WJA WATER JETTING INJURY TREATMENT ALGORITHM

The WJA Water Jetting Injury Treatment Algorithm© has been developed by Dr Sancho Rodriguez-Villar, the WJA's senior medical advisor, and Dr Robert Charles Kennedy (PhD) , the WJA's clinical research coordinator, after they had led research, commissioned by the Water Jetting Association, into the causes and effects of water jetting injuries, notably high pressure fluid injection injuries.

The research is published in the European Journal of Trauma and Emergency Surgery:
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Dr Sancho Rodriguez-Villar LMS, MSc (EQF 7), PhD cum laude (EQF 8), EDIC, AFICM, an Intensive Care Consultant at King's College Hospital, London, strongly advises all parties to use the WJA algorithm to maximise the chance of recovery from injury and minimise the risk of life-changing injury or death.

Hydraulic fluid injection can occur at pressures as low as 7 bar, or 100 psi, far lower than the pressure achieved by many over-the-counter water jetting machines. Ultra-high-pressure jetting exceeds 1,700 bar, or 24,650 psi.

The WJA is the member organisation for water jetting in the UK. It represents contractors, equipment hirers, sellers, training bodies, and all stakeholders with an interest in water jetting. It is also the UK's leading water jetting training provider. This algorithm is referenced in the WJA's codes of practice.

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Water Jetting Association - Engine House, Veridion Way, Erith, Kent, DA18 4AL, UK

1 FIRST AID AT SCENE
Two approaches to follow

1.

S	Shout for help
A	Assess the scene and approach with care
F	Find the casualty and free them from danger
E	Evaluate the mechanism of injury, then the casualty

2. C-ABC (Catastrophic Bleeding – Airway, Breathing, Circulation) as per ATLS® guidelines

WATER JETTING TRAUMA FIRST AID

1. Apply direct pressure to bleeding wounds.
   Where TRAUMA KIT(s) are available on site, apply pressure using a haemostatic agent (such as Quickclot® or Celox®) and a trauma bandage and/or tourniquet. Otherwise, apply pressure over the bleeding site and elevate the injured limb, where possible.
2. Pack any severed body parts in a sterile cloth or clean plastic bag and chill if possible.
3. Note the time of the injury, nature of the material in the jet and environment. i.e. sewer, industrial site, highway.
4. If clinical circumstance allows, and there is clean water available, wound irrigation should be done. Monitor vital signs if possible.
5. Keep warm, nil by mouth, and reassure casualty.

ARRANGE TRANSFER TO HOSPITAL

Arrange the urgent transfer/evacuation of the patient to a hospital/medical facility nearby in the first instance.

- Initiate evacuation planning at point of injury in advance in remote areas such decks, large footprint chemical refineries, industrial sites, manufacturing sites or oil platforms.
- Confined space extraction protocols to be used, where necessary.
- An air ambulance is likely to be needed.
- An assessment by a trauma or vascular surgeon needs to be organised as quickly as possible.

CLINICALLY UNSTABLE - MULTIPLE WOUNDS

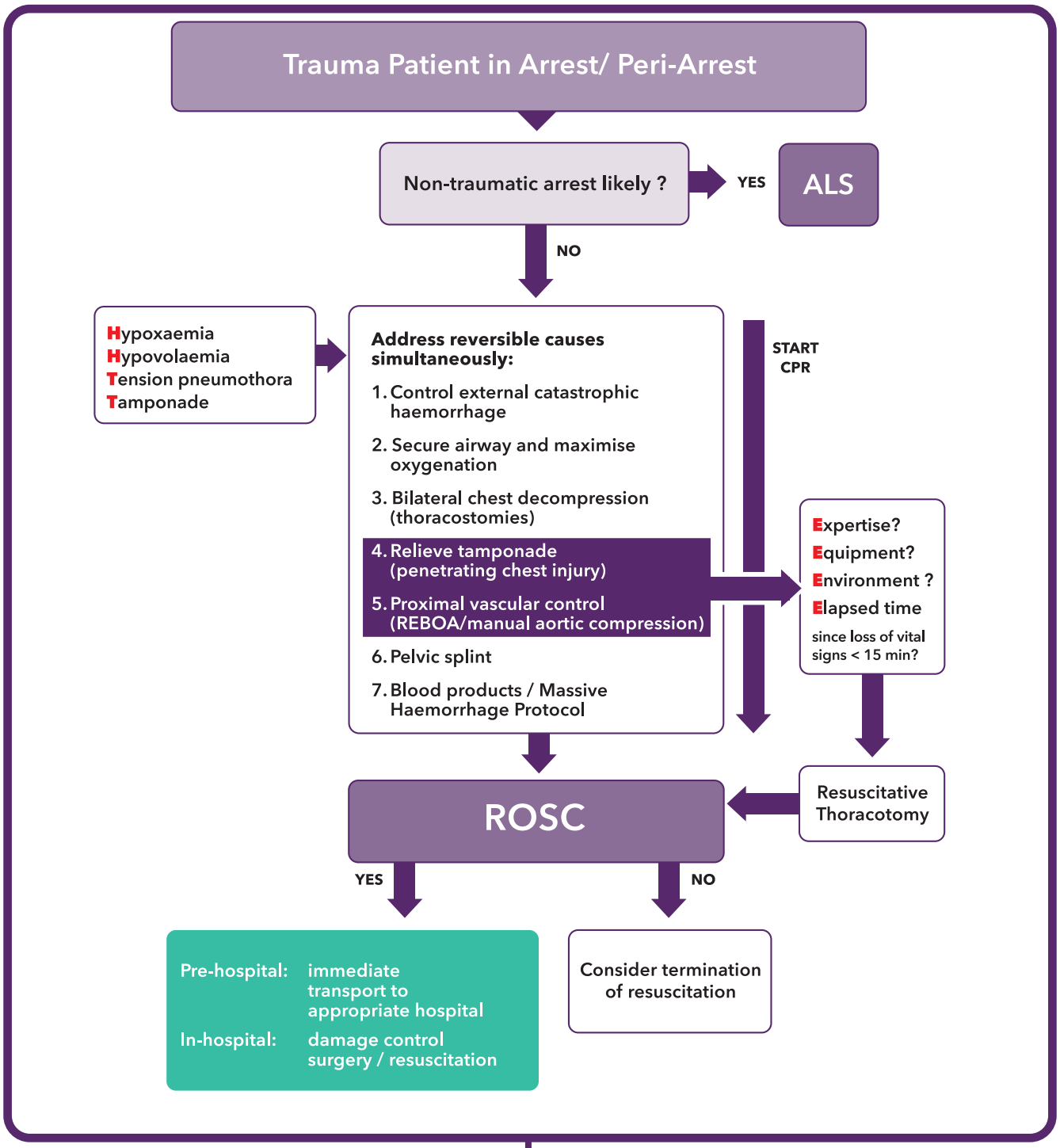
GO TO 2

CLINICALLY STABLE

TRANSFER TO A&E OR EMERGENCY DEPARTMENT

GO TO 4

2 FIRST AID AT SCENE
MAJOR TRAUMA



TRANSFER TO SURGICAL THEATRE
GO TO 3

MAJOR TRAUMA
FROM 2

ACCIDENT & EMERGENCY / EMERGENCY DEPARTMENT
FROM 4 5 6

3 SURGICAL EMERGENCY THEATRE

Arrange the urgent transfer/evacuation of the patient to a hospital/ medical facility nearby in the first instance.

1. Initial **DEBRIDEMENT** and **DECOMPRESSION** should start as soon as an experienced trauma surgeon is available.
2. **WOUND SWABS** and **TISSUE SAMPLES** should be taken and sent for microbiological and histological examination so the presence of fungal spores can be identified.
3. **DECOMPRESSION FASCIOTOMY** of all compartments must be one if the patient is having, or is at high risk of, compartment syndrome.
4. Tissue that is definitely avital must be removed. Traumatised but potentially surviving tissue will be evaluated in a **'SECOND LOOK'** 36-48 hours later.
5. In cases of contamination (often the case), manual wound **IRRIGATION** 3-9 L will be useful, with additives such polyhexanide, octenidine or superoxidised water.
6. **NEVER ATTEMPT PRIMARY CLOSURE**, as this is a contaminated wound. Primary closure only in the case of certain decontamination and overall vitality of the wound. For high grade injuries, a temporary NPWT (negative pressure wound therapy) could be used until the earliest possible definitive plastic surgical wound closure.

TRANSFER TO DISCHARGE
GO TO 7

FIRST AID AT SCENE
FROM 1

4 ACCIDENT & EMERGENCY / EMERGENCY DEPARTMENT

This is initially a CONTAMINATED injury which requires EMERGENCY SURGERY to be performed - until clinically proven otherwise.

Trauma team

- Handover: ATMIST (mechanism, injuries, signs and symptoms and treatment received).
- Primary assessment as per ATLS® guidelines (ideally by surgeon).
- If patient is in shock, all traumatic causes must be considered and treated.

Medical history

- Time of incident.
- Details of the contaminant. Check for paints or solvents and **Exclude** general intoxication.
- Past medical history.
- Allergies.
- Date of last tetanus injection.

Examination

- General examination.
- Examination of the injury site (note the size and site of the entry wound).

Check for local swelling, erythema and skin colour change. Assess the range of movement and tendons function (strength grade) and neurological weakness and numbness. Watch for compartmental syndrome. Wounds must not be surgically explored in ED.

IF NECESSARY, TRANSFER TO EMERGENCY SURGERY
GO TO 3

CONTINUE MEDICAL INVESTIGATION
GO TO 5

CONTINUE INVESTIGATION
FROM 4

5 INVESTIGATIONS

ACCIDENT & EMERGENCY / EMERGENCY DEPARTMENT

Arrange the urgent transfer/evacuation of the patient to a hospital/medical facility nearby in the first instance.

Investigations

- **Imaging**: If patient is haemodynamically unstable: EFAST/ portable pelvic X-ray and chest X-ray can be considered. If patient is haemodynamically stable: a CT-scan can be considered. Always obtain X-rays of the injured area to check for presence of subcutaneous air, foreign bodies or fractures. Preferably, obtain an urgent CT-angiogram scan.
- **Laboratory:**

Basal blood cultures	Liver function tests (LFT)	Clotting (including fibrinogen and calcium levels) especially if it is a haemorrhagic trauma
Cross match	Direct (conjugated) bilirubin	C-reactive protein and creatinine kinase (CK)
Full blood account (FBC)	Hepatitis screening A, B and C	
Arterial blood gas (ABG)	Biochemistry	
Urea & electrolytes (U&Es, BUN)	Basal procalcitonine	

General Management

1. In isolated limb wounds, steroids if there is irritant material (petroleum-based products). Continue for a minimum of 24 hours or up to 7 days, depend of the case.
2. Hydrocortisone 200 mg/IV/ Stat, followed by 50 mg/6h/IV or prednisolone 0.5 mg/kg/OD. Currently, it is not advised on only water injuries.
3. Pain control: morphine boluses 2.5-5mg PRN or ketamine 50-100 mg (as required) IV and an anti-emetic such ondansetron 4-8 mg/6h/IV or cyclizine 50 mg/8h/IV.
4. Preoperative CT-angiogram is advisable IF possible. Distal pulse does not exclude arterial injury in these circumstances.
5. The patient should be taken to theatre for exploration of the injured limb.

IF NECESSARY, TRANSFER TO EMERGENCY SURGERY
GO TO 3

SELECT ANTIMICROBIALS
GO TO 6

SELECT ANTIMICROBIALS
FROM 5

6 ANTIMICROBIALS

ACCIDENT & EMERGENCY / EMERGENCY DEPARTMENT

- **Tetanus status. If uncertain, vaccinate.**

Avoid if severe penicillin allergy, seek specialist advice*	**Antimicrobial prophylaxis**	**Comments**
Patient presenting for immediate debridement after HPWJ injury <24h	Co-amoxiclav 1.2 g/IV/TDS ***Alternative for penicillin allergic patients:*** Cefuroxime* 1.5 g/IV/TDS for 5 days plus Metronidazole 500mg/ IV /TDS for 5 days	Extensive debridement essential. Send samples for culture and sensitivity. Modify treatment according to culture results. Assess need for MRSA cover in areas with high prevalence. Close monitoring and start antifungal if: • Fungal hypahae are seen in tissue after debridement. • Wound becomes infected/ necrotic tissue.
Patient presenting >24h after the injury or with established soft tissue infection	Piperacillin-Tazobactam 4.5g/IV/ TDS plus Posaconazole 400mg/IV/ OD ***Alternative for penicillin allergic patients:*** Ciprofloxacin 400mg/ IV/ BD plus Clindamycin 1.2 g/IV/QDS plus Posaconazole 400mg/IV/ OD	Extensive debridement essential. Send samples for microscopy, culture and sensitivity. Continue antibiotic treatment until first surgical debridement/ washout. Modify treatment according to culture results. Total duration will depend on extent of injuries and intra-operative findings.
Patient not responding or developing infection while on first line treatment	Meropenem* 1g/IV/ TDS Plus Vancomycin IV (adjust as required). Plus Posaconazole 400mg BD for 14 days	Extensive debridement essential. Send samples for microscopy, culture and sensitivity. Modify treatment according to culture results.

*Avoid in severe penicillin allergy. Seek specialist advice.

IF NECESSARY, TRANSFER TO EMERGENCY SURGERY
GO TO 3

PREPARE FOR DISCHARGE
GO TO 7

7 PATIENT DISCHARGE

Thinking about discharging such a patient? THINK TWICE!!!

If discharging from A&E or ED – REMEMBER

Normal examination at this stage does not exclude serious and potentially limb-threatening complications developing.

Pain may not be present initially.

ACTIONS NEEDED

1. Without fail: keep the patient in observation for at least 24h before discharge.
2. Watch for early signs of infection.
3. Keep in mind the possibility of unusual organisms being present and compartmental syndrome developing.

If discharging from hospital ward

ACTIONS NEEDED

- Encourage the patient to return to hospital if they experience loss of functionality, pain, fever, swelling or any other symptoms.
- Makes sure you arrange a follow up by the appropriate specialist.
- PLEASE, encourage the patient to contact the Water Jetting Association via its website (**www.waterjetting.org.uk**) or +44 (0) 2083 201090 for the most up-to-date treatment development and clinical research findings.

CONSIDER COMPLICATIONS
GO TO 8

PATIENT DISCHARGED

FROM 7

8 COMPLICATIONS
USUALLY PRESENT AFTER A WEEK

From surgical wound

1. Check results from **WOUND SWABS** and **TISSUE SAMPLES** taken and sent previously for microbiological and histological examination.
2. If unusual pathogens or any filamentous fungi are detected, liaise with infectious disease specialist for advise on management and antimicrobial treatment.
3. Consider urgent surgical review if patient deteriorates.
4. Consider **NEW DEBRIDEMENT** and **DECOMPRESSION** and closure by second intention.
5. For high grade injuries already on temporary NPWT (negative pressure wound therapy) there would be a need for a new “wash out”.
6. Use the earliest possible definitive plastic surgical wound closure.

Systemic presentation

- Unusual infections with micro-aerophilic organisms (usually GRAM negative) and fungal. Check for previous cultures.
- Leptospirosis (Weil´s disease) presents as a flu-like illness with severe headaches, fever, nausea, and sometimes aseptic meningitis. Classical triad involves: jaundice, renal failure, and haemorrhage.
- Check (IgM) ELISA. Hepatitis A, B, C.

ADVISE SELF-REFERRAL TO GP IF PATIENT HAS ANY CONCERNS

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IHPFII Research abstract

Management of industrial high-pressure fluid injection injuries (IHPFII): the Water Jetting Association (WJA) experience with water driven injuries

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Abstract Background Industrial high-pressure fluid injection injuries (IHPFII) are largely occupational in nature, where these injuries are most often sustained by male manual workers. Such traumatic injuries are largely sustained with water, grease, paint, gasoline or paint thinner. IHPFII are extremely serious injuries with life and limb-threatening potential carrying the risk of life-long disability.

Methods We reviewed the Water Jetting Association© adverse incident database of advisory alerts detailing cases from around the world that have been brought to the association's attention and the English-language literature on high-pressure hydrostatic injuries from 1937 to 2018.

Results Accidents involving high-pressure water jets in the industry are uncommon. The clinical impact in all of the cases reviewed and the effects of water jet impacts range from instant fatalities at scene to loss of limb function and amputation.

The majority of observed fatalities are due to major hemorrhage (exsanguination) secondary to the direct dissection of great vessels or high-energy blunt soft tissue injury and traumatic brain injury.

Conclusions As with any other trauma, IHPWJI commonly result in amputation or death. Nonetheless, a lack of comprehension of the potential severity of injuries and range of infective complications appears to be largely due to the apparent benignity of the initial presentation of the wound. This in turn leads to delays (both avoidable and unavoidable) in the transfer to appropriate medical facilities and definitive care. There is an identifiable need for education (including for health care providers across multiple levels), training and the availability of personal trauma kits for the timely and effective management of IHPWJI from the initial jet impact on the scene, as well as a need for an established referral system.

Keywords Industrial high-pressure fluid injuries · High-pressure fluid injection · Water jetting
Hydrostatic injuries · Ultrahigh pressure · High-pressure water jet injury · Water jet injury

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To read the full research paper, search: **WJA Injury Springer**

IHPFII Case Study - see p507

a The patient was admitted to hospital after an accident cleaning concrete, he underwent an urgent decompression and extensive debridement, the wound left open and had three more consecutive and increasingly extensive surgical explorations at incident plus 1 day and incident plus 4 days.

b Forearm and hand after almost 1 year elapsed time from an accident and after two plastic surgery reconstructions requiring an abdominal flap.

Minimising injury risk – standards and training

The WJA seeks to minimise the risk of water jetting injury through its codes of practice and City & Guilds accreditations training programme.

WJA codes of practice

Blue Code

For the use of high pressure and ultra high pressure water jetting equipment.

Red Code

For the safe use of water jetting equipment in drains and sewers and surface preparation with a jetting gun at pressures up to 275 bar that an operative can comfortably control.

Purple Code

(Due for publication in 2024)

For the use water jetting equipment for pressure washing up to 207 bar (3,000 psi).

Course	Type	Duration	Assessed
Safety Awareness (SA)	Class-based	1 day min	Yes
Safety Awareness Refresher	Class and practical	1 day min	Yes
Safety Awareness CNC Automation	Class-based	1 day min	Yes
Practical Modules			
Surface Preparation (SP)	Class and practical	0.5 days min	Yes
Drain and Sewer (DS)	Class and practical	0.5 days min	Yes
Drain, Sewer and Surface Preparation (DSP)	Class and practical	0.5 days min	Yes
Tube and Pipe (TP)	Class and practical	0.5 days min	Yes
Hydrodemolition (HD)	Class and practical	1 day min	Yes
Other Courses			
Pressure Washing (PW)	Class and practical	1 day min	Yes
Water Jetting for Managers *(under development)*	Class-based	1 day min	Yes
Level 2 Water Jetting Technical Certificate*	SA + 2 practical modules + work-based formal assessment	52 hours of class and practical learning + 122 hours of guided learning	Yes

*Accredited by ABBE

How to achieve WJA certification

1. Attend and pass safety awareness course
2. Attend and pass at least one practical module
3. WJA certificate and training card issued
4. To retain certification – attend and pass safety awareness refresher course every 3 years

TALK TO US

The Water Jetting Association welcomes enquiries from organisations and people who deliver, use, or benefit from water jetting services

- **Join the WJA**
- **Find out about WJA training**
- **Work with us to promote standards and safety**

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