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Ukraine Trauma Project: the feasibility of introducing advanced trauma-care skills to frontline emergency medical services responders

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ABSTRACT

Objectives To design, develop, deliver and assess a training initiative on haemorrhage control for emergency medical services (EMS) staff in Ukraine, in an active wartime setting.

Design Using the Medical Research Council framework for complex interventions, a training programme was designed and developed in a collaboration between Irish and Ukrainian colleagues and delivered by experienced prehospital clinicians/educators. Feedback was gathered from participants.

Setting The Russian invasion of Ukraine has caused large numbers of trauma patients with limited access to advanced prehospital emergency care. Ukrainian authorities requested support in delivering such care.

Participants Ukrainian EMS nominated clinical staff as trainees, in partnership with an educational institution in Kyiv.

Intervention One day provider and train-the-trainer courses were developed and delivered, focused on early delivery of tranexamic acid (TXA), using intraosseous access (IO) in victims of wartime trauma.

Outcome measures Safe organisation and delivery of courses, assessed knowledge and skills competence and self-reported satisfaction and pre/post confidence/competence.

Results Two provider and one train-the-trainer courses and four equipment supply exercises were delivered for 89 EMS staff (doctors, nurses, paramedics); none had prior experience of IO or prehospital delivery of TXA. All participants were assessed as competent as providers and/or trainers. High levels of satisfaction and significantly improved self-assessed confidence and competence were reported.

Conclusion Rapid design and delivery of a training programme focused on an identified need for advanced care of trauma patients in a wartime setting has been possible. Training and immediate access to appropriate equipment was demonstrated. Evidence of frequency of use and safe, effective interventions has not been collected; such data are important for evaluation but difficult to collect in this setting. A high level of demand for this training now exists.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The Medical Research Council framework for complex interventions is a useful tool for urgent operational research.
⇒ Ukraine has experienced serious systems problems in providing advanced prehospital care to the many victims of trauma since the Russian invasion. Experience and expertise from other European countries can be of value.
⇒ Extracts from professional advanced prehospital emergency care courses can be adapted for presentation to frontline healthcare providers.
⇒ This study reports some important indicators of feasibility but contains no data on clinical effectiveness.
⇒ Course based and self-assessment tools may provide useful feedback on training but cannot replace clinical evaluation of safe and effective delivery of therapeutic interventions.

INTRODUCTION

The Russian invasion of Ukraine in February 2022 has led to very large numbers of military and civilian trauma casualties, with significant variability between sources. Recent published reports of US government estimates indicate that between 189 500 and 223 000 Russian soldiers have been killed (35 000 to 43 000) or wounded; the equivalent figures for Ukraine's losses are between 124 500 and 131 000 soldiers killed or injured.[1] As of 3 April 2023, the UN Commission for Human Rights recorded 22 607 civilian casualties since the invasion with 8451 killed and 14 156 injured.[2]

Evidence from battlefield studies strongly suggests that many deaths and serious injuries relate to massive bleeding immediately after injury and that most preventable deaths can be achieved with control of blood loss.[3–5] Vigorous efforts to address the challenges of massive blood loss have been exemplified by the US military's Tactical Combat Casualty

Care (TCCC) training and management programmes for all service members, widely adopted or reflected by similar programmes in many other countries, including Ukraine.[6]

From March 2022, large numbers of Ukrainian refugees began to arrive in Ireland (almost 80 000 had arrived by April 2023) and many institutions around the country offered accommodation, logistic and educational supports. University College Dublin (UCD) School of Medicine engaged closely with arriving Ukrainian doctors and subsequently received requests from public representatives and emergency medical services (EMS) in Ukraine to offer training support for care of trauma patients. UCD Centre for Emergency Medical Science has a long background in training Advanced Paramedics in Irish emergency services and Combat Medical Technicians in the Irish Defence Forces; a full range of core and advanced trauma care skills is delivered by those services and practitioners.[7 8] These requests were very positively received; this descriptive paper outlines the response to those requests, through the establishment of the Ukraine Trauma Project. The feasibility of an effective response had to be assessed by pilot training and supply exercises, in order to assess the potential for a larger programme of work.

The objectives of the paper are to report on the design, development, delivery and assessment of the feasibility of a training initiative on haemorrhage control for EMS staff in Ukraine. A specific study objective was to assess the self-reported precourse and postcourse confidence and competence of trainees in the clinical and teaching skills included.

METHODS

The study describes the approach to the requests for assistance, outlining the principles adopted, the implementation of that response and brief outlines of the provider and training the trainer courses established. The 2008 Medical Research Council guidance on complex interventions provided an appropriate framework for this approach and for reporting on the intervention; the major components are development, feasibility/pilot testing, evaluation and implementation.[9] The development and feasibility/pilot phases are most relevant to this paper.

Feedback from course participants on the initial two courses was gathered. Participants were nominated by Ukrainian statutory and voluntary EMS agencies providing frontline prehospital trauma care. Feedback on both courses was limited to feasibility issues (access, positive issues, advice on changes); in course 2, brief data were collected from participants on training, relevant clinical skills and clinical teaching and the perceived impact of training. In course 2, precourse and postcourse self-completion Likert questionnaires were developed by the authors (online supplemental file 1) and administered anonymously, covering self-reported confidence and competence in a range of clinical and teaching issues. SPSS V.27 was used for analysis and Wilcoxon signed rank test was used for pre/post grouped comparisons. No identifying or demographic information was requested other than duration of prior medical training.

Patient and public involvement

It was not appropriate to involve patients or the public in the design of the study, given the setting.

Framework of response

1. *Partnership approach.* Support offered from Ireland was made possible with the agreement and guidance of Ukrainian partner agencies and key stakeholders. Sustainability, acceptability and relevance were identified as key elements of any successful initiative—any contribution had to address important unmet needs and to ideally be iterative. Ukrainian partner organisations include charitable fundraising bodies, educational partner agencies and state/military/EMS agencies which were the sources of invitations for the missions set out below and acted as operational supports. The Ukrainian embassy in Ireland also provided formal endorsement and support.
2. *Preliminary discussions between Irish and Ukrainian doctors on key challenges, with preparation of proposal, rationale and outline delivery plan.* This early discussion identified the need for a focused response to early, severe blood loss as the key, addressable goal for a training package. That package would build on the widespread adoption of TCCC training across Ukrainian military and civilian EMS services.
3. *Key interventions identified.* The early administration of tranexamic acid (TXA) significantly reduces mortality and morbidity following severe trauma, including battlefield injuries; however, early (preferably within one hour) intravenous or intraosseous (IO) administration is required for best effect. An important understanding to emerge from our discussions was that while a wide range of resuscitative measures for trauma (including TXA) were available in stabilisation centres, hours could elapse before trauma patients reached these centres. There were no established systems in place to provide TXA at or near the point of injury.
   A rapid intervention programme to train first responders to administer TXA by IO routes immediately after serious injury was identified. If the initial dose of TXA does not occur until later than 3 hours after injury, there is some evidence of increased harm.[10]
   Additional measures addressed included use of pelvic binders (used also as ad-hoc junctional tourniquets) and an introduction to the use of inhaled methoxyflurane for analgesia following resuscitation. The importance of early extremity tourniquet application was stressed.
4. *On-line, in-depth presentation/review of proposal to in-country Ukrainian decision makers.* A secure online meeting was set up to present these proposals (with detail on the

evidence base) to a key group of Ukrainian doctors, paramedics and trainers involved in the delivery of EMS services locally. Mediated by medically qualified interpreters, a detailed discussion led to agreement and strong support for the proposals.

5. *Programme design/equipment purchase/fundraising*. A one day, pilot provider programme was designed (outlined below), based on teaching materials in Ukrainian, skills stations taught by experienced clinicians/trainers and an assessment of competence and confidence. Individual treatment kits were designed, purchased and prepared; significant practical input was received from EMS and military medical experts on design of the kits. Fundraising was entirely from philanthropic and charitable donations, in partnership with UCD's registered charity, UCD Foundation.
6. *Pilot mission*: with the support of experienced volunteer clinicians/trainers a pilot mission was planned for November 2022 to deliver a provider course to staff nominated by Ukrainian EMS services. In addition, the first batches of standardised kits would be distributed.
7. *Constraints*: the reality of an ongoing war, the difficulties of reliable communication and planning with those at the frontline or close to it, the volunteerism needed for trainers to offer their services, language interpretation challenges, having units and services identify trainees, release them and transport them to and from the secure locations where training occurred and the uncertainty of whether resupply of kit could happen are among the many real-world issues which place this project in a very different setting to the mainstream of health services or medical education research. They also reflect the fact that the training and responsibilities offered are of a different standard, structure and acceptability to those used in peacetime conditions. The risks and challenges inherent in all of these constraints were acknowledged by the individuals and organisations involved and accepted as worthwhile.

Implementation of response

Mission 1: a four-person trainer team delivered pilot course 1 (provider/one day) at a secure location in Ukraine. The course was attended by 29 staff from military medical units and civilian EMS services. Two trainers with extensive prehospital emergency care experience in Ireland and two Ukrainian doctors working in Ireland made up the team. The visit also supplied standardised IO/TXA kits × 30, multipurpose pelvic binders, combat tourniquets and inhaled methoxyflurane units x 30.

Mission 2: at the request of the trainees from mission 1, delivery of further standardised TXA kits × 20 was made to the group about 4 weeks later.

Mission 3: a six-person trainer team delivered course 2 (provider and train the trainers course/3 days) at a different secure location in Ukraine. The course was attended by 60 staff from military medical units and civilian EMS services and was delivered by five staff from Ireland with extensive prehospital emergency care/training experience and one Ukrainian doctor working in Ireland, with support from two local professional interpreters. In addition, participants were provided with standardised IO/TXA kits × 50.

Key training principles

Provider course

1. Builds throughout on TCCC stage 1 (care under fire) and 2 (care when safe) 'All Service Member' course, extensively taught as the basis of EMS care in Ukraine, using the 'MARCH (Massive bleeding, Airway, Respiration, Circulation, Hypothermia)' approach. Key TCCC skills include sequence of care, combat tourniquets, wound packing, haemostatic dressings and airway care. Immediate tourniquet use for massive bleeding is an essential, life-saving procedure highlighted by TCCC and emphasised by our training.[11 12]
2. Essential theory only: to include key indications, understanding the role of TXA and possible complications. Standard indications include gunshot wound above knee or elbow, amputation above hand or foot, head injury with altered level of consciousness, obvious severe blood loss/clinical shock.
3. Focus on key skills, taught by experienced providers in small groups: IO access (humerus and tibia only, using simulation materials), preparation and administration of initial TXA dose (1 g in 100 mL NaCl over 10 min), use of pelvic binder (including as junctional binder).
4. Other initiatives: a specific request was made from Ukrainian partners for a basic introduction to Chemical, Biological, Radiological, Nuclear and Explosive (CBRNE) skills, particularly because of exposure to phosphorus burns; the issue was addressed by a certified CBRNE instructor. In earlier discussions about analgesia, it was accepted that the use of opiate analgesia was inappropriate in frontline/combat environments because of the potential for psychological effects; however, a proposal was made to trial the use of methoxyflurane, a self-administered, non-narcotic, inhaled analgesic for follow-up pain relief after administration of TXA and not as preparation for IO access. Both TXA and methoxyflurane are licensed for use in Ukraine.
5. Assessment: core knowledge items and individual assessment of core skills.

Train the trainer course

1. Initial successful completion of provider course.
2. Key teaching and learning principles introduced and demonstrated for both didactic and skills teaching. The course comprised two full days of teaching, resourced by six experienced faculty members. More than half of the available time and teaching sessions were devoted to small group teaching sessions, focused on clinical skills acquisition and skills teaching.
3. Participants assigned teaching tasks from provider course and were assessed for competence.
4. Clear demonstration of effective interactions with colleagues.

RESULTS

Feedback from participants

Course 1

The initial provider course was attended by 29 staff from a range of military and civilian EMS agencies. Participants included four registered medical practitioners from a range of disciplines and 'medics' whose training and backgrounds ranged from professional paramedic training to those with very limited or informal training. At least 25 of the group were first responders to combat injuries and had provided early care which sometimes extended for hours before evacuation to a care facility.

The focus was mainly on the feasibility of organising and delivering the course and structured feedback was kept to a minimum. The positives included the safe, on-time attendance of 29/30 expected candidates most of whom came from frontline units, the availability of good quality teaching facilities, the attention and interaction demonstrated by candidates and their complete attention to the content of the course. Individual skills stations assessed the knowledge base and ability of candidates to safely and accurately insert an IO needle and prepare and administer the correct dose of TXA. Each of the candidates was assessed as competent to carry out these tasks by direct observation by a faculty member of each candidate undertaking the specific clinical tasks of preparation of intravenous fluids and TXA for administration and IO insertion in tibial and humeral sites using training mannikins. The obvious limitations included a single day in which to carry out training, language challenges, variable background training and experience and the unfamiliarity of candidates with the procedures involved.

Course 2

Of 60 participants, 55 returned feedback forms. Table 1 shows that more than half of the group selected to attend had at least a year's training in medical or prehospital medical care; four of these clinicians were registered medical practitioners and the remainder were emergency paramedics. Most of the group were first responders to combat injuries and had provided early care which sometimes extended for hours before evacuation to a care facility.

Table 2 indicates that most clinical tasks were familiar to participants but confidence levels were limited; following the course, significant improvements in confidence were reported. While use of a combat tourniquet was not unexpectedly the most familiar task, there was some familiarity with parenteral access and administration of TXA. By contrast, the use of methoxyflurane or (basic) CBRN procedures were very unfamiliar but improved significantly.

Table 3 reports similar significant changes in confidence levels at completion of the course. Candidates were provided with copies of the teaching materials and teaching models used including a Ukrainian language version of the TCCC ASM materials, Ukrainian language PowerPoint presentations on each of the clinical skills taught and a number of tibial and humeral models for IO access training. Each of the components formed the basis for the assessed teaching sessions.

Table 1 Completed months of medical training (n=55)

>12 months	32 (58.2%)
6–12 months	13 (23.6%)
>3<6 months	4 (7.3%)
>1<3 months	5 (9.1%)
<1 month	1 (1.8%)

Table 2 Confidence in clinical procedures: (1, no confidence, 4 completely confident) (n=55)

	Before the course Median (range)	After the course Median (range)	P value
Intraosseous access	2.0 (1–4)	4.0 (3–4)	<0.001
Intravenous access	3.0 (1–4)	4.0 (2–4)	<0.001
Administration of TXA	2.0 (1–4)	4.0 (3–4)	<0.001
Use of combat tourniquet	4.0 (1–4)	4.0 (3–4)	0.008
Use of pelvic binder	3.0 (1–4)	4.0 (3–4)	<0.001
Use of PENTHROX	1.0 (1–4)	4.0 (3–4)	<0.001
CBRN procedures	1.0 (1–4)	4.0 (2–4)	<0.001

CBRN, Chemical, Biological, Radiological, Nuclear; TXA, tranexamic acid.

DISCUSSION

The Ukraine Trauma Project was established as a real-time humanitarian effort to share evidence-based trauma interventions from a well-established civilian training and care system in Ireland to wartime environments in Ukraine where they were not available but could potentially have real impact. Ireland's EMS training and delivery systems are relatively small and could not aspire to provide widespread advanced EMS training or to duplicate existing basic training systems. However, the 'action-research' approach outlined here has identified key trauma interventions in which civilian expertise could be potentially cascaded to where it might have effect.

Table 3 Confidence in teaching clinical procedures: (1, no confidence, 4 completely confident) (n=55)

	Before the course Median (range)	After the course Median (range)	P value
Intraosseous access	2.0 (1–4)	4.0 (3–4)	<0.001
Intravenous access	2.0 (1–4)	4.0 (2–4)	<0.001
Administration of TXA	3.0 (1–4)	4.0 (3–4)	<0.001
Use of combat tourniquet	4.0 (1–4)	4.0 (3–4)	0.006
Use of pelvic binder	3.0 (1–4)	4.0 (3–4)	<0.001
Use of PENTHROX	1.0 (1–4)	4.0 (2–4)	<0.001
CBRN procedures	2.0 (1–4)	4.0 (2–4)	<0.001

CBRN, Chemical, Biological, Radiological, Nuclear; TXA, tranexamic acid.

The initial steps outlined here demonstrate the feasibility of the key steps needed to implement such a response; the specific study objective to assess the self-reported precourse and postcourse confidence and competence of trainees demonstrated significant improvements in key clinical and teaching issues. Clearly, further data collection will be needed to establish the utility, availability and impact of the clinical interventions themselves and planning is underway to gather data to address these issues. Nonetheless, anecdotal case reports from participants in our first course indicate the intervention has been carried out in critically injured patients on a number of occasions, very close to and soon after battlefield injuries. Course candidates have returned to EMS services in which they provide care to both military and civilian patients.

The process outlined here reflects aspects of familiar health services research such as the 2008 MRC framework for complex interventions, whose four phases are described as development or identification of an intervention, feasibility, evaluation and implementation. The collaborative approach taken rapidly identified a critical gap in the trauma systems in use in Ukraine (early availability of TXA), which could be addressed using well established clinical interventions from Irish EMS systems (IO or intravenous administration of TXA) and which proved compatible with a rapid intervention cascade programme (provider and training the trainer courses). The evaluation has necessarily been constrained by having to deliver the intervention in a wartime setting but has demonstrated that it is possible to do so, that participants demonstrate evidence of significant learning and satisfaction and that the local EMS agencies find the process sufficiently worthwhile to send their staff on the courses and to request the urgent delivery of more. TXA is licensed and available for use in Ukraine and is familiar within hospital but not prehospital systems. While our project has supplied TXA from Ireland for use by trainees, a system-wide adoption of early TXA use should not encounter significant supply issues. IO access kit is currently much less available in Ukraine but is used by some prehospital agencies; intravenous access/infusion kit is widely available. Again, system-wide adoption of early TXA use will need to examine the training/logistic options available.

Important limitations include limited training time, language challenges, the variable backgrounds of candidates as well as the dangers and unpredictability of working in an active wartime setting. More specifically, the effectiveness, safety and accessibility of the interventions included have not been demonstrated in this setting and must be explored in future research.

Those leading the project do not underestimate the challenges inherent in asking candidates to take responsibility for the interventions offered in this course. Candidates for the Advanced Paramedic Training Programme in Ireland must complete a minimum of 2 years as registered Paramedics and then undertake a one year Master's level academic, clinical training and internship programme which is built around comprehensive advanced diagnostic and procedural training, including IO access and TXA administration. A course lasting some days cannot have the same objectives, content or outcomes, particularly for candidates who may have limited backgrounds in paramedic or medical practice. Nonetheless, the recognition of major combat injuries is a current responsibility of these medics; the additional use of a technical procedure may be achievable, clinically effective and requires continuing evaluation.

Limited data have emerged from the war in Ukraine on the roles and effects of early care trauma systems. Our results align with those of Kivlehan *et al* who reported significant improvements in knowledge and confidence among Ukrainian participants in a 5-day WHO-ICRC Basic Emergency Care course carried out in 2022.[13]

Epstein *et al* compared some of the lessons learnt from the US 'Global War on Terror' to the work of their group in supporting surgical care services in Ukraine.[14] Riley has examined the potential lessons from the war for large-scale NATO led medical operations[15] and Zasiekina has explored the impact of Post Traumatic Stress Disorder at community level.[16] However, we believe that this study is one of the first to describe an intervention aimed at directly improving the care of trauma patients through collaboration and dissemination of critical interventions. Further research to evaluate implementation of these procedures and to evaluate effectiveness (to the extent possible in this setting) is being planned.

Further training and supply of appropriate items of equipment is planned, at the specific request of the Ukrainian EMS agencies involved, with the intention of complementing more generalised introductory TCCC training. That ongoing collaboration will provide the context for further research and development in relation to the initiatives described in this paper.

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Competing interests None declared.

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Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by Institutional Review Board, Prytula Institution, Kiev VO-2023-320. Participants gave informed consent to participate in the study before taking part.

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