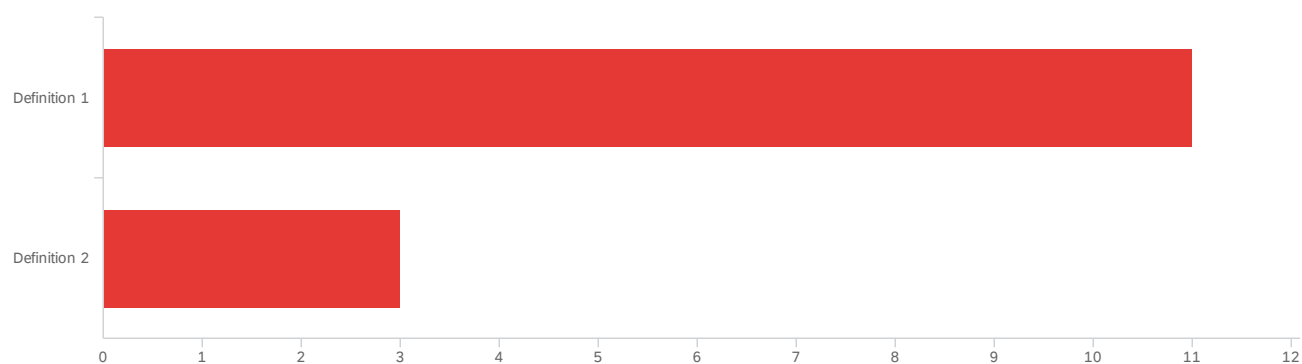


Q2 - Crush Syndrome Definition In Round One, 33% of participants entered free text responses with a new definition (this has been compiled and summarized as Definition 1 presented here). In Round One, 47% of participants selected Definition 2, which was derived from the literature. The following are updated definitions for crush syndrome:

Definition 1: Crush syndrome is the systemic manifestation of extensive skeletal muscle damage, due to the disruption of cellular integrity and release of its contents into circulation. It manifests as haemodynamic and metabolic disturbances, and can result in acute kidney injury, multisystem organ dysfunction or death. Definition 2: Crush syndrome is the systemic manifestation of crush injury, which can result in acute kidney injury, multisystem organ dysfunction or death. What is your preferred definition for crush syndrome?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Crush Syndrome Definition In Round One, 33% of participants entered free text responses with a new definition (this has been compiled and summarized as Definition 1 presented here). In Round One, 47% of participants selected Definition 2, which was derived from the literature. The following are updated definitions for crush syndrome: Definition 1: Crush syndrome is the systemic	1.00	2.00	1.21	0.41	0.17	14

#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
	<p>manifestation of extensive skeletal muscle damage, due to the disruption of cellular integrity and release of its contents into circulation. It manifests as haemodynamic and metabolic disturbances, and can result in acute kidney injury, multisystem organ dysfunction or death. Definition 2: Crush syndrome is the systemic manifestation of crush injury, which can result in acute kidney injury, multisystem organ dysfunction or death. What is your preferred definition for crush syndrome?</p>						

#	Field	Choice Count
1	Definition 1	78.57% 11
2	Definition 2	21.43% 3

Q4 - Anaerobic vs. Aerobic Mechanisms of Crush One of the participants provided the following comments: "Myorenal syndrome or myonephropathic syndrome can be classified as aerobic and anaerobic. [The aerobic type] occurs after whipping, or when patients sustain multiple crush injuries to muscles and soft tissues; no ischaemic component is present. The anaerobic type occurs when a limb has been ischaemic for several hours and is then reperfused (e.g. when a tourniquet has been on a leg and is then released, or when a leg has been entrapped under collapsed building rubble and is then freed). In both types, myoglobin is released into the circulation, with nephropathy to follow. However, in the anaerobic type, products of ischemia-reperfusion are also released into the circulation, which can cause multiple organ failure and death (sometimes very rapid death). It is important to distinguish between these two categories, and a single predictive model should not be used for both." Do you agree with this participant's sentiment that patients with ischemia-reperfusion injury are inherently different? Based on your experience, how does ischemia-reperfusion injury influence a given patient's clinical course and outcomes?



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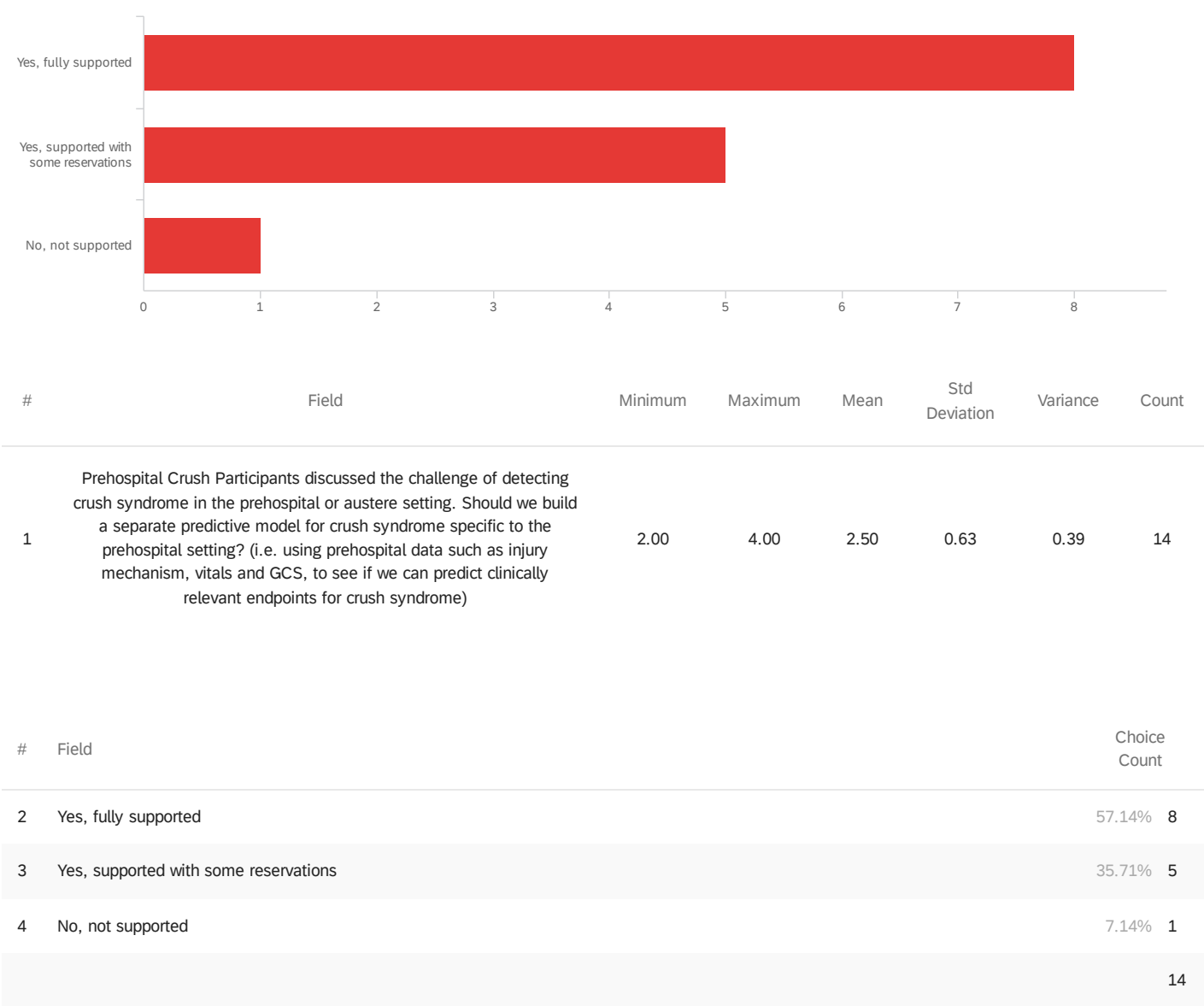


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Q3 - Prehospital Crush Participants discussed the challenge of detecting crush syndrome in the prehospital or austere setting. Should we build a separate predictive model for crush syndrome specific to the prehospital setting? (i.e. using prehospital data such as injury mechanism, vitals and GCS, to see if we can predict clinically relevant endpoints for crush syndrome)



## Q3.1 - Please provide your rationale for your above response regarding prehospital crush syndrome prediction.

Please provide your rationale for your above response regarding prehospital...

The important point here is actually the history of muscle tissue that has been subjected to physical trauma. With this history, I think the concepts of hypotension and hemodynamic instability without bleeding in the early period are important. As a result, due to CRUSH syndrome, a distortive shock clinic occurs in the early period in patients (vascular permeability increases, vasodilation occurs, etc.) It is necessary to recognize and manage this type of shock before hospitalization. For this purpose, there is no obstacle in the evaluation of the patient as Crush syndrome if muscle trauma in the history, vital parameters in the early period are compatible with shock and the clicks are compatible with shock, conditions such as bleeding and CNS damage are ruled out in the patient. Translated with DeepL.com (free version)

While some modalities are not available in the prehospital setting, and for this reason supported, I am cognisant of the issues of having more than one standard.

to improve the quality of patient care

Prehospital Specific endpoints and guidelines are always invaluable. However, emergency care in the prehospital milieu is offered as part of the continuum of care, this is to say that prehospital provides are often called upon to enter early, middle and late into this journey. a prehospital specific tool may only be useful in the immediate phase- its value may decrease during the healthcare journey. Should we therefore not calculate prehospital provides with what has already been established as clinical indicators? POC testing ?

I think the predictors will be too non-specific to attribute to a diagnosis of crush syndrome in the pre-hospital setting.

This will assist in guiding management in the rural setting as well as acute setting leading to cost effective practice, decreased length of stay ect.

Pre-hospital settings, particularly in rural or austere environments which imply patients are geographically far from definitive diagnosis and treatment. Starting treatment earlier based on the likelihood of a crush syndrome may help achieve better outcomes

As prehospital teams have limited resources, they should have a simplified predictive model, to identify or predict crush syndrome and therefore will determine which institution will be appropriate to manage the patient.

A lack of any lab values greatly reduces prediction in the case of prehospital and not sure if there is a relevant intervention available that could be given based on predicted outcome.

Not all injuries would be associated with a high risk of crush syndrome. Therefore, it would be important to note in whom a crush injury protocol should be instituted by first responders.

not sure how sensitive and specific such an assessment would be beyond what is done currently. It may not be much more beneficial

A prehospital predictive tool would be invaluable to earlier diagnosis, guide early treatment and decide early on if a higher/lower level of care is appropriate. Loss of time due to delays in facilities awaiting for transfer could be avoided. Also, as treatments for crush vary by facility it would be helpful to start heading in a unified direction - with the first step being making the diagnosis in a consistent way using new informed tools.

time of transfer, fluids initiated at scene, entrapment, time from injury to EMS arrival

We need one for military purposes where laboratory testing is limited

## Q5.1 - Please describe 1 or more clinical scenarios involving crush injury patients where you feel confident discharging the patient within the first 4 to 6 hours of their emergency department visit.

Please describe 1 or more clinical scenarios involving crush injury patient...

We have recently presented an effective algorithm for decision-making on this issue after the February 6 earthquakes. We developed an exclusion criterion that decides the need for dialysis in the early period with the history and blood parameters at the first presentation of the patient. Today, it is used in Emergency Departments in all MCIs including earthquakes in Turkey. We think it is important to include these criteria in this study. I share the research with you below: - Yilmaz S, Cetinkaya R, Ozel M, Tatliparmak AC, Ak R. Enhancing Triage and Management in Earthquake-Related Injuries: The SAFE-QUAKE Scoring System for Predicting Dialysis Requirements. Prehospital and Disaster Medicine. 2023;38(6):716-724. doi:10.1017/S1049023X23006453

.

A patient sustains a crush injury to the forearm with minor soft tissue damage but no open wounds, severe bruising, or swelling. The patient reports pain but can move all fingers and has no numbness or tingling in the hand.

4-6 hours of their ED visit does not necessarily imply that they would have been screened/assessed/ managed- waiting and assessment/work up times vary. A large proportion of patients visit the ED to have a police document completed by a physician- required for opening up a case of assault. Prolonged entrapments, owing to MOI are referred up to tertiary level( direct trauma referral pathway). These instances, in the absence of significant injuries create a backlog for purposeful units. Owing to this notion, I am very cautious with this notion of identifying clinical scenarios- context and condition preferred

not applicable to myself

In a patient with history of minor injuries and no hematuria at 6 h after injury will mostly be discharged without further investigation in the rural/austere setting.

Fully awake, alert, mobilising, haemodynamically stable, no haematuria, normal Creat and bloodgas parameters. Able to continue oral hydration and means of follow-up available.

a patient with microscopic hematuria or not with a normal blood agas and a normal creatine (normal kidney function)

I would feel confident to discharge a patient with isolated injury, normal mental status, normal or minimally elevated CK.

Low risk mechanism of injury in patients who have received isotonic intravenous fluids at the scene (prehospitalization) and no clinical evidence of muscle swelling or myalgia, and no laboratory evidence of hemoconcentration (in patients who did not receive intravenous fluids) or hyperkalemia. Absence of hemoglobin/myoglobin on urine dipsticks.

Early presentation, good history, good urine output and trace myoglobin on urine dipstix. Also ability to return easily enough.

A participant that has mostly soft tissue injuries, where injury occurred at least more than 12 hours ago, no change in GCS, not intoxicated, remains mobile, has ingested fluids and can prove adequate fluid intake independently and who has an initial normal creatinine, CK, blood gas and urine dipstick. Same patient as above, but normalisation of investigations occur within 6 hours.

a patient with: CK < 2500, normal UKE, normal GCS

Please describe 1 or more clinical scenarios involving crush injury patient...

Minor crush injuries that are ambulatory and making urine that can be appropriately risk stratified



## Q5.2 - Please describe clinical scenario(s) involving crush injury patients where you feel confident that a patient will require hospitalization.

Please describe clinical scenario(s) involving crush injury patients where...

We have recently presented an effective algorithm for decision-making on this issue after the February 6 earthquakes. We developed an exclusion criterion that decides the need for dialysis in the early period with the history and blood parameters at the first presentation of the patient. Today, it is used in Emergency Departments in all MCIs including earthquakes in Turkey. We think it is important to include these criteria in this study. I share the research with you below: - Yilmaz S, Cetinkaya R, Ozel M, Tatliparmak AC, Ak R. Enhancing Triage and Management in Earthquake-Related Injuries: The SAFE-QUAKE Scoring System for Predicting Dialysis Requirements. Prehospital and Disaster Medicine. 2023;38(6):716-724. doi:10.1017/S1049023X23006453

A patient presents with a crush injury to multiple body parts after a severe accident. The patient is alert but reports muscle weakness, dark urine, and generalized pain. These symptoms suggest rhabdomyolysis, a condition where damaged muscle tissue releases its contents into the bloodstream. Laboratory tests confirm elevated creatine kinase (CK) levels, indicative of muscle breakdown, and the patient's urine tests positive for myoglobin. Kidney function tests are abnormal, suggesting acute kidney injury. The patient requires hospitalization for aggressive fluid resuscitation to prevent kidney damage, monitoring of electrolyte levels, and potentially dialysis if kidney function deteriorates. This scenario requires interdisciplinary management, including nephrology and possibly surgery, depending on the extent of the injuries.

### Community assaults

Not applicable to me, but I have noted cases where, based on physical examination alone, I thought that the patient's outcomes could have been different if they had received medical attention. One case involved a young male who had been repeatedly beaten with whips and poles and sustained multiple blunt-force injuries to his back, arms, legs, and buttocks. There were no visible open wounds or visceral injuries, but he had extensive muscular injuries and soft tissue haemorrhage.

History of extensive blunt trauma, hematuria present, arterial blood gas: PH < 7.2 in the austere setting will be admitted and managed as crush syndrome while awaiting CK bloods and renal function ect.

The obviously critically injured requiring ventilatory support, and/or dialysis. Patients with haematuria, upgoing creatinine, oliguria or anuria Haemodynamic instability or fluctuations Requiring significant parenteral fluid hydration Initial abnormal vital signs: tachycardia, hypotension, decreased LOC Comorbidities Multi-trauma

A patient with extensive injuries , with coke like urine, metabolic acidosis and Aki

Patient will require hospitalization if they have injuries, a decrease in mental status for any reason, Initial CK greater than 5000, Ischemia from a tourniquet or vascular injury lasting more than two hours.

A patient who remains oliguric despite adequate volume resuscitation.

No/little urine output with frank haematuria, deranged kidney function and clinical presentation

A participant that has soft tissue injuries in addition to long bone injuries, ischaemic-type injuries still in evolution, recent injury possibly still in evolution, an altered GCS inclusive of intoxication, immobile, unwilling or unable to take PO fluids independently, creatinine abnormalities at presentation, abnormal investigations that do not normalise.

any abnormal UKE on presentation and/ or CK > 5000 and/or any features of oliguria/ anuria after 6hrs

Major crush in the setting of polytrauma requiring other interventions for treatment



## Q5.3 - Please describe clinical scenario(s) involving crush injury patients where you experience the greatest uncertainty about the triage decision.

Please describe clinical scenario(s) involving crush injury patients where...

We have recently presented an effective algorithm for decision-making on this issue after the February 6 earthquakes. We developed an exclusion criterion that decides the need for dialysis in the early period with the history and blood parameters at the first presentation of the patient. Today, it is used in Emergency Departments in all MCIs including earthquakes in Turkey. We think it is important to include these criteria in this study. I share the research with you below: - Yilmaz S, Cetinkaya R, Ozel M, Tatliparmak AC, Ak R. Enhancing Triage and Management in Earthquake-Related Injuries: The SAFE-QUAKE Scoring System for Predicting Dialysis Requirements. Prehospital and Disaster Medicine. 2023;38(6):716-724. doi:10.1017/S1049023X23006453

An elderly patient with a history of diabetes and peripheral neuropathy sustains a crush injury to the foot. The patient reports minimal pain, possibly due to neuropathy, but there is visible bruising and swelling. The presence of pre-existing conditions complicates the assessment. The patient's reduced pain sensitivity might mask the severity of the injury, and their comorbidities could increase the risk of complications such as infection, delayed healing, and even compartment syndrome without typical symptoms. The decision to admit for close monitoring and aggressive management of potential complications versus outpatient management with close follow-up is challenging. The risk of complications needs to be weighed against the patient's ability to manage at home and access to follow-up care.

Burns and poly trauma mass casualty context- clinical needs of patients versus availability of beds and facility capacity

Not applicable to me.

Acute injury- blunt trauma history where extent of injuries may be difficult to establish on history (various reasons for this- language barrier or intoxicated patient...) , extent of injuries may also be difficult to establish due to short period since time of injury, no hematuria on presentation.

Initial abnormal vital signs: tachycardia, hypotension, decreased LOC that responds favourably within 4-8 hours

A patient with extensive injuries microscopic hematuria, normal blood gas, normal creatinine function or mild renal impairment

Patients with obtunded mental status, patient with initial CK between about 1000 and 5000

Unable to answer as all patients referred to me has established AKI.

delayed presentation, dark pigmentation and large overweight patient. urine output and kidney function reasonable or minor derangement.

Very recent injury which may still be in evolution (ie falsely normal investigations), intoxicated patients, those with abnormal or borderline CK and blood gas anomalies.

CK > 5000 with normal UKE

Crush in the setting of hemorrhage where both crystalloid and blood are needed

## Q5.4 - In light of the above responses, what patient population should the crush clinical decision tool target?

In light of the above responses, what patient population should the crush c...

The decision algorithm for crush syndrome should focus on the decision phase in the initial processes of the emergency department.

Given the complexity and variability of crush injuries, as well as the scenarios outlined above, the crush clinical decision tool should ideally target a patient population that falls within the intermediate risk category. This approach can help healthcare providers navigate the uncertainties and intricacies of triage decisions for those who do not clearly require immediate discharge or hospitalization. Specifically, the tool should focus on: Patients with Unclear Extent of Injury: Those who present with symptoms and signs that do not clearly delineate the severity of the crush injury. This includes patients without overt signs of compartment syndrome or systemic involvement but who may have underlying tissue damage, minor fractures, or are at risk of developing complications. The tool could aid in assessing the likelihood of such complications, guiding the need for further diagnostics, observation, or specialist consultation. Patients with Complicating Factors: Individuals with pre-existing conditions (such as diabetes, peripheral vascular disease, or neuropathy) or other factors (such as age or polypharmacy) that may obscure symptoms and increase the risk of complications. The decision tool can help in evaluating how these factors impact the risk profile of the injury and guide decisions regarding observation, further evaluation, or proactive management. Patients with Moderate Injuries and Potential for Worsening: Those who have sustained injuries that, while not immediately life-threatening, have the potential to worsen without appropriate intervention. This includes patients with injuries that might not yet show signs of severe complications like rhabdomyolysis or compartment syndrome but are at risk due to the nature and location of the injury. Patients Requiring Multidisciplinary Assessment: Patients whose injuries may benefit from the input of multiple specialties, such as orthopedics, plastic surgery, nephrology, or mental health services. The tool could help identify the need for such assessments and prioritize referrals. By targeting this intermediate risk patient population, the crush clinical decision tool can serve as a critical resource for healthcare providers, helping to stratify patients based on the severity of injury, potential complications, and the need for specialized care. This focus will enable more nuanced and informed triage decisions, optimizing patient outcomes and resource allocation. It will also facilitate the early identification of patients who, although not immediately apparent, may require hospitalization or specialized interventions, as well as those who can safely be managed through outpatient care with appropriate follow-up.

Tools guide and provide suggestive pathways- they can't replace clinical gestalt and reasoning. For this purpose, it may be beneficial to cast a wide net and use it for all patients within this category. Measuring effectiveness, up take and influence on clinical behaviour would direct the targets thereafter

Patients with a history or clinical features of blunt force trauma or limb possible traumatic limb ischemia where the history, examination, and side room tests are suggestive.

As described above- patient presenting recently after injury where history may not be reliable and bruising may not reflect the extent of the injury a decision making tool to assist cost effective and time effective management of patients- more specifically to assist with decisions as to who can be discharged at time of presentation without needing a blood gas and further monitoring.

As above. Subgroup that cannot be immediately discharged and not meeting criteria for RTT

1.A patient with extensive injuries, with coke like urine, metabolic acidosis and Aki 2. A patient with extensive injuries microscopic hematuria, normal blood gas, normal creatinine function or mild renal impairment

Is there an initial CK level that allows safe discharge? I would target those with obtunded mental status, because the lack of reliable physical exam findings and pain make the diagnosis much more difficult.

All patients with suspected crush injury should be included.

the more difficult diagnostic patient (admission or not?)

In light of the above responses, what patient population should the crush c...

It would be most helpful to have a tool that decides discharge versus observation. Therefore, evaluate those patients with fairly recent injury, where crush is suspected to be 'in evolution' and with grey area results - CK, creatinine, blood gas not severely worsened but also not normal. In the end to decide/predict what the 'peak' metabolic derangement is expected to be and whether this needs in-hospital or higher level intervention.

High CK (>5000) without any features of renal impairment as yet

Young, healthy trauma patients that otherwise be risk stratified to a lower resource setting (e.g. floor instead of ICU) or discharged home

## Q6.1 - What history and exam findings suggest that the patient is likely to have a full recovery from the crush injury without any specific interventions?

What history and exam findings suggest that the patient is likely to have a...

I don't think there is such a finding.

History Time Since Injury: As the injury occurred about 12 hours ago, understanding the progression of symptoms since the incident is crucial. A lack of worsening symptoms is a positive sign. Mechanism of Injury: Details about the assault, such as the type of blunt objects used and the force applied, can provide insight into the potential severity of the injuries. Symptom Progression: Stability or improvement in pain and swelling, without the development of new symptoms, suggests a lower risk of severe complications. Previous Health Status: A history of good health and absence of pre-existing conditions that might complicate recovery, such as diabetes or peripheral vascular disease. Physical Examination Vital Signs: Stability in vital signs, including blood pressure, heart rate, and respiratory rate, without signs of shock or distress. Inspection and Palpation of Injured Areas: Absence of significant swelling, bruising that is not expanding, and the absence of severe tenderness could indicate minor soft tissue damage. Range of Motion and Strength: The ability to move the affected areas without significant pain or limitation suggests minor injury. Neurovascular Assessment: Normal sensation, color, and temperature of the skin below the injury site, alongside palpable pulses, indicate no neurovascular compromise. Compartment Assessment: No signs of compartment syndrome, such as extreme pain, pain with passive stretch of muscles, or a firm and swollen compartment. Recovery Indicators Pain Management: The patient's pain is manageable with non-opioid analgesics, and pain does not significantly increase with movement. Functional Ability: The patient can perform basic activities of daily living, indicating that the injury's impact is minimal. No Signs of Systemic Involvement: Absence of symptoms like fever, chills, or disorientation that might suggest a systemic response to the injury.

History: Assault with minimal force : the patient describes minimal discomfort and no physical dysfunction. The patient is eating, drinking, and passing urine normally. Exam findings: Normal vital signs Normal dipstick No swelling, erythema, induration, bruising or skin discolouration.

Only a single blow to the thigh only. Minimal bruising and no findings suggesting development of haematoma or fluid collection- no tightening of skin and tissue at site of injury. No signs of compartment syndrome. Force not enough to cause fracture, neurological injury or injury to other structures. No hematuria

Fully awake, alert, mobilising Haemodynamically stable No frank or microscopic haematuria on dipstick Able to maintain oral fluid hydration No pain out of proportion or clinical signs of tense compartments

A patient with low ISS, normal blood gas, normal creatinine function

Short blows with blunt objects, would seem to be much less likely to cause a crush syndrome, in comparison to a more prolonged and sustained pressure to a larger area. The thigh can tolerate more swelling without developing compartment syndrome in comparison to the leg.

There is no history of passage of reddish-brown urine following the injury. Patient has not noticed reduced urination. Absence of respiratory distress and Kussmaul's breathing. No tachycardia or bradycardia (hyperkalemia). Absence of clinical features of hypovolemia (normal blood pressure).

light pigmentation with minimal tram tracking or swelling.

History - as noted, no further injury, normal kidney function at baseline Examination - absence of tram-line bruising, normal mobility, unaltered GCS, adequate hydration Other - adequate urine output, normal urine colour

adequate fluid intake, appropriate urine volume & colour (not coke!)

What history and exam findings suggest that the patient is likely to have a...

Normal urine output, normal urine color, normal vital signs

## Q6.2 - What history and exam findings would suggest that this patient would likely require aggressive resuscitation and hospitalization for the crush injury?

What history and exam findings would suggest that this patient would likely...

Hemodynamic instability (blood pressure, rhythm, consciousness)

History Indicators Mechanism of Injury: Reports of significant force or prolonged pressure applied during the assault suggest a higher risk of deep tissue damage. Symptom Progression: Increasing pain, especially pain out of proportion to the apparent injury, or the development of systemic symptoms like confusion, weakness, or fatigue. Delay in Seeking Care: A delay of 12 hours or more before assessment, coupled with worsening symptoms, increases the risk of complications such as compartment syndrome or rhabdomyolysis. Pre-existing Conditions: Existing medical conditions that may complicate recovery, such as kidney disease, diabetes, or peripheral artery disease. Physical Examination Findings Vital Signs: Evidence of shock or dehydration, such as tachycardia, hypotension, or altered mental status. Severe Swelling and Bruising: Expanding or severe bruising, particularly with tight, shiny skin over the injured areas, suggesting underlying damage and the risk of compartment syndrome. Compartment Syndrome Signs: Extreme pain, especially on passive stretching of muscles in the affected area, paresthesia, pallor, paralysis, or pulselessness (the "P"s of compartment syndrome). Evidence of Rhabdomyolysis: Dark or tea-colored urine, a sign of myoglobinuria from muscle breakdown, and generalized swelling or tenderness in the muscles, indicating a systemic response to muscle injury. Systemic Involvement: Signs of systemic inflammatory response syndrome (SIRS) or sepsis, such as fever, tachypnea, or an elevated heart rate, which could suggest an evolving infection or systemic impact of severe muscle damage. Need for Aggressive Resuscitation and Hospitalization Fluid Resuscitation: Evidence of rhabdomyolysis or shock requires immediate fluid resuscitation to maintain renal perfusion and prevent acute kidney injury. Pain Management: Severe pain not relieved by basic analgesics may necessitate more advanced pain management strategies and monitoring. Monitoring for Complications: The need for close observation for the development of compartment syndrome, which may require surgical intervention (fasciotomy) to relieve pressure. Renal Function Monitoring: Signs suggestive of rhabdomyolysis necessitate monitoring and potential intervention to support renal function, including possible dialysis.

Urine colour change Clinical parameters outside normal limits ECG changes .resp system involvement -compensatory

History: Multiple assailants The use of large, heavy objects, metal poles, whips, rods, planks, etc. The patient is unable to mobilize independently due to pain, discomfort, or limitation in movement after assault. Patient has not been passing urine regularly, has had a change in the colour of their urine, and is not eating or drinking. Exam: low BP tachycardia/ bradycardia positive urine dipstick swelling and bruising of the involved areas with tenderness and pain at rest. Signs of dehydration.

Multiple blows with a blunt object with extensive bruising. Force enough to cause injury to surrounding structures. Signs of acidosis. Hematuria present.

Haemodynamic instability and shock Decreased level of consciousness Oliguria or anuria Signs of compartment syndrome

A patient with high ISS, metabolic acidosis and acute kidney injury

Signs and symptoms of compartment syndrome, myoglobinuria, severe pain out of proportion to the apparent injury.

Oliguria, Kussmaul's breathing, bradyarrhythmias, pulmonary edema

dark pigmentation with significant swelling and bruising. very swollen over injured area. history of dark or blood in urine

History - history of abnormal kidney function at baseline Examination - tram-line bruising, immobility, altered GCS, any signs of dehydration Other - inadequate urine output, myoglobinuria

clinically dehydrated, poor urine output, dark urine, extensive muscle injury (limbs usually), confusion, tense compartments, extensive soft tissue



What history and exam findings would suggest that this patient would likely...

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injury

Hemodynamic instability, s/s c/w AKI

## Q6.3 - What history and exam findings would suggest that the patient has a high probability of requiring dialysis?

What history and exam findings would suggest that the patient has a high pr...

Decreased or absent urine output, respiratory distress with given fluid, arrhythmia

.

History Indicators Significant Crush Injury: A history of severe crush injury, especially involving large muscle groups or prolonged compression. Delayed Presentation: A delay in seeking medical care after the injury can increase the risk of complications, including AKI. Dark Urine: Reports of dark, tea-colored, or cola-colored urine, indicating myoglobinuria, a key feature of rhabdomyolysis. Decreased Urine Output: A decrease in urine output despite adequate fluid intake may indicate renal impairment. Pre-existing Kidney Disease: Patients with pre-existing renal conditions are at a higher risk of AKI following rhabdomyolysis. Physical Examination Findings Generalized Muscle Swelling and Tenderness: Indicates extensive muscle damage, which is a risk factor for rhabdomyolysis. Signs of Dehydration: Such as dry mucous membranes or reduced skin turgor, which can exacerbate kidney damage. Vital Signs: Hypotension or tachycardia may suggest hypovolemia, contributing to renal hypoperfusion and AKI. Altered Mental Status: Can be a sign of severe electrolyte imbalances or uremia, indicating renal dysfunction. Laboratory Findings Suggestive of Dialysis Need While not available in a prehospital or austere setting, certain lab findings, if known, can indicate a high probability of requiring dialysis: Elevated Creatine Kinase (CK): Extremely high levels of CK suggest severe rhabdomyolysis. Elevated Serum Creatinine and Blood Urea Nitrogen (BUN): Indicate impaired kidney function. Hyperkalemia: Elevated potassium levels, which can lead to cardiac dysrhythmias, are a dialysis indication. Metabolic Acidosis: Indicates severe acid-base imbalance requiring correction. Myoglobinuria: Direct evidence of myoglobin in urine, suggesting severe rhabdomyolysis.

.

History: No urine output despite adequate intake loss of consciousness Exam: No urine output or decreasing outputs with dark urine and hematuria and adequate input. Generalized anasarca Encephalopathy respiratory distress/ acidotic breathing

Signs of resp involvement- pulmonary oedema Signs of acidosis Decreased urine output

Shock Decreased level of consciousness Oliguria and anuria Requiring ventilatory support

A patient with high ISS, metabolic acidosis, acute kidney injury with worsening creatinine function and anuric or oliguric

Severe myoglobinuria that is not clearing over the first day, severe swelling and pain, hypotension, lack of urine output

Oliguria, Kussmaul's breathing, bradyarrhythmias, pulmonary edema.

altered mental status without obvious head injury (combined with the findings above)

History - history of abnormal kidney function at baseline Examination - persistent altered GCS, persistent neurological deficit Other - persistent low urine output, anuria

delayed presentation/ lack of IV fluids/ peripheral oedema/ pulmonary oedema/ anuria uremic features: frosting, pericardial friction rub, encephalopathy

Anuria despite adequate fluid intake

## Q7.1 - How would you diagnose clinically important renal injury for the patient with crush injury in this scenario?

How would you diagnose clinically important renal injury for the patient wi...

Serum Creatinine Levels, Blood Urea Nitrogen (BUN) Levels, Acid-Base Balance:Electrolyte Levels

Clinical Evaluation: Begin with a thorough clinical assessment, focusing on the extent of the crush injury, signs of rhabdomyolysis (such as muscle tenderness, swelling, and color of the urine), and any indicators of decreased renal function (e.g., reduced urine output, although difficult to track in this scenario, or any signs of fluid overload). Point-of-Care Testing Urine Dipstick: This can be immediately useful for detecting the presence of blood (hematuria) or myoglobin (which may present similarly to hematuria on dipstick) in the urine. Both can be indirect markers of muscle injury and subsequent renal risk. Note that myoglobin itself isn't specifically tested on a urine dipstick, but large amounts of blood without red blood cells on microscopy suggest myoglobinuria. Venous Blood Gas (VBG): Look for signs of metabolic acidosis, which can occur with severe rhabdomyolysis and renal impairment. An elevated anion gap may also be indicative of metabolic acidosis secondary to renal injury. Serum Chemistry Given the limitation of a single serum chemistry panel every 12 hours, prioritize the following tests to assess renal function and risk of injury: Creatinine and Blood Urea Nitrogen (BUN): Elevated levels can indicate renal impairment. Comparing these values with known baseline levels would be ideal, but in their absence, any elevation can be concerning. Electrolytes: Specifically, potassium and phosphate levels, as hyperkalemia and hyperphosphatemia can occur in the setting of rhabdomyolysis and subsequent renal injury. Calcium levels are also relevant, as hypocalcemia can occur early in rhabdomyolysis, with potential later hypercalcemia during recovery. Creatine Kinase (CK): While not a direct marker of renal function, an elevated CK level can indicate significant muscle injury and risk for rhabdomyolysis, leading to renal injury. CBC While a complete blood count is not directly useful for diagnosing renal injury, it can help assess the patient's overall condition, including any evidence of infection or significant anemia that could complicate the patient's status. Clinical Integration Integration of Findings: Combine clinical findings with test results to assess the likelihood of renal injury. Evidence of muscle damage (via CK and urine dipstick) alongside abnormal renal function tests (creatinine, BUN) and electrolyte imbalances consistent with renal impairment would suggest a clinically important renal injury. Monitoring and Decision-Making: Even with limited diagnostics, continuous monitoring of the patient's clinical status, including any changes in symptoms, fluid balance (as possible), and response to initial management, is crucial. Repeat testing within the 12-hour limitation to track trends in renal function and related markers.

Serial vital signs every hour to detect patterns of hypotensions and tachycardia Serial dipstick every hour Serial blood gas every 4 hours to monitor acidemia, lactate levels, bicarb, electrolytes, Hb 12 hourly bloods to confirm progress/ deterioration

Blood gas monitoring- ph, bicarb, k+

Evidence of haematuria on urine dipstick Initial bloodgas parameters abnormal: acidosis, bicarb or electrolyte abnormality, elevated lactate Initial Creatinine elevated or upward trend

To diagnose important renal injury, i will do a dipstick, to determine the color of the urine; if it is dark, it is an indicator of kidney injury. I will give iv fluid, one liter or two of crystalloid and repeat u dipsticks; if persistent microscopic hematuria, I will be concerned for a kidney injury. Urine catheter should be inserted the monitoring of the output as well even though nurses wont monitor rigorously, I will still insert it. I will check CK level and creatine function as well. raised CK with raised creatinine and metabolic acidosis on blood gas will indicate renal injury.

Low urine output, myoglobinuria (Blood on urine dipstick with RBC neg) that does not clear with fluid resuscitation, acidosis, hyperkalemia, rising creatinine

Urine dipsticks for hemoglobinuria and urine specific gravity of <1.012. Blood gas for metabolic acidosis and potassium concentration. Serum potassium and creatinine concentration. Hematocrit and hemoglobin.

urine dipstix +++ blood, Acidotic on blood gas and mild renal derangement

Creatinine level Blood gas - specifically note acidosis and altered bicarbonate

urea, creat level as baseline. VBG to assess: lactate> 2, BE> -2, Bicarb <19

How would you diagnose clinically important renal injury for the patient wi...

— Creatinine, BUN, proteinuria, positive blood on dip, casts

## Q7.2 - Please share your thoughts a practical approach to the diagnosis of clinically important renal injury in resource-limited settings.

Please share your thoughts a practical approach to the diagnosis of clinica...

Yilmaz S, Cetinkaya R, Ozel M, Tatliparmak AC, Ak R. Enhancing Triage and Management in Earthquake-Related Injuries: The SAFE-QUAKE Scoring System for Predicting Dialysis Requirements. Prehospital and Disaster Medicine. 2023;38(6):716-724. doi:10.1017/S1049023X23006453 The above research belongs to me. Please review it for the final answer.

..

In resource-limited settings, diagnosing clinically important renal injury requires a pragmatic approach, focusing on thorough clinical evaluation for signs of muscle damage and renal impairment, such as changes in urine output or color and swelling or tenderness in muscles. Utilize available point-of-care tests like urine dipstick for blood (indicating possible myoglobinuria) and measure serum creatinine and BUN levels if possible, even with limited laboratory access. Electrolyte imbalances, particularly hyperkalemia, should be monitored as they can signal renal dysfunction.

Give the patient a bottle with measuring lines that they can mark to track output if they can track it themselves.

Mostly the only investigation available is blood gas which would guide as to if further referral is needed or may be needed.

Shock Evidence of haematuria on urine dipstick Initial bloodgas parameters abnormal: acidosis, bicarb or electrolyte abnormality, elevated lactate Initial Creatinine elevated or upward trend

A practical approach will be: 1. Collection of urine; determine color: dark urine is an indicator of kidney injury 2. Persistent microscopic hematuria on dipsticks despite IV fluid with crystalloid will also be an indicator of Kidney injury. 3. Insertion of indwelling urine catheter; output should be minimum of 0.5ml per kg per hour. less than that is an indicator of kidney injury.. 4, coupled to high ISS

I think acidosis is the most important finding, it is important to track pH, urine output, and the color of the urine. If the patient continues to worsen in spite of fluid resuscitation, early muscle debridement, to include amputation, is essential to preventing renal failure and death.

Urine dipsticks are freely available, cheap and easily utilized and interpreted. Point of care blood gas machines are also immediately available and can provide several biochemical abnormalities including: Metabolic acidosis (including lactic acidosis or acidosis secondary to AKI) Hemoconcentration (high hb and hct), which occurs early. Hypoxemia due to pulmonary edema Hyperkalemia Hypocalcemia (ionized) If the laboratory offers single chemistry tests every 12 hours, a rising serum creatinine 12 hrs apart will identify cases of AKI.

Cannot comment.

Dipsticks are readily available, but provide very little information on clinically important renal injury. Creatinine levels provide indication of severity and can be monitored for trend, which makes it ideal and is generally available, but result delays may be more than 6 hours. The quickest tool is blood gas, but does not really have a direct measure of renal function rather an inferred renal function looking at pH and bicarbonate - useful and quick, but abnormalities may not necessarily be specific to renal injury.

McMahon score is an easy predictor of patients that may require RRT

Laboratory guided IV infusions that can be titrated to lab data and urine output. It would be useful if we had a tool that could be protocolized so that the physician can be removed from the loop and focus on other tasks that require more in depth focus.

Q8 - optional - Thank you so much for taking the time to respond to the Round 2 survey for this modified Delphi process. Your expertise is greatly valued. We will collate your responses and be in touch regarding a brief third and final round to settle any remaining areas of uncertainty. If you have any further thoughts, questions, or comments, please share below.

Thank you so much for taking the time to respond to the Round 2 survey for...

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just waiting for the feedback

Coming from a prehospital setting, it is difficult to comment on the in hospital scenarios

Thank you for the opportunity, as before - a thought-provoking activity.

**End of Report**