

# Prehospital emergency thoracotomy performed by helicopter emergency medical service team: A case report

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## ABSTRACT

Emergency thoracotomy can be a life-saving procedure in critically injured patients who present with chest injuries. Currently, the indications for an on-the-scene thoracotomy are penetrating trauma of the chest or upper abdomen with cardiac arrest that has occurred in the presence of an emergency team or within 10 minutes prior to their arrival. The indications for an emergency thoracotomy in blunt chest trauma are less clearly defined. In the present case, a helicopter emergency medical service (HEMS) team performed an emergency thoracotomy at the scene. To the best of our knowledge, it is the first description of such a procedure in Poland. A 41-year-old male was crushed in a tractor accident. Though all available measures were taken, a sudden cardiac arrest occurred. The HEMS team performed an emergency thoracotomy at the scene as an integral part of prehospital cardiopulmonary arrest management. The patient survived, and was later discharged from the hospital in good physical condition. No neurological deficit was identified (cerebral performance category I). The patient returned to his previous activities with no complications or deficits. The presence of a fully trained crew allows for the performance of a potentially critical on-the-scene emergency thoracotomy. In a well-selected group of patients with blunt thoracic injury, a prehospital emergency thoracotomy may be a significant and life-saving procedure.

**Keywords:** Emergency treatment; prehospital critical care; thoracotomy.

## INTRODUCTION

Helicopter emergency medical service (HEMS) has 2 important assets: it quickly delivers highly qualified medical aid to the site, and has the advantage of reducing transport time to the destination facility.

Due to a large catchment area and precisely defined dispatch criteria, HEMS crews are more likely to be involved with

critical trauma patients. In addition, they are more capable of making decisions under the pressure of time, as well as performing high-risk, invasive medical procedures on site. One of these rarely performed, life-saving procedures is prehospital emergency thoracotomy (PET). Only a few air ambulance services in the world have introduced a systematic procedure regarding PET.<sup>[1,2]</sup> The indications for the procedure are penetrating trauma of the chest or upper abdomen with circulatory arrest that has occurred in the presence of

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emergency team or up to 10 minutes before their arrival.<sup>[3,4]</sup> An emergency thoracotomy in cases of blunt trauma may be associated with higher mortality, as the indications for its performance are less clearly defined.<sup>[1,2,5]</sup>

Presently described is the case of a patient with a crush injury to the chest in which the HEMS team performed an emergency thoracotomy at the scene. To the best of our knowledge, it is the first description of such a procedure in Poland.

## CASE REPORT

A 41-year-old male was crushed in a tractor accident. As the local air ambulance helicopter was involved with another mission, the dispatch center sent the nearest paramedic-staffed ambulance, which arrived on site after about 30 minutes. Following extrication and initial management, the patient was moved to a temporary landing site at a local stadium. Upon the arrival of the HEMS team, approximately 80 minutes after the accident (08:11 pm), the patient was positioned in the left lateral recumbent position, clearly suffering, breathing spontaneously, and required supplementary oxygen therapy (15 l/minute) through a face mask. During the initial examination by a HEMS doctor, the patient was conscious (Glasgow Coma Scale 12), and was found to be under the influence of alcohol. The patient was markedly dyspneic with a respiratory rate of about 30/minute and an oxygen saturation ( $SpO_2$ ) level of 81%. There was bleeding from the mouth as a result of bilateral open mandible fracture. Subcutaneous emphysema developed and progressed rapidly on the face and the trunk, while chest palpation revealed bilateral instability of the chest wall with multiple ribs fractures. The abdominal wall was pain-free on palpation. The outline of the extremities was normal and the pelvis was stable. No other external bleeding was observed, both jugular veins were distended, the heart rate (HR) was 135/minute, and the noninvasive blood pressure (NIBP) was 109/40 mmHg.

Once intravenous (IV) access was obtained (17G), 25 mg of IV ketamine was administered, followed by 500 mL of crystalloids. The patient was rotated to a supine position, and 2 intravenous cannulas were placed into both thoracic cavities in the second intercostal space: an angiocath 14G  $\times$  83 mm in the midclavicular line on the right side, due to subcutaneous emphysema, and a standard 14G on the left. Air flow was obtained from both cannulas under pressure. Due to a quickly deteriorating state of consciousness, worsening subcutaneous emphysema, and aggravating respiratory failure despite pleural decompression, the patient was intubated with a 9.0-mm tube to a depth of 22 cm. The initial end-tidal carbon dioxide ( $EtCO_2$ ) of 30 mmHg decreased rapidly in line with the deterioration of cardio-respiratory function. Pulseless electrical activity (PEA) was observed at 08:23 pm and manual chest compressions were started. A chest drain (28F) was inserted into the left pleural cavity with continued cardio-pulmonary resuscitation followed by 100 mL of bloody discharge. As the

HEMS team was equipped with only a single thoracic drainage set, a 6.0-mm cuffed endotracheal tube was inserted through the single incision and manual tissue dilation into the right pleural cavity was initiated. Owing to the suspicion of cardiac tamponade (persisting PEA with progressive deformation of QRS complexes, significant distention of jugular veins), a substernal incision was attempted. Due to the patient's marked obesity, as well as the subcutaneous emphysema, the attempt to reach the pericardiac sac failed. In this situation, considering the ineffectiveness of the chest compressions (multiple rib fractures with chest wall instability, low  $EtCO_2$  values, and the widening of QRS complexes), the team decided to perform an emergency thoracotomy. The incision of the left 5<sup>th</sup> intercostal space, used to introduce the drain, was widened to a length of about 20 cm. After manual retraction of the ribs and ruling out cardiac tamponade, the treating physician began direct compressions of the heart. After 4 minutes, ventricular fibrillation (VF) was observed and an external biphasic defibrillation with a 200 J of energy was performed. After another minute of cardiac compressions, the return of spontaneous circulation (ROSC) was seen, with a palpable carotid artery pulse. The total time of circulatory arrest was about 10 minutes. The HR was 130/minute, NIBP: 113/82 mmHg (mean 90),  $SpO_2$ : 90%, and  $EtCO_2$ : 28 mmHg after ROSC. All tubes and cannulas, as well as the thoracotomy itself were fixed with sterile dressings, and the patient was covered with thermo-insulating material. Due to emerging hypotension, a continuous infusion of norepinephrine was initiated at a dose of 0.25  $\mu$ g/kg/minute. The transport to the trauma center in Cracow took 34 minutes. The parameters on admission were HR: 130/minute, NIBP: 78/50 mmHg,  $SpO_2$ : 97%, and a slow but pronounced pupillary reaction to light.

After performing an imaging examination and laboratory tests, both the thoracotomy and chest drainage were managed surgically. A chest computed tomography scan revealed bilateral pneumothorax and hydrothorax, pneumomediastinum, subcutaneous emphysema, massive contusion of both lungs with numerous sites of tissue tearing, and multi-

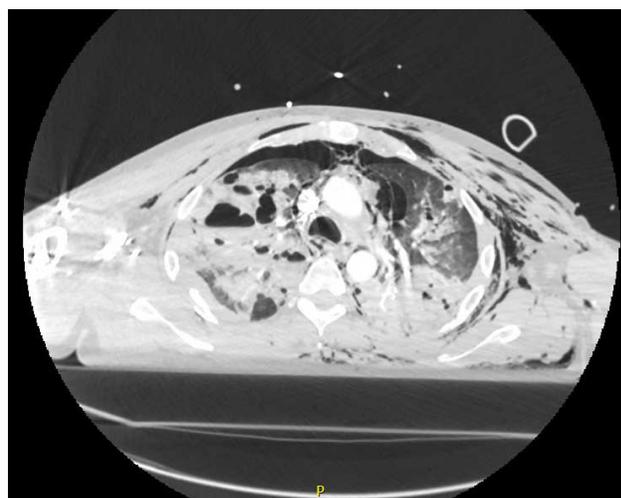


Figure 1. A chest computed tomography scan of the injuries.

level, bilateral fractures of the ribs (Fig. 1). The patient was extubated on the 17<sup>th</sup> day. Chest tubes were removed on the 22<sup>nd</sup> day. No neurological deficits were identified (cerebral performance category I). On the 31<sup>st</sup> day, the patient was discharged from the intensive care unit for further treatment in the rehabilitation ward. Having completed the rehabilitation program, the patient returned home free of any neurological deficits and returned to his previous activities. At 1-year follow-up, his general condition was in line with the state before the accident.

## DISCUSSION

Although the first PET was probably performed in 1902,<sup>[6,7]</sup> the first reported case was published in 1994.<sup>[8]</sup> Both cases occurred in the United States, and both patients survived and recovered fully. However, it was in other countries, such as Great Britain, Japan, Australia, Holland, Austria, and Spain, where PET became recognized as part of the algorithm used for severe trauma patients.<sup>[2,4,9-11]</sup> In recent years, there has been an increase in the number of case reports and case series of patients for whom PET was performed, with both penetrating and blunt injuries.<sup>[1,2,11-15]</sup> The presented case is probably the first example of an effective prehospital emergency thoracotomy performed on-scene in Poland.

Emergency thoracotomy performed in a hospital setting by qualified personnel is a commonly recognized procedure, which greatly increases the survival rate in patients after a major penetrating trauma with simultaneous or immediate cardiac arrest.<sup>[16]</sup> There is still, however, a lot of controversy around both the ethical as well as practical and procedural issues concerning conditions, indications, and the timing and selection of candidates for this procedure. In particular, there are concerns regarding the indications to perform PET in patients with blunt trauma.

Conventional resuscitation procedures have proven to be less effective in patients with cardiac arrest in trauma.<sup>[17-19]</sup> A recently published comparative analysis of groups of patients subjected to either external chest compressions or direct heart compressions after blunt injury revealed that both the 24-hour and definitive (on discharge) survival rate was lower in the PET group. An attempt to identify subgroups of patients in which an emergency thoracotomy was performed in an emergency unit that would increase chances of survival was unsuccessful. However, this analysis did not take into account a range of important factors, such as time intervals between emergency actions or the precise mechanism of injury.<sup>[19]</sup>

The survival rate of patients after PET was performed in the emergency department due to blunt injury to the chest has been reported to be 1.4% to 12.9%,<sup>[20,21]</sup> compared with a rate of 8.8% to 41.6% of those with penetrating injuries.<sup>[20,21]</sup> The interesting fact is that an analysis of HEMS data in

London (where the PET procedure was introduced in 1993) revealed that of 27 patients with blunt injuries who had PET performed on site, 2 (7.4%) survived, including 1 presenting no signs of life on the team's arrival.<sup>[1]</sup> The explanation for these surprisingly good treatment results, may be the active approach, decision time, and efficiency of the medical team. Indeed, the importance of the time factor has been confirmed by Matsumoto et al.<sup>[2]</sup> In that group of 95 patients with blunt injuries treated by PET, the probability of survival was significantly higher in the subgroup in which the PET had been performed by doctors at the scene compared with PET performed in the emergency department. Furthermore, the study carried out by Athanasiou et al.<sup>[1]</sup> suggests that patients with signs of life on arrival represents the target group most likely to benefit from PET.

The teams most experienced in performing PET are currently HEMS teams.<sup>[2,15]</sup> The knowledge, equipment, and high skill level of HEMS personnel, combined with their professional flexibility and task organization make them especially predisposed to act in a "stay and play" manner.

The safe and effective performance of PET requires a high degree of surgical training. Thus, the suggestion of introducing such a procedure to the HEMS in Norway was criticized by the Norwegian Surgical Association.<sup>[5]</sup> However, considering other invasive procedures performed on site (such as emergency cricothyrotomy and thoracostomy), it is not simply the extent of tissue damage that determines the ethical issue of one or another procedure in a situation when other techniques fail.<sup>[5]</sup> Nonetheless, it is beyond doubt that the degree of complexity of PET requires appropriate preparation of the whole team based on merit. This can only be achieved with both regular theoretical and practical training.

We hope that the case presented above will stimulate discussion concerning PET, and will induce further discussion regarding introducing nationwide services and the possible training of medical personnel in performing this life-saving procedure.

Conflict of interest: None declared.

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## OLGU SUNUMU - ÖZET

### Helikopter acil tıbbi servis ekibi tarafından yapılan hastane öncesi acil torakotomi: Bir olgu sunumu

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Göğüs yaralanmaları ile başvuran kritik hastalarda acil torakotomi hayat kurtarıcı bir işlem olabilir. Halen, olay yerinde uygulanan torakotomi için endikasyonlar acil ekip varlığında veya gelmeden 10 dakika önce meydana gelen kalp durması nedeniyle göğsün veya karnın üst bölümünün penetran yaralanmasıdır. Künt göğüs travmasında acil torakotomi için endikasyonlar daha düşük netlikte tanımlanmıştır. Bu olguda bir helikopter acil tıbbi servis ekibi olay yerinde acil torakotomi gerçekleştirmiştir. Bildiğimiz kadarıyla, Polonya'da böyle bir müdahale ilk kez tarif edilmektedir. Kırk bir yaşındaki bir erkek, kazaen traktör altında kalarak ezilmiştir. Tüm mevcut önlemler alınmış olmasına rağmen, yaralının kalbi aniden durmuş. Helikopter acil müdahale ekibi hastane öncesi kardiopulmoner arest tedavisinin ayrılmaz bir bileşeni olarak olay yerinde acilen torakotomi gerçekleştirmiştir. Hasta hayatta kalmış ve daha sonra hastaneden iyi bir fiziksel durumda taburcu edilmiştir. Serebral performans kategorisi I'e göre nörolojik defisit saptanmamıştır. Hasta önceki aktivitelerine herhangi bir komplikasyon veya defisit olmaksızın geri dönmüştür. Tamamen eğitilmiş bir ekibin varlığı, olay yerinde potansiyel olarak kritik acil durumda torakotomi yapılmasına olanak sağlar. Künt toraks yaralanması olan iyi seçilmiş bir hasta grubunda, hastane öncesi acil torakotomi önemli ve hayat kurtarıcı bir işlem olabilir.

**Anahtar sözcükler:** Acil tedavi; hastane öncesi kritik bakım; torakotomi.

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