FACULTY OF PRE-HOSPITAL CARE

Extrication following a Motor Vehicle Collision

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Introduction

Motor vehicle collisions (MVCs) are a leading cause of injury and death. Following an MVC some patients remain in the vehicle. Extrication is the process of assisting or removing injured, or potentially injured, people from motor vehicles following a collision. This consensus statement aims to provide guidance on the approach to and early management of patients trapped following an MVC.

The Faculty of Pre-Hospital Care (FPHC) initially considered guidance in this area of practice in 2012. Unfortunately, the evidence available at the time was not sufficient to recommend changes to accepted practice. Over the last few years, the FPHC has worked closely with the "EXtrication In Trauma (EXIT) Project'' and its collaborators and this has led to additional evidence in relation to extrication and immediate post-collision care.

This consensus statement draws on a systematic scoping review, the findings of the EXIT project and a consensus day held in April 2024.

Consensus was achieved across a range of extrication related subject areas including: approach and targets, self-extrication, clinical care, immobilisation and delivering a patient-centred rescue.

Key terms:

Motor Vehicle Collision/Road Traffic Collision

The term "MVC" originated from the Centres for Disease Control in the United States. Originally referred to as "Motor Vehicle Crash" and then later "Motor Vehicle Collision". The term "MVC" is used throughout the transport and clinical literature, including most recent extrication related publications. MVC can be considered synonymous with the UK term Road Traffic Collision (RTC).

Absolute movement minimisation

An extrication where the focus is on absolute minimisation of spinal movement.

Extrication

Extrication is the process of removing injured or potentially injured patients from motor vehicles following a collision.

Gentle patient handling

This is the process of assisting patients to move from one area to another to expedite the next stage of their care when they are unable to do this independently. This term is intended to imply careful and purposeful handling (or assistance) of patients as required by the individual scenario, but with a focus on progressing patient care in a timely manner (rather than a focus on movement minimisation).

Patient/Casualty

The term ‘patient’ is used in this guidance to refer to an injured or potentially injured person.

Patient-centred rescue

This is a bespoke, evidence-based extrication with the primary focus of minimising physical and psychological injury to the patient.

Vehicle relocation

The process of moving a vehicle away from an obstruction to enable more timely patient assessment and/or optimal access for expeditious egress or extrication.

Background

Road traffic injury is the leading cause of death in children and young adults aged 5-29 years. In addition to the 1.3 million road deaths per year, an additional 20-50 million people incur significant injury and often long-term disability from road traffic injury. Motor vehicle collision (MVC) is the leading cause of road traffic injury. Following an MVC, up to 40% of patients will remain trapped in their vehicles. Extrication is the process of removing injured or potentially injured patients from motor vehicles following a collision.

Rescue service extrication techniques have evolved since the 1950s. This evolution has been facilitated by the production of faster, more powerful cutting and lifting equipment. However, in the last 70 years there has been little change in the fundamental tenet of extrication: that of absolute 'movement minimisation'. This has influenced strategies, techniques and approaches that conceptually lead to minimal spinal movement of the patient being extricated. Rescue service guidelines and firefighter manuals inform us that the purpose of movement minimisation is to minimise the frequency and severity of secondary spinal cord injury.

Closer examination of the movement minimisation concept raises the following considerations:
- Absolute movement minimisation takes time; the longer an extrication takes, the longer a patient will remain trapped and the timeline between injury and clinical intervention will extend. Where there is time-critical injury, this may result in excess death and increased morbidity.

- The utility of current extrication techniques to deliver movement minimisation was, until recently, unclear. Recent analysis has challenged the assumption that standard rescue techniques achieve their central purpose of movement minimisation.

- The origins and justification of movement minimisation as the central tenet of extrication practice are unclear. Importantly, there is no evidence of high quality

data being used to inform the use of the absolute movement minimisation approach.

In more recent years, these paradigms have come under increasing challenge; commonly cited statistics on spinal injuries caused by rescuer handling are unsubstantiated and lack identifiable origins. Recent reports on injuries and outcomes, the biomechanical performance of extrication techniques and patient experience from the EXIT project and others provides additional evidence of the need to provide updated guidance. We have built on the available evidence with a consensus finding meeting and we present the outcome of this and our recommendations below.

Consensus Recommendations

Hierarchy of evidence is applied to all consensus statement recommendations. The grade of each recommendation is outlined below after the careful review of all available evidence by the consensus panel. (Please see Appendix D).

1. All patients with injury should be considered time dependent. Operational and clinical team members should work together to rapidly develop a bespoke patient-centred extrication plan with the primary focus of minimising entrapment time. [IV D]

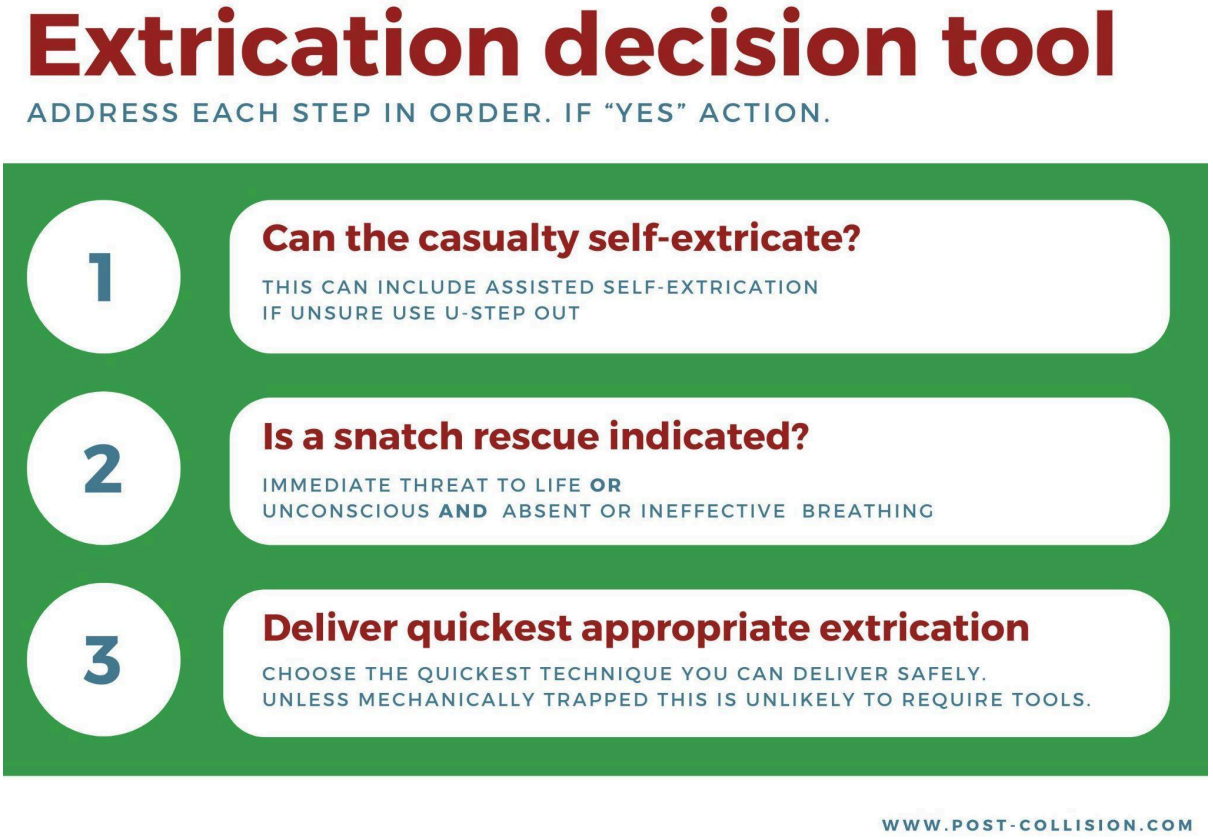
Patients who are trapped following a motor vehicle collision are more likely to have significant injuries and an excess morbidity and mortality[1]. To deliver the best outcomes, early assessment and treatment are required which are facilitated by early release. Recent evidence has demonstrated the difficulty of accurate identification of time-dependent /critical injury.[2]

Extrication approaches that are focused on absolute movement minimisation, take time, delay release and increase time to intervention and definitive treatment.[1,3]

Biomechanical analysis demonstrates that extrication techniques do not perform as expected and techniques aimed at minimising patient movement do not achieve this aim.[4,5] Rapid extrication techniques, B-post rip and roof off extrication techniques, are all associated with similar movement at the spine.[4]

2. Non-clinicians should be empowered to decide on the extrication mode and deliver this before the arrival of the clinical team. [IV D]

Fire and rescue personnel and non-clinical responders (e.g. Police and National Highways personnel) often arrive on scene before ambulance clinicians.[6] Extrication should not be delayed in order to await the arrival of clinicians. Non-clinicians can use the extrication decision tool to decide on the most appropriate extrication mode.



3. Self-extrication or minimally assisted extrication should be the standard 'first line' extrication for all patients who do not have contraindications. [III D]

Self-extrication is associated with the least spinal movement and the shortest extrication times.[4,5]

Contraindications to self-extrication are:

i) an inability to understand or follow instructions and/ or

ii) injuries or baseline function that prevents standing on at least one leg.[7]

Self-extrication **is** appropriate for children who can understand and follow instructions, patients who are experiencing neck or back pain, patients experiencing soft neurological signs (e.g.non-dermatomal tingling) and patients with signs of central cord syndrome.

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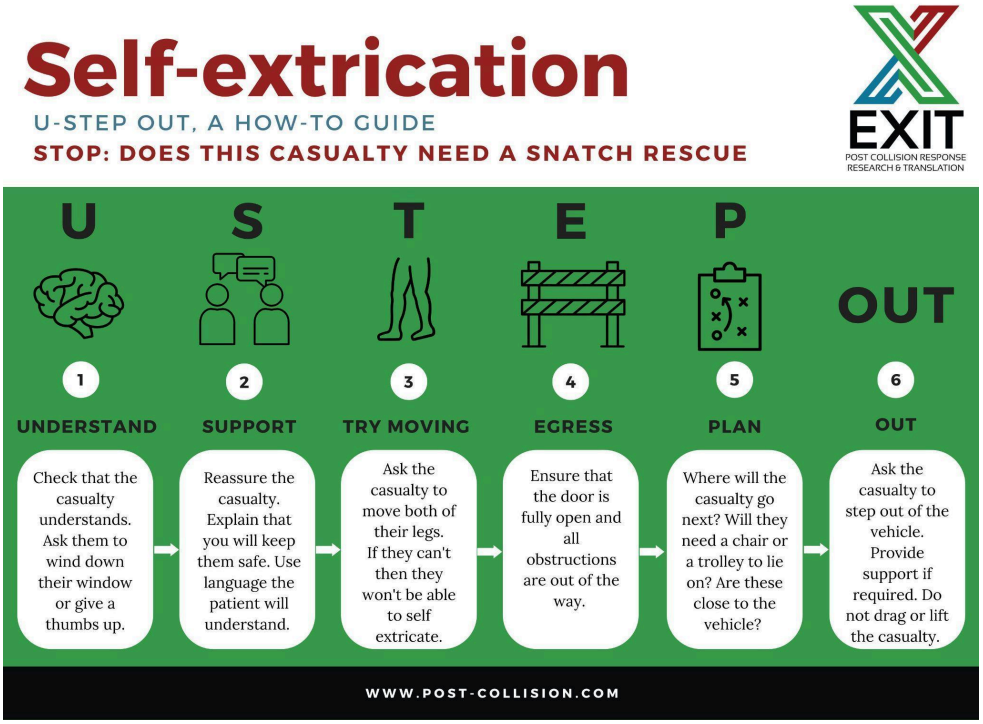
4. Self-extrication decision making for non-clinicians should use an appropriate tool, such as U-STEP Out. [IV D]



The introduction of self-extrication as the primary form of extrication may reduce morbidity and mortality. Early application of self-extrication will further reduce entrapment times.

The U-STEP out tool has been developed and tested to support non-clinical decision making in relation to self-extrication. Fire and rescue personnel and non-clinical responders (e.g. Police and National Highways personnel) should be trained in and empowered to use this tool.

5. Patients who cannot independently self-extricate may benefit from assisted self-extrication. [IV D]

When physiology and injuries are considered, the ability to self-extricate is similar across all age-groups.[8] For particular patient groups and/or injury patterns, assisted self-extrication may enable an additional number of patients to benefit from self-extrication.

Assisted self-extrication involves providing gentle support and/or guidance. Examples include: providing an arm to assist a patient in coming to their feet, or providing additional stability, or traction through a belt at the waist. It should NOT involve dragging or uncontrolled lifting of a patient.

6. In fully conscious patients who do not have neurology, it is not necessary to provide Manual In-line Stabilisation (MILS) in the vehicle. [IV D]

Historically, and in current practice, FRS personnel commonly provide Manual In-Line Stabilisation (MILS) of patients who are trapped following a collision. The purpose of this intervention was to provide absolute movement minimisation.

Patients who are fully conscious have the ability to maintain their neck in a position of comfort and MILS does not add value.[9] Furthermore, the addition of MILS consumes resources, prevents self-extrication and as a result may lead to prolonged entrapment times.

7. If hard neurological signs are present on initial assessment, the patient should have a rapid extrication with gentle patient handling. [IV D]

Approximately 0.7% of patients who are trapped following a MVC will have a spinal cord injury.[1] Approximately half of these patients will have another major (AIS3+) injury in another area of the body.[1] These other injuries may impact physiological stability which may further compromise those with spinal cord injury.

Minimisation of secondary spinal cord injury, such as through maintenance of oxygenation and perfusion, cannot be meaningfully optimised during the entrapment phase of patient care, especially when concurrent injuries are present.

Extrications with a focus on absolute movement minimisation take longer than other extrication types and do not effectively minimise movement[4]. As tool-based extrications cause similar spinal movements, it is appropriate to choose the quickest deliverable method.

8. Collars reduce neck movement. They should be applied prior to extrication when indicated and removal considered when the extrication phase is complete. [III D]

Recent systematic reviews have failed to demonstrate the clinical benefit of cervical collars.[10] In biomechanical studies, collars were associated with reduced maximal movement at the cervical spine. The in-vehicle application of a collar and subsequent self-extrication produced total cervical spine movements which were similar to extrication without a collar [11].

In this interim phase whilst we await the delivery of further evidence on the harm vs benefit of cervical collars it is important both to provide guidance and to accept its limitations:

- Patients with a suspected serious neck injury (e.g. evidence of neurological injury) or with a GCS of <15 and evidence of significant injury in any body compartment, should have a collar applied for the entrapment and extrication phase of their treatment.
- In this context, the collar should be considered an extrication device and in the absence of evidence of neurological injury, the collar should be removed following extrication.
- Local clinical protocols should determine if a collar is required for the subsequent phases of patient assessment and transport.

9. Vehicle relocation, including vehicles in which patients are trapped should be implemented if this will reduce entrapment time. [IV D]

Vehicle relocation is supported within the National Fire Chiefs Council National Operational Guidance and may enable quicker egress following entrapment.[12] Vehicle relocation should be considered when it will reduce entrapment time.

10. Rescuers should be aware that clinical observations may prolong entrapment time and consequently should be kept to a minimum. [IV D]

Extrication pauses associated with clinical and physiological assessments prolong entrapment times.[13] “Routine” clinical observations should be considered on a harm vs benefit analysis and only continued if they are likely to lead to a meaningful intervention or change of approach. The specific delays associated with clinician-collected physiological assessment using a monitoring system should be carefully considered and only utilised if likely to bring overall patient benefit.

11. Clinical care during entrapment should be limited to necessary critical interventions to expedite safe extrication. [IV D]

Clinical care during entrapment prolongs extrication time.[13] Clinical care should be limited to interventions which are time-critical or promote quicker extrication. Examples include the early administration of TXA or the administration of analgesia to facilitate self-extrication. More complex interventions, such as advanced airway management, should be delayed until the extrication phase of entrapment is complete.

12. If a pelvic binder is indicated, this should be applied after the process of extrication is complete. [IV D]

Applying a binder whilst a patient remains in the car is technically challenging, may not result in optimum placement and can contribute to extended entrapment times.

Patients with suspected major pelvic injury should be extricated using the quickest appropriate extrication technique (likely a rapid extrication technique) and re-assessed following extrication. If a pelvic binder is indicated, it should be applied at this stage.

13. The psychological impact of extrication should be considered and support mechanisms implemented. [III D]

Patients who have been extricated report the importance of communication, explanation and companionship to reduce the distress of the extrication experience.[14] They have reported the benefits of having an "extrication buddy" who (with appropriate PPE) joins the patient in the vehicle, explains the extrication process and provides reassurance. This experience was augmented when the rescuer built a connection with the patient, explained actions and used their name.

Communication is important to patients. Mobile devices have increased the expected level of communication between friends and family members and have changed the way people document and share their life experiences. If it is appropriate, patients should be allowed to continue with communication to family members during their rescue.[7]

Patients who have been trapped report the negative effects of images being captured at the scene and published during or after the incident. Patients find the use of social media by onlookers to be intrusive and have described a psychological toll associated with the publication of such content on social media.

Other countries have legislation which rules against onlookers recording content at the scene of an accident.

Steps should be taken to minimise the ability of onlookers to record content at the scene of an accident.[7]

FRS teams often publish photographs and other media of the jobs that they attend. Patients found that this was intrusive and led to negative psychological outcomes.[14] Patients did not object to the capture of content for internal training purposes.

14. FRS services / brigades and ambulance trusts should ensure regular joint multidisciplinary learning, sharing and case review opportunities. [IV D]

Extrication requires a multi-disciplinary approach which needs specific and multidisciplinary training and communication. Paramedic curricula should be standardised to ensure that entrapment MVC receives appropriate attention with an evidence-based approach. Tools should be co-developed to optimise communication on scene. A single point of contact in each ambulance trust, air ambulance and FRS brigade would maximise opportunity for training, case review and co-development of relevant protocols and standard operating procedures.

Conclusion

This consensus statement supports the delivery of an evidence-based, patient-focused extrication. Where gaps in the evidence-base exist, we aim to have provided balanced, clear and pragmatic solutions.

Additional work is needed in the approach to the physically trapped patient, the limits of self/assisted extrication and the role of non-clinical, non-FRS responders and bystanders in the early care of patients injured in MVC. We actively encourage the formation of multi-disciplinary/multi-professional data sets for audit and research purpose and we are supportive of research in this area of clinical/operational practice.

Appendix A - References

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Appendix B - Methods

The methods for developing and delivering this guidance consist of:

1) Systematic Scoping Review
2) The EXIT Project
3) FPHC Consensus Meeting

1. Systematic Scoping Review

Nutbeam T. Extrication of patients trapped following a motor vehicle collision: a systematic scoping review of the literature [Internet]. medRxiv; 2024 [cited 2024 Jun 12]. p. 2024.06.10.24308701. Available from: https://www.medrxiv.org/content/10.1101/2024.06.10.24308701v1

2. The EXIT Project

The EXIT project was established to consider post-collision response, research and translation.

Aims:

The primary aim of this work was to develop evidence-based guidance for the extrication of patients trapped in motor vehicles. This was achieved through:

- Describing the injury patterns, morbidity and mortality of patients involved in MVCs (trapped and not trapped).

- Analysing the movement associated with and the time taken to deliver across a variety of extrication methods.

- Determining the perceptions of patients who have undergone vehicle extrication and describe their experiences of extrication.

- Developing consensus-based guidelines for extrication.

Methods:

In order to achieve this aim, ten studies were planned and delivered. Study 1 (Appendix B1) is a scoping review using systematic methodology to consider the

literature in relation to extrication and related topics from medical, rescue and grey sources. Evidence gaps are highlighted and discussed. Studies 2,3 and 4 are retrospective cohort studies based on the United Kingdom, national trauma registry. These studies consider the rate of spinal injuries and time-dependent injuries in trapped and not trapped patients. The effect of biological sex (study 3) and ageing (study 4) are analysed and reported separately. Multivariate logistical regression techniques are used to compare the groups and identify and report the excess mortality associated with entrapment.

The relevant scientific evidence section of the EBM framework is completed with four biomechanical studies (studies 5-8). Each of these studies are powered using a minimally clinical important difference in cervical spine movement and utilise healthy volunteers across a range of ages and body mass indexes. Inertial motion units are used to capture movements at the cervical and lumbar spine across a range of extrication types.

Study 9 considers patient values and preferences. Semi-structured qualitative interviews are used to report the patient experience of extrication.

Finally in study 10, Delphi consensus techniques were used to consider statements related to extrication derived from studies 1-9. Stakeholder organisations nominated subject matter experts for participation. Following the Delphi process, stakeholders agreed a set of principles based on the consensus statements on which future guidance should be based.

Results

The scoping review demonstrated that the link between reported injuries and deaths associated with MVCs and the evolution of extrication techniques is tenuous.

Study 2 demonstrated that trapped patients have a higher mortality[1] and are more significantly injured (trapped injury severity score (ISS) of 18 (interquartile range (IQR) 10–29) vs not trapped 13 (IQR 9–22). The rate of spinal injuries that are likely to influence extrication technique is extremely low (0.7%). In Study 3, female patients are more likely to be trapped than males[2] and have a higher incidence of spinal[3] and pelvic[4] injuries. Male patients have a higher incidence of head[5], chest[6] and limb injuries[7]. Study 4 demonstrated that older patients have an excess mortality associated with entrapment[8]. Older trapped patients have increased but still low rates of spinal injury[9]. Injured older patients have a similar potential for self-extrication as younger people[10]

In the biomechanical studies (studies 5-8) when volunteers self extricated a collar was found to reduce movement at the cervical spine[11]. Self-extrication produced the smallest anterior-posterior movement at the cervical spine (2.6mm), with rapid extrication producing the largest (6.21mm). The differences between self extrication and all other methods were significant ($p < 0.001$), small non-significant differences existed between roof removal, b-post rip and rapid removal. Study 9 identified that the main theme across all participants in the patient interviews was the importance of communication; successful communication resulted in a sense of wellbeing and where communication failures occurred this led to distress. The data generated three key sub-themes; 'on-scene communication', 'physical needs' and 'emotional needs'. Specific practices were identified that were of use to patients during entrapment and extrication.

In June 2022, the EXIT project published consensus findings on the extrication of patients following a motor vehicle collision. This consensus process was supported by Subject Matter Experts from the National Fire Chiefs Council (NFCC), the United Kingdom Rescue Organisation (UKRO), the National HEMS Research & Audit Forum (NHRAF), the College of Paramedics (CoP), the Pre-Hospital Trainee Operated Research Network (PHOTON) and the Faculty of Prehospital Care (FPHC).

Principles:

- Operational and clinical team members should work together to develop a bespoke patient centred extrication plan with the primary focus of minimising entrapment time.

- Independent of actual or suspected injuries, patients should be handled gently. A focus on absolute movement minimisation is not justified.

- When clinicians are not available, FRSs should where necessary assess patients, deliver clinical care and make and enact extrication plans (including self-extrication)[1]

- Self-extrication or minimally assisted extrication should be the standard 'first line' extrication for all patients who do not have contraindications. The contraindications are:
    - § An inability to understand or follow instructions,
    - § Injuries or baseline function that prevents standing on at least one leg, (specific injuries include: unstable pelvic fracture, impalement, bilateral leg fracture)

- All patients with evidence of injury should be considered time-dependent and their entrapment time should be minimised.

- Incidents where a patient may require disentanglement are complex and associated with a high morbidity and mortality. A senior FRS and clinical response should attend such instances[2].

Clinical care during entrapment:

- o Can be delivered by FRS or clinical services[1].
- o Should be limited to necessary critical interventions to expedite safe extrication[3]
- o Rescuers should be aware that clinical observations may prolong entrapment time and as such should be kept to the minimum.
- o FRS and clinical personnel should be aware of the physical and observable signs of patient deterioration and if identified should make this known to the responsible clinician.

Immobilisation:

- o Longboards are an extrication device and should not be used beyond the extrication phase.
- o Kendrick Extrication Devices prolong extrication time, and their use should be minimised.
- o Pelvic slings should not be applied to patients until they have been extricated.
- o Cervical collars should only be used following assessment and should be loosened or removed following extrication.

Patient focused extrication:

- Build a connection with patients, explain actions, and use their name.
- Where appropriate, reassure patients as to the safety of their co-occupants and others involved in the incident (including animals)
- Provide an 'extrication buddy'.
- Allow communication with family members or other close contacts
- Rescue teams should not publish extrication related imagery to social media or other outlets.
- Minimise the ability of the public to view the accident, take photographs or record videos. Provide education to this effect.

On initial call to Emergency Services:

- Attempt to clarify entrapment status
- Attempt to identify patients who require disentanglement (and dispatch an appropriate priority senior[2] response)
- A standard multi-agency MVC trauma message should be developed to ensure the correct resources are deployed.

- Multi-professional datasets should be developed with patient and public engagement and should include entrapment status, entrapment time, injuries, extrication approach, clinical care

Agreed nomenclature for categories of patient:

- Not injured
- Minor injuries (evidence of energy transfer but no evidence of time-dependent injury)
- Major injury (currently stable but should be assumed to be time-dependent)
- Time critical injured (Time critical due to injury; use fastest route of extrication)
- Time critical hazard (e.g. secondary to fire or other hazard)

Footnotes:

1 FRS clinical care should be standardised and delivered with appropriate training and clinical governance oversight.

2 A senior or enhanced clinical and operational response should be dispatched. This may include enhanced / critical care and will benefit from further consideration.

3 In-car interventions may include the administration of tranexamic acid, analgesia and oxygen. Interventions may include the management of compressible haemorrhage and decompression of suspected tension pneumothorax. Patients who require volume (fluid or blood product) resuscitation are likely to have time critical injuries and their removal from the vehicle should be prioritised. In the small number of patients who cannot be released quickly then 'in vehicle' fluids and /or blood products may be required.

3. FPHC Consensus Day:

Brief: The EXIT project team has worked closely with Joint Royal Colleges Ambulance Liaison Committee (JRCALC) and the National Operational Guidance (NOG) team to support the development of guidance which facilitates the delivery of the EXIT principles.

Anecdotally there have been reports of successful integration of the EXIT principles into practice and many “good news” stories where this has led to positive patient outcomes. However, (as expected) integration and adoption has not been seamless and there is more work to do.

The purpose of this meeting is to:

- Reach consensus on the clinical and operational translation to practice of consensus guidance reached through the EXIT project
- Reach consensus on additional areas of extrication related clinical and operational practice where:
    - The translation to practice of the EXIT project has identified gaps in current guidance
    - The original consensus document lacked clarity, would benefit from refinement or should be updated

Subjects identified for discussion and consensus:

1) Case study review
2) Empowerment of FRS personnel to risk stratify and deliver self-extrication and define limits of this practice.
3) Empowerment of lay persons on scene to deliver self-extrication and define limits of this practice
4) Communication on scene / development of shared language / tools
5) Location of patients post-extrication
6) Training requirements needs
7) Additional steps for translation to practise

The outcomes of the consensus day were used to inform this consensus statement.

Appendix C - All diagrams & charts

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Appendix D - Hierarchy of evidence & grading of recommendations

Hierarchy of Evidence

Level of evidence	Type of evidence
Ia	Evidence from systematic reviews or meta-analysis of randomised controlled trials
Ib	Evidence from at least one randomised controlled trial
IIa	Evidence from at least one controlled study without randomisation
IIb	Evidence from at least one other type of quasi experimental study
III	Evidence from non-experimental descriptive studies such as comparative studies, correlation studies and case-control studies
IV	Evidence from expert committee reports or opinions and/or clinical experience of respected authorities

Grade of recommendation	Type of evidence
A	Based on hierarchy I evidence
B	Based on hierarchy II evidence or extrapolated from hierarchy I evidence
C	Based on hierarchy III evidence or extrapolated from hierarchy I or II evidence
D	Directly based on hierarchy IV evidence or extrapolated from hierarchy I, II or III evidence

Shekelle PG, Woolf SH, Eccles M, et al. (1999). Clinical guidelines: developing guidelines. BMJ: British Medical Journal. Feb 27;318(7183):593.

Quick Reference Guide

Summary of Recommendations

1. All patients with injury should be considered time dependent. Operational and clinical team members should work together to rapidly develop a bespoke patient centred extrication plan with the primary focus of minimising entrapment time. [IV D]

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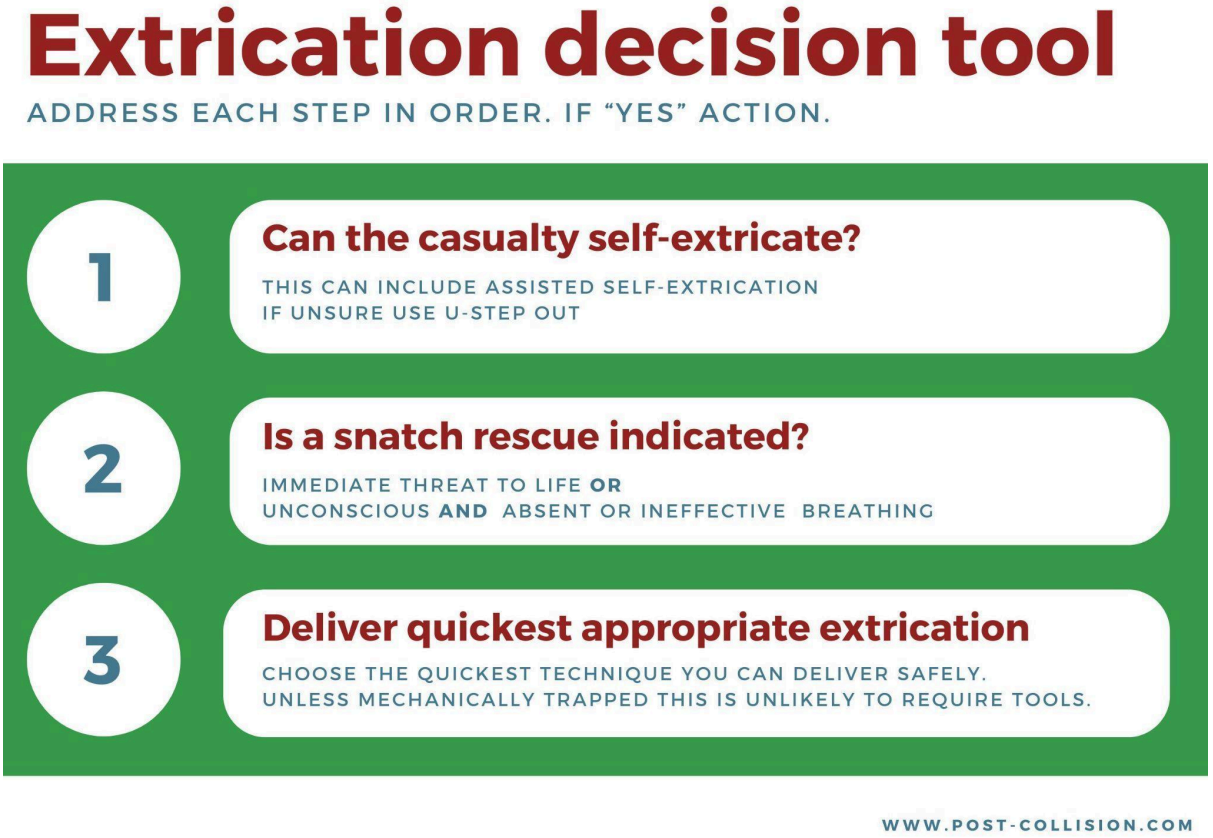

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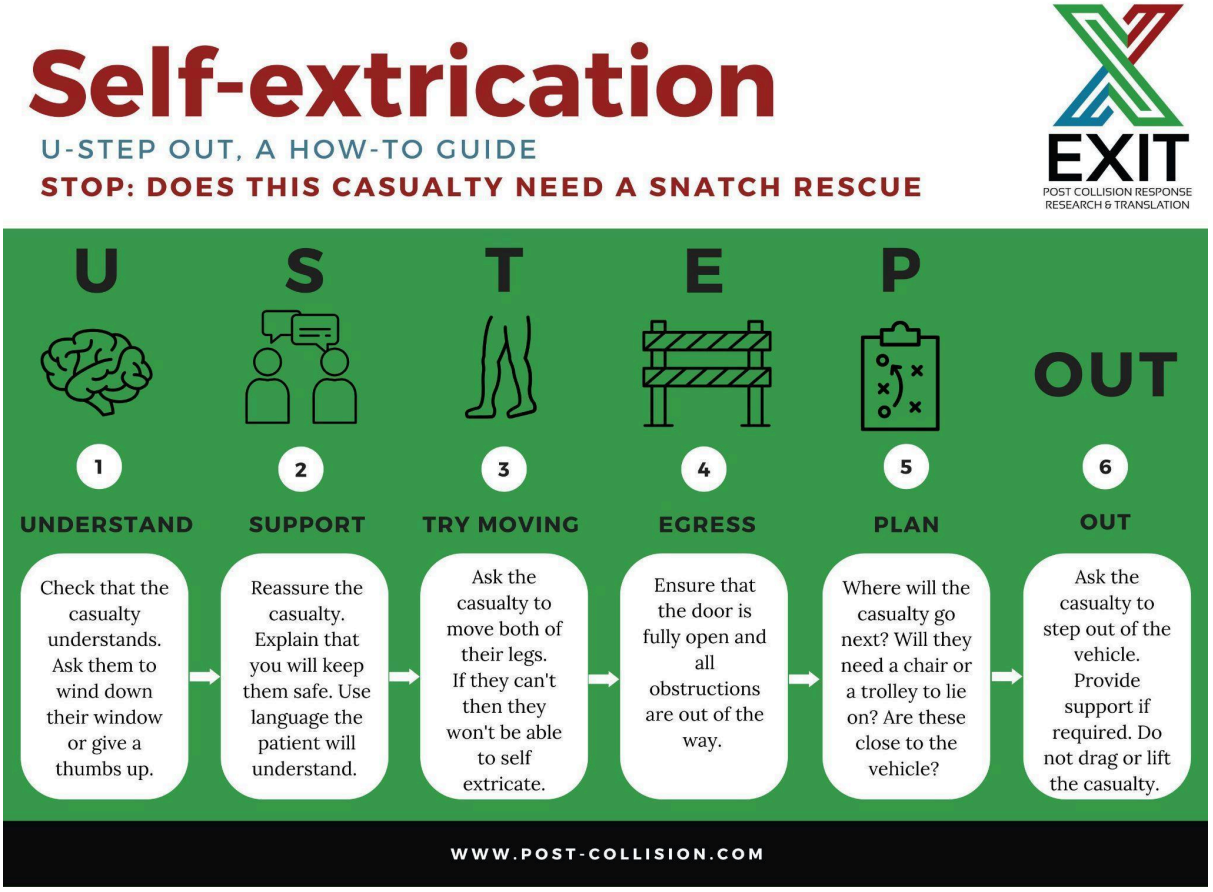

5. Patients who cannot independently self-extricate may benefit from assisted self-extrication [IV D]

6. In fully conscious patients who do not have neurology it is not necessary to provide manual inline stabilisation in the vehicle [IV D]

7. If hard neurological signs are present on initial assessment the patient should have a rapid extrication with gentle patient handling [IV D]

8. Collars reduce neck movement. They should be applied prior to extrication when indicated and removal considered when the extrication phase is complete [III D]

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