Emergency medicine residents in the war zone: organizing humanitarian expeditions to train healthcare personnel during the conflict in Ukraine

Giovanni Cappa,[1,2] Valeria Mauri,[3] Erika Negrello,[3] Bruno Barcella,[1,2] Flavia Resta,[1,2] Valentina Angeli,[1,2] Stefania Marconi,[4,5] Lorenzo Tiraboschi,[2] Paolo Minzioni,[6] Andrea Pietrabissa,[3,7] Ferdinando Auricchio,[4,5] Stefano Perlini[1]

[1]Emergency Medicine Unit and Emergency Medicine Postgraduate Training Program, IRCCS Policlinico San Matteo University Hospital, University of Pavia; [2]SIMAE (Italian Society of Medicine in Extreme Environments); [3]SC General Surgery 2, Fondazione IRCCS Policlinico San Matteo, Pavia; [4]Department of Civil Engineering and Architecture, University of Pavia; [5]Fondazione IRCCS Policlinico San Matteo, Pavia; [6]Department of Electrical, Computer and Biomedical Engineering, University of Pavia; [7]Department of Clinico-Surgical, Diagnostic and Pediatric Sciences, University of Pavia, Italy

Correspondence: Giovanni Cappa, Emergency Medicine Postgraduate Training Program, IRCCS Policlinico San Matteo University Hospital, University of Pavia, Viale Camillo Golgi, 19, 27100 Pavia, Italy
Tel.: +39.3331044658.
E-mail: giovanni.cappa01@universitadipavia.it

Key words: humanitarian expedition, Stop the Bleed, 3d printing, tactical medicine, Tactical Combat Casualty Care.

Contributions: GC, VM, and EN conceived and designed the study and the prototype. VM, EN, SM, and FA elaborated on the prototype and were responsible for the whole production process. GC, BB, VA, and FR tested the prototype in Italy and afterward, they trained the Ukrainian special forces in Ukraine with the final product. FA, SP, LT, PM, and AP overviewed the whole project. All authors have contributed significantly to the study and this manuscript.

Conflicts of interest: the authors declare no conflict of interest.

Funding: none.

Availability of data and materials: all data underlying the findings are fully available upon reasonable request to Giovanni Cappa, giovanni.cappa01@universitadipavia.it

Ethics approval and consent to participate: not applicable.

Informed consent: not necessary.

Acknowledgments: we would like to thank all the institutions that contributed to this volunteering project: 3D4Med Lab for their help in realizing the hemorrhage simulation devices; The University of Pavia, which lent part of the training material for these courses; Flamor S.r.l, a tactical medical company based in Italy, that donated the tourniquets; Rotary District 2050 and the Rotaract Club of Pavia, that supported and promoted this project.

Received: 13 February 2024.
Accepted: 18 February 2024.
Early view: 5 April 2024.

Emergency Care Journal 2024; 20:12385
doi:10.4081/ecj.2024.12385

Dear Editor,

When faced with a crisis, particularly when it involves humanitarian aid, emergency medicine (EM) practitioners push themselves to question, "How can we help?" and "To the best of our knowledge and skills, what can we truly do?". The mindset of EM personnel is presumably one of "How can I help in these situations?" and, more crucially, "How can I help the most effectively?". To answer these questions, we present our experience in Ukraine.

The background: the war in Ukraine

Russia-Ukraine war broke out on October 30, 2023, and six months into the conflict, a regional chapter of a well-known service organization, Rotary International,[1] asked us to help with a humanitarian project as EM clinicians. Rotary District 2050 (Northern Italy) was delivering generators, medications, and ambulances to healthcare personnel at Ukrainian military bases and hospitals.

Considering that the greatest preventable cause of death in the military setting is uncontrolled bleeding, which plays a crucial role in patient care in conflict zones,[2] and that massive hemorrhages can be effectively managed with basic techniques like the application of tourniquets (in the case of limb wounds), compression, and wound packing with hemostatic dressings, we decided to share our experience as instructors of a trauma course called "Stop the Bleed".[3] In this course, both civilians and healthcare professionals can learn to manage life-threatening hemorrhages with simple and easy materials and methods. Less than a week later, we were teaching our first trauma course to the military members at the first military base we engaged in Ukraine. Six months later, we returned to Ukraine in collaboration with a joint mission with the World Extreme Medicine (WEM) to provide the military special forces with a comprehensive Tactical Combat Casualty Care course (Figure 1). After these first two courses, we were contacted by the WHO local healthcare coordinators, asking us to deliver more first aid courses to their partners and the local doctors and paramedics.

Simulation equipment

We wanted to provide high-quality instruction with Vanguard simulation utilizing the fewest resources feasible. The collaboration with our hospital's 3-D printing lab, 3D4Med.,[4] and donations of tactical medical supplies from Italian specialty enterprises

(Flamor S.r.l.)[5] have made this possible. San Matteo Hospital in Pavia, Italy, hosts a clinical 3-D printing laboratory that produces anatomically realistic models using a variety of materials that may mimic human tissue consistency and can be used for the simulation of any invasive procedure. We spent several months designing with the lab massive hemorrhage simulators that would travel with us to the battlefield. Using Autodesk® Inventor® CAD software, we first created a virtual model that included a simplified skin section of a human thigh to be used as a mold, a rigid structure axially shaped like a femur, two breaches that simulated deep wounds, and a network of tubing that ran close to the bone and opened up at the wound site to mimic a femoral artery (Figure 2). The final products weighed 2 kg and were roughly 16-17 cm, which was ideal for our travels (Figure 3). The instructor can mimic pulsatile bleeding by slowly pumping the fluid in the syringe until the learner provides satisfactory compression or proper wound packing.

For this humanitarian project, our university (University of Pavia, Italy) provided us with specifically designed material and other simulation devices.

Risk assessment

The choice to visit these remote and significant sites was not easy to make, and a careful risk analysis was done. Our travel plans, including the precise locations of our stays and our routes, were communicated to the Italian Ministry of Foreign Affairs and the local Italian consulate. Each course was planned in collaboration with the WHO and the Ukrainian Department of Health, who also helped us with trip plans, including lodging and transportation.

We scheduled one of these expeditions based on reports from private intelligence firms, and we kept the Air Alert app open on all of our smartphones at all times. This app alerts users to the possibility of an impending bombing in the vicinity of their current location and advises them to seek cover as soon as feasible.[6] A digitized map of every bomb shelter that was reachable in the region where we were working was also provided to us.

We had to refuse a few requests. For instance, we were asked to organize first aid courses right next to the front lines, but we believed that the risks would be too high in these circumstances. Instead, we agreed with the stakeholders to gather the attendants further away from the active front line and hold the courses in safer areas. On site, after receiving warnings of imminent air attacks, we were forced to repeatedly stop the course and take refuge in the nearest underground air raid shelter. Undoubtedly, we were terrified every time we visited these places, but we always assumed that we could live with the possibility of feeling scared every time we went there. However, given the volume of requests — especially from reliable organizations like the WHO and the national health system — we thought we could bear the risk.

What comes next?

So far, we organized four "Stop the Bleed" courses in different regions and one TCCC course with WEM (Figure 4), training about forty soldiers and fifty civilians working in critical scenarios for the local NGOs. Our first courses were offered to the Ukrainian military since the NGOs with which we worked at the start of this project saw the need to teach military personnel advanced trauma and TCCC courses. As we operate as a volunteer organization on

Figure 1. A lesson in Kyiv to the Ukrainian Military Special Units.

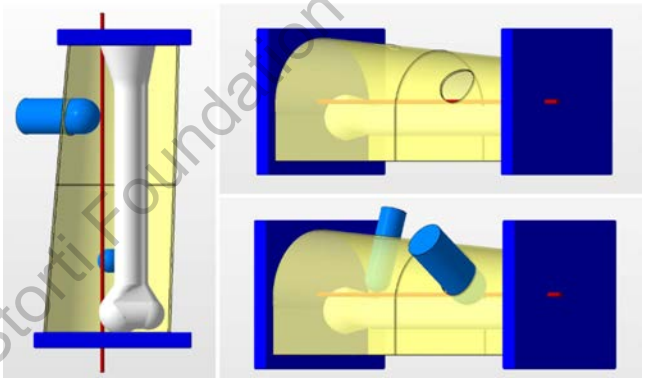

Figure 2. CAD-designed prototype representing the simplified skin mold, femur, deep wounds, and artery. The simulated femoral artery was added with a 3-way stopcock connector at one of its ends to which a syringe can be connected. The artery's other end was cut, left open and connected to the wound, thus allowing the hemorrhagic flow to be simulated.

Figure 3. Ukrainian soldiers training massive hemorrhage control on our 3D printed simulation devices.

Figure 4. The instructors team of the TCCC course we organized in collaboration with World Extreme Medicine (WEM) - from left to right: Valentina Angeli, Jacob Levene, Maarten Zijp, Flavia Resta, Bruno Barcella, Giovanni Cappa.

our own, we are currently adhering to the recommendations made by the regional WHO chapters. For these reasons, the final courses were therefore planned for their partners, who are volunteers from the local community. We are currently planning an advanced trauma course for the healthcare professionals of the national healthcare system.

We acknowledge that the collaboration between the 3D4Med researchers and the EM post-graduate program made these expeditions possible: our combined efforts resulted in high-quality simulators at low costs, thanks to new technologies like 3-D printing and additive manufacturing, which allowed us to schedule multiple courses without having to purchase pricey simulation materials from the market. However, we are always aware that the most effective method to lower the number of casualties in a war zone is to train people to perform life-saving techniques like applying a tourniquet or dressing a wound. It has been estimated that 100,000 Ukrainian soldiers have lost their lives since November 2023,[7] after almost two years of conflict. For this reason, we are designing more simulation devices with 3D4Med, and we are currently planning the next trauma training course for medical professionals and paramedics.

Additionally, we started to teach these courses as part of our post-graduate program in emergency medicine so that future EM professionals would be competent in carrying out the aforementioned actions on humanitarian missions.

Finally, by sharing our experience, we hope to inspire and encourage other groups of driven professionals — EM clinicians and not only — to collaborate with local companies and institutions to achieve their goals and realize a "good emergency medicine".

References

1. Rotary Club. Available from: https://www.rotary.org/
2. Holcomb JB, Butler FK, Rhee P. Hemorrhage control devices: Tourniquets and hemostatic dressings. Bull Am Coll Surg 2015;100:66-70.
3. Stop the Bleed. Available from: https://www.stopthebleed.org/
4. 3D4MED. Available from: https://www.3d4med.eu/clinical-3d-lab/
5. FLAMOR S.r.l. Available from: https://www.flamor.com
6. VisitUkraine.today. Available from: https://visitukraine.today/blog/143/air-alert-app-that-notifies-about-danger-in-certain-region-in-your-smartphone
7. Britzky H. How US troops in Germany are training Ukrainians to save one another on the battlefield | CNN Politics. CNN. Published March 26, 2023. Accessed August 18, 2023. Available from: https://edition.cnn.com/2023/03/26/ politics/us-army-ukraine-medical-training/index.html