic acidosis, and reducing hyperkalemia	- Symptomatic alkalosis, calcium deposition in soft tissues, worsening of hypocalcemia	- Administer to all victims in small scale disasters. - Average need for HCO3 is 200-300 mmol/day.
	Mannitol-alkaline solution* (Basal solution: half-normal saline)	50 mmol to each liter	50 ml 20% mannitol to each liter	- Expands volume, promotes diuresis, decreases intracompartmental pressure	- Congestive heart failure in case of overdose, and potential nephrotoxicity	- Contra-indicated in anuric patients; consider only if close monitoring is possible - Usual dosage of mannitol is 1 to 2 g/kg per day [total, 120 g/day] at a rate of 5 g/h
Colloids	Albumin	N/A	N/A	- Expand extracellular volume effectively	- No major benefit on mortality - Higher risk of side effects (anaphylaxis, coagulation abnormalities, tubular injury) and higher costs	- Do not select them for volume resuscitation in disaster crush victims
	Hydroxyethyl-starch (HES)*	N/A	N/A			

- *Test dose of mannitol*: give 60 ml of 20% mannitol iv over 3–5 min.
- Stop it if no significant increase in the urine output.
- Continue it if urine output increases by 30–50 ml/h above baseline.

Abbreviation: N/A, not applicable

SECTION III. OTHER MEASURES TO BE TAKEN AFTER EXTRICATION (TABLE 3)

- Diagnose and treat concurrent medical complications.
- Expect hyperkalemia at all times. If laboratory testing is not available, utilize point-of-care (iSTAT^{R}) devices or ECG.

Table 3. Treatment of life-threatening of serious complications at the disaster field in the crush victims of mass

Complication	Treatment	Comments
Airway obstruction	- Jaw thrust, Mayo cannula providing free airway, aspiration of secretions, administration of oxygen, tracheal intubation (if possible)	- Consider as first-line measures because of their life-saving capacity. - Transport to a hospital as early as possible.
Pain	- Narcotics, ketamine	- Give morphine IV since the response to IM morphine is unpredictable. - Do not use NSAIDs for analgesia.
Hypotension	- Administration of IV fluids, transfusion of blood or blood products. - Treatment of ischemic heart disease, electrolyte abnormalities and infection(s)	- Stop active bleeding by any means. - Need for fluids may be high in crush cases because of sequestration in the tissues.
Hypertension	- Calcium antagonists and nitrates - Diuretics in victims with urine production	- Avoid excessive fluid administration in oligoanuric victims. - Psychologic support is helpful in patients with severe stress.
Myocardial ischemia and infarction	- Relief of pain, treatment of hypertension and anxiety, administration of short acting nitrates, oxygen inhalation	- Transport to a hospital as early as possible.
Left ventricular failure	- Short acting nitrates, diuretics, oxygen	- Place in a sitting position. - Transport to a hospital as early as possible. - Application of intermittent venous tourniquets may be useful.

Abbreviation: NSAID, nonsteroidal anti-inflammatory drug

SECTION IV. TRANSPORT OF VICTIMS

- Once stabilized, prepare the patient for transport to field or conventional hospitals as soon as possible.
- Weigh time required to perform minor procedures e.g. splinting of minor fractures and bandaging of wounds, against the advantages of immediate transport.
- During transport, ensure full spinal immobilization for patients with spinal trauma.
- Administer pre-emptive kayexalate to avoid fatal hyperkalemia.

SECTION V. MAIN POINTS OF FOCUS AND RESPONSIBILITIES AFTER A MASS DISASTER

Table 4. Main Points of focus and responsibilities at the disaster field or field hospitals for health care providers after a mass disaster

Global tasks	Specific
Determination of personal status	- Resolve own disaster-related problems and make a plan for the requirements of own family - Inform the coordinating authorities if unable to function in general relief
Intervention before extrication	- Consider own safety when approaching damaged buildings - Begin medical evaluation of entrapped victims as soon as contact is established - Start a 1000 ml/h infusion of isotonic saline even before extrication, if possible
Intervention during extrication	- Re-evaluate victims during the progress of extrication, if possible - Continue isotonic saline administration at a rate of 1000 ml/hr for the first two hours in adults, and 15-20 ml/kg in children - Adjust the rate of fluids not to exceed 500 ml/hr in adults, if extrication takes longer than 2 hours
General approach to the victim after extrication	- Remove the victim as quickly as possible from the site of structural collapse - Check vital signs and perform a 'primary survey' - Perform triage - Treat any life-threatening emergency - Perform a 'secondary survey'
Fluid administration and urinary volume monitoring after extrication	- Continue (or initiate) isotonic saline at a rate of 1000 ml/hr, in adults - Consider ambient conditions to determine fluid needs - Insert an indwelling bladder catheter to monitor urine output
Other measures to be taken after extrication	- Treat problems other than crush injury, i.e. airway obstruction, respiratory distress, intractable pain - Diagnose and treat hyperkalemia as early as possible - Prepare the patient for transport to a hospital once stabilized