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The diagnostic and therapeutic protocol in multiple and multi-organ trauma

Protokół diagnostyczno-terapeutyczny w mnogich i wielonarządowych obrażeniach ciała

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Abstract. Aim of the study**:** to evaluate the trauma patient load of the Emergency Department of the Military Institute of Medicine (ER) and to analyze the selected elements of the trauma team actions, identifying any possible means to improve the trauma resuscitation efficacy. Material and methods**:** the retrospective analysis was performed on the records from the patients being treated in the ER during the whole year of 2013. The following data was analyzed: the number of trauma patients, the number of patients fulfilling the criteria for trauma center admittance, the means of their transport and the number of trauma fatalities. The time of the trauma team acting in the resuscitation area was calculated. The applied protocol was analyzed and compared to data available from the literature. Results: patients with multiple and multi-organ trauma accounted for 0.71% of the total number of cases admitted to the ER. The criteria for the trauma center admittance were met by 58.7% of them. The fatality rate was 1.8%. The applied protocol was: to admit the trauma patient to the red area of the ER and to perform the trauma survey, the initial diagnostics and treatment. The median of the resuscitation time was 38 minutes, with first and third quartiles respectively: 29 and 48 minutes. Conclusions: the implementation of the team work model in management of the trauma patients may shorten the resuscitation time and improve its effectiveness.
Key words: diagnostic and therapeutic protocol, Emergency Department, multiple trauma, multi-organ injures

Streszczenie. Cel pracy: ocena obciążenia SOR WIM pacjentami urazowymi oraz analiza wybranych elementów działań zespołów urazowych w celu wykazania możliwości poprawy efektywności resuscytacji okołourazowej. Materiał i metody: przeprowadzono retrospektywną analizę danych zawartych w dokumentacji medycznej oraz szpitalnym systemie informatycznym dotyczących pacjentów urazowych leczonych w 2013 r. na SOR WIM. Analizie poddano liczbę pacjentów urazowych leczonych na SOR, liczbę pacjentów spełniających kryteria hospitalizacji w centrum urazowym, sposób transportu do SOR oraz liczbę zgonów z przyczyn urazowych. Obliczono czas działania zespołu urazowego. Poddano analizie stosowany protokół postępowania, który skorelowano z danymi z piśmiennictwa. Wyniki: Chorzy po urazach z mnogimi i wielonarządowymi obrażeniami ciała stanowili 0,71% wszystkich hospitalizacji na SOR. Kryteria transportu do centrum urazowego spełniało 58,7% poszkodowanych. Śmiertelność okołourazowa wyniosła 1,8%. Stosowany protokół postępowania polegał na przejęciu pacjenta urazowego w obrębie części czerwonej SOR z następowym badaniem urazowym, monitorowaniem, wstępną diagnostyką i leczeniem. Mediana czasu resuscytacji wyniosła 38 minut, a pierwszy i trzeci kwartyl odpowiednio: 29 i 48 minut. Wnioski: Wdrożenie zespołowego modelu postępowania z pacjentami urazowymi może skrócić czas trwania resuscytacji okołourazowej oraz zwiększyć jej efektywność.
Słowa kluczowe: mnogie obrażenia ciała, protokół diagnostyczno-terapeutyczny, SOR, urazy wielonarządowe

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Introduction

Trauma is the most common cause of death of people aged below 44 [1-9]. Every year, approximately 3.5 million people in Poland suffer from trauma, 300 thousand of whom require specialist treatment. Multiple trauma constitutes 10-20% of hospitalization cases caused by trauma. The fatality rate following trauma is 75 per 100 thousand inhabitants [6,7]. Trauma is the third biggest cause of death in Poland, after cardiovascular diseases and neoplasms [6].

Most patients with multi-organ trauma are brought to Emergency Departments (ERs) as victims of non-penetrating trauma, mainly due to road accidents. A major percentage of the injured patients (50-63%) dies shortly after trauma exposure during the pre-hospital period. Other severe trauma patients, who are transported to the hospital, are at the risk of loss of life due to hemorrhagic shock, acute respiratory distress syndrome (ARDS) or an upper motor neuron lesion. The above pathologies occur in a number of cases, which hampers diagnosis and treatment [4,10].

In response to the need for specialist and comprehensive care for post-trauma patients, a network of 14 trauma centers has emerged in Poland. The centers fall under the Regulation of the Polish Minister of Health of 18 June 2010 on trauma centers [11]. The Regulation specifies organizational matters and defines, among other things, the trauma team functioning within the Emergency Department (ER) as a group of specialists who make comprehensive diagnoses and provide a trauma patient with multi-specialist treatment in accordance with the current medical knowledge of the treatment of severe, multiple or multi-organ trauma.

Trauma patients undergoing treatment in the ER require procedures that focus on the rapid stabilization of vital signs, and the recognition and the rescue treatment of trauma posing a direct threat to life. When patients whose trauma has been initially identified as multi-organ trauma are admitted to the ER, their clinical condition may be different, depending on the location and severity of injuries, the mechanism and time of their occurrence and the scope of activities undertaken by the medical rescue team at the place of accident. The fate of the patient depends on the rapid identification of trauma, setting of priorities and development of an action plan [3]. The emergency protocol thus demands increased activity from the emergency team, with an aim to effectively target trauma and prevent possible complications. It is necessary to operate efficiently in such situations, which is possible only if an optimal diagnostic and therapeutic protocol has been implemented.

Aim

The aim of the study is to evaluate the trauma patient load of the Emergency Department of the Military Institute of Medicine (ER) and to analyze the selected elements of the trauma team actions, identifying any possible means to improve the trauma resuscitation efficacy.

Material and Methods

The study comprised a retrospective analysis of data contained in medical documentation and the hospital's IT system, which pertain to patients with multiple and multi-organ trauma undergoing treatment in 2013 in the ER. The analyzed data included the number of trauma patients undergoing treatment in the ER, the number of patients fulfilling the criteria for trauma center admittance, a method of transporting the patient to the ER and the number of deaths due to trauma. The analysis involved the calculation of the following parameters: the median, the first and the third quartile of the time of the trauma team activity in the ER's resuscitation area, measured from the moment when the Medical Air Rescue Team (MART) or the Medical Rescue Team (MRT) transfers a patient to the ER, until the moment when the patient reaches the operating room (if the case requires immediate surgery) or when the patient reaches the Radiology Department for imaging diagnostics (if the case does not require immediate surgery. The ER's protocol for trauma patients was analysed as well, which was correlated with data from references.

Results

The adopted methods indicate that the ER treated 337 patients with multiple and multi-organ trauma in 2013. This constitutes 0.71% of all interventions taking place in the ER. 198 of the injured patients (58.7% of the study group) fulfilled the criteria for treatment in the trauma center at the time of their admission to the ER. 6 patients died due to their injuries during rescue activities performed in the resuscitation area of the ER (1.8% of the study group). 98 patients were transported to the ER by the MART and the remaining number of patients was transported to the ER by the MRT.

Table 1 contains the times of the trauma team acting in the resuscitation area, which were calculated according to the adopted methods.

The ER procedure involves taking over a trauma patient from the leader of the MRT or the MART in the resuscitation area of the ER and carrying out trauma examination, monitoring, preliminary diagnosis and treatment. The examination was performed in accordance with the ATLS protocol. The preliminary diagnosis included the monitoring of physiological parameters, the performance of lab tests, blood type identification and, if necessary, toxicology and FAST. Depending on the condition of a trauma patient, preliminary treatment included resuscitation activities, oxygen therapy, stabilization of the circulatory system, sedation and analgesia. Patients with indication for emergency surgery

Table 1. The time of the trauma team acting in the resuscitation area (hh:mm:ss)
Tabela 1. Czas działania zespołu urazowego na obszarze resuscytacyjno-zabiegowym SOR (gg:mm:ss)

	1st quartile	Median	3rd quartile
Time	00:29:00	00:38:00	00:48:00

were transported directly to the operating room. Patients without indication for surgery, suffering from hemodynamic or respiratory instability resistant to intensive treatment were transported to the Intensive Care Unit (ICU). If there were no vacant places left at the ICU, a patient was placed in the ER's preliminary intensive care area until he or she was admitted to a department capable of providing him or her with intensive care. Remaining patients were directed to undergo an in-depth imaging diagnosis and then to temporarily stay in the preliminary intensive care area or the ER's monitoring area or to stay in a selected department for definitive treatment.

Following the adopted procedure, the leader of the trauma team (a surgeon or an emergency physician) managed all rescue activities. The trauma team was created ad hoc and included some members of the ER personnel on duty. There was no procedure for arranging the team beforehand and assigning tasks to particular trauma team members.

Discussion

A network of trauma centers has been undergoing development since 2010 on the basis of selected multi-specialist centers. Polish legislation specifies the tasks of the trauma centers, which include admission, comprehensive diagnosis and multi-specialist treatment of trauma patients according to the current medical knowledge of the treatment of severe, multiple or multi-organ trauma [11,12]. It also provides the centers with clear criteria for patient admittance that are based on the co-occurrence of particular anatomical injuries and physiological disturbances [11]. Unfortunately, it frequently happens that many of the currently admitted trauma patients do not fulfill the criteria specified by the Regulation. 58.7% of patients with multiple and multi-organ trauma who were admitted to the ER (which functions within the structure of a trauma center) did not fulfill the criteria for admittance in 2013. Since the ER personnel has the obligation to provide patients suffering from the most severe trauma with specialist treatment, it has to be highly competent and familiar with the medical knowledge related to emergency cases and the care of patients with multi-organ trauma. Rules for the resuscitation and the preliminary treatment of trauma patients indicate that the personnel is obliged to perform intense rescue activities from the moment when the patient enters the ER. The activities should remain in continuity with activities undertaken in the pre-hospital period and they should result in the identification and the treatment of life-threatening trauma, determination of the character and the size of other occurring pathologies and establishing diagnostic and therapeutic priorities.

American trauma centers operate according to procedures specifying criteria for activating a trauma team, its members, the location of the members by the patient's bed and their tasks. Trauma teams are activated when there is a necessity to resuscitate a trauma patient. Every member of a trauma team has different tasks and the members carry out rescue procedures simultaneously, which shortens the time of resuscitation activities. Tasks of a trauma team include determining the character and the scope of sustained injuries, resuscitation and stabilization of vital functions, setting priorities and the order of treatment and preparing and transporting a patient to the place of definitive treatment [13]. Table 2 [13] presents phases of preliminary proceedings for the management of trauma patients according to the guidelines by the American Surgical Association. Figure [1] presents an example position of trauma team members.

Bearing in mind the data from references, it seems that optimal results for the treatment of patients with multi-organ trauma require teamwork-based treatment and pre-planning of activities of team members participating in trauma-related resuscitation [14]. These assumptions allow team members to simultaneously carry out their assigned tasks, which shortens the time of preliminary treatment and thus increases the survival chance of a trauma patient.

The study of the data regarding the ER at the Military Institute of Medicine reveals that the median time of trauma-related resuscitation performed in the resuscitation area was 38 minutes and the first and the third quartile were 29 and 48 minutes, respectively. The results are comparable to the data mentioned in the American medicine literature. The analysis of trauma-related resuscitation times for non-penetrating trauma in level I American trauma centers (St Paul Ramsey Medical Center and Hennepin County Medical Center) revealed the following corresponding results: 39 ±13 and 27 ±12 minutes [15]. The data included in the reference indicate that it is possible to reduce the time of resuscitation activities by 9-12%, if a trauma center implements a teamwork-based action model and assigns particular tasks to individual team members. Moreover, changing the work organization of trauma teams reduces the commencement time of life-saving procedures, thereby reducing both early and late trauma fatality [14].

The authors' experience indicates that the proper organization of hospital areas for early resuscitation activities and the provision of the areas with appropriate equipment are key to the successful treatment of patients with multi-organ trauma. The areas should have conditions allowing a trauma team

Table 2. Stages of initial management with trauma patients according to ATLS [1]
Tabela 2. Etapy postępowania wstępnego z pacjentami urazowymi według ATLS [1]

Primary survey (15 seconds)
– ***A**irways* – examination of the cervical spine, voice, air movement, open airway, immobilization of the cervical spine
– ***B**reathing* respiratory sounds, chest movements, blood circulation in jugular veins
– ***C**irculation* skin color, heart rate, blood pressure, blood circulation in jugular veins, external bleeding
– ***D**isability* opening the patient's eyes, verbal response, response to pain
– ***E**xposure*
Resuscitation
– ECG monitoring, saturation, RR, venipuncture, lab tests
– treatment of life-threatening conditions identified during the primary survey
– gastric probe, urinary catheterization
Secondary survey
– head-to-toe examination
– The SAMPLE interview (S – *symptoms*, A – *allergies*, M – *medications*, P – *past illness*, L – *last meal*, E – *events related to injury*)
– imaging (FAST, X-ray, CT, MR)
The team may interrupt the secondary survey if it appears necessary to transport the patient whose condition is unstable or critical to the operating room.
Definitive care
– surgery (possible to perform in the resuscitation phase)
– dressing fractures
– pharmacotherapy (3A): *analgesics, antibiotics, anti-tetanus*
– Specialist consultations
– transporting a patient to a specialist ward

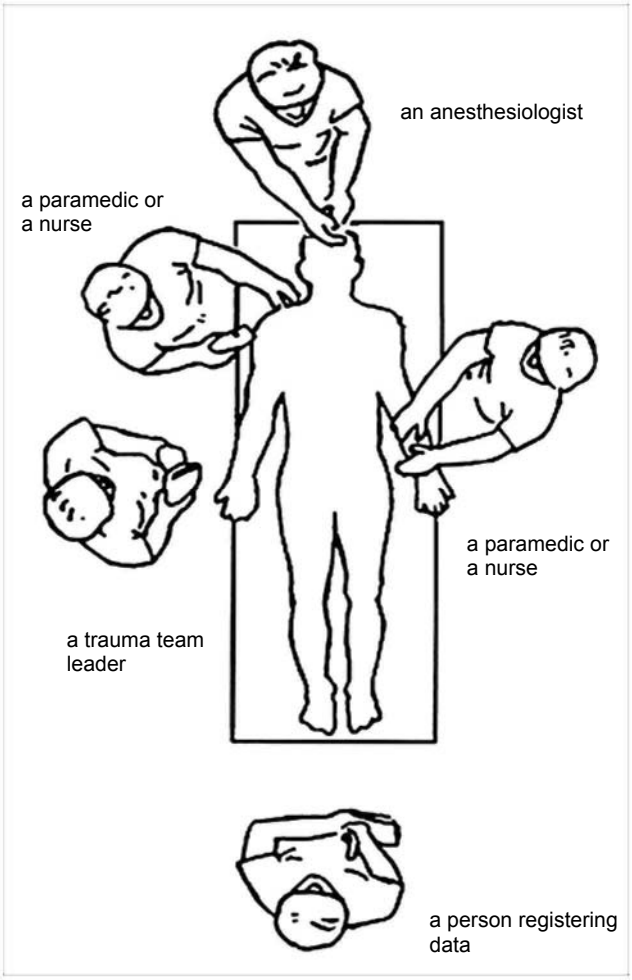

Figure. An example of the trauma team
Rycina. Przykładowy skład zespołu urazowego

at least to monitor and maintain the vital functions, carry out trauma-related resuscitation, basic early diagnosis and initial trauma treatment. It is necessary to provide a trauma team with continuous access to blood preparations and their ingredients and with the ability to perform emergency surgeries whose scope is frequently reduced due to the critical condition of a patient (damage control surgeries). This requires strict cooperation with specialist surgeons and constant access to an operating room adapted to all kinds of surgical procedures.

Polish system for the treatment of trauma patients needs improvement in a number of aspects. Patients with multiple and multi-organ injuries who are admitted to the emergency room should be provided with medical care by a highly-qualified team that is capable of immediately starting effective and well-organized resuscitation activities, stabilizing the condition of a patient, identifying and definitively treating the sustained trauma. In order for rescue activities to be as optimal as possible, trauma team members should perform their clearly pre-defined tasks concurrently [16,17]. If the rescue tasks are not pre-planned, they may cause chaos, decreasing the effectiveness of patient care and increasing the risk of diagnostic errors. In view of the above, it is crucial that the team work model in management of the trauma patients is implemented in the ER and trauma centers.

Conclusions

Implementation of the team work model in management of the trauma patients may shorten the resuscitation time and improve its effectiveness.

References

1. Peitzman AB, Rhodes M, Schwab CW, et al.: The trauma manual. Philadelphia, Lippincott Williams & Wilkins, 2002
2. Brongel L, Lasek J, Słowiński K (eds): Podstawy współczesnej chirurgii urazowej [The basics of contemporary trauma surgery]. Kraków, Krakowskie Wydawnictwo Medyczne, 2008
3. Brongel L, Duda K (eds): Mnogie i wielonarządowe obrażenia ciała [Multiple and multi-organ trauma]. Warsaw, Wydaw. Lek. PZWL, 2001
4. Lasek J. Mnogie obrażenia ciała [Multiple bodily injuries]. In: Brongel L, Lasek J, Słowiński K (eds). Podstawy współczesnej chirurgii urazowej [The basics of contemporary trauma surgery]. Kraków, Krakowskie Wydawnictwo Medyczne, 2008: 581
5. Dattaro JA. Urazy [Trauma]. In: Plantz SH, Wipfler EJ: Medycyna ratunkowa [Emergency medicine]. Wrocław, Elsevier Urban & Partner, 2008: 623-673
6. Lipiński J (ed.): Program zwalczania skutków ciężkich i mnogich obrażeń ciała [A program for the eradication of the effects of severe and multiple bodily injuries]. Warsaw, MZiOS, 1997
7. Mlekodaj S, Piasecki Z, Olakowski T.: Wpływ następstw wypadków na kształtowanie się sytuacji zdrowotnej społeczeństwa polskiego [The influence of accidents on the health situation of the Polish society]. Pol Przegl Chir, 1995; 67: 267
8. Gula P, Koszowska M, Larysz D, et al.: Wstępne postępowanie diagnostyczne w mnogich obrażeniach ciała [Preliminary diagnostic procedure for multiple trauma]. Med Intensyw Ratunk, 2008; 2: 85-90
9. MacKenzie EJ, Morris JA, Smith GS, et al.: Acute hospital costs of trauma in the United States: implications for regionalized systems of care. J Trauma, 1990; 30: 1096
10. Payne SR, Waller JA: Trauma registry and trauma center bases in injury research. J Trauma, 1989; 29: 424
11. Rozporządzenie Ministra Zdrowia z dnia 18 czerwca 2010 r. w sprawie centrum urazowego [Regulation of the Polish Minister of Health of 18 June 2010 on trauma centers]. Journal of Laws 2009, no. 39 item 322
12. Ustawa z dnia 8 września 2006 r. o Państwowym Ratownictwie Medycznym [Polish Act of 8 September 2006 on the National Emergency Medical Service]. Journal of Laws 2006, no. 191 item 1410
13. American College of Surgeons: Resources for the optimal care of the injured patient: 2006. Chicago, IL, American College of Surgeons, 2006
14. Driscoll PA, Brook S. Intensywne leczenie doraźne chorych po ciężkich urazach [Intensive emergency treatment of patients with severe trauma]. In: Driscoll PA, Gwinnutt CL, Jimmerson CL, et al.: Doraźne leczenie urazów. [Trauma resuscitation: the team approach]. Warsaw, Wydaw. Lek. PZWL, 1997:29
15. Khetarpal S, Steinbrunn BS, McGonigal, et al.: Trauma faculty and trauma team activation: impact on trauma system function and patient outcome. J Trauma, 1999; 47: 576-581
16. Brongel L, Kuliś M: Algorytm postępowania w mnogich obrażeniach ciała [A procedural algorithm for the management of multiple trauma]. In: Brongel L (ed): Złota godzina, czas życia, czas śmierci [The golden hour: the time of life, the time of death]. Kraków, Krakowskie Wydawnictwo Medyczne, 2007: 107-124
17. Driscoll P, Skinner D, Earlam R.: ABC postępowania w urazach [ABC of Major Trauma]. Wrocław, Wydaw. Med. Górnicki, 2008

A massive bleeding – what can we do in prehospital tactical care? Combat lessons-learned

Ostra utrata krwi – co możemy zrobić w warunkach przedszpitalnych? Doświadczenia pola walki

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Abstract. The authors presented the practical conclusions and therapeutic recommendations for the heavily bleeding patients, managed under combat conditions. Such therapy is vital for the wounded in the hostile tactical environment. The military medical solutions for assuring the effective hemostasis or applying the restrictive fluid therapy in internal bleeding cases may be useful also in civilian medicine.
Key words: hemorrhage, massive bleeding, tactical combat care

Streszczenie. Autorzy przedstawili praktyczne wnioski i zalecenia postępowania w przypadku wystąpienia krwotoków w warunkach pola walki. Ich stosowanie ma kluczowe znaczenie dla osiągnięcia sukcesu i przeżycia rannych w niesprzyjających warunkach środowiska taktycznego. Doświadczenia medycyny wojskowej i praktyczne rozwiązania w celu zapewnienia skutecznej hemostazy lub zachowania restrykcyjnej płynoterapii w przypadku krwotoków wewnętrznych mogą znaleźć zastosowanie również w cywilnej opiece przedszpitalnej.
Słowa kluczowe: krwotok, masywne krwawienie, polowa opieka nad rannym

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Massive bleeding is the most frequent cause of death under combat conditions. Limb trauma is currently the main cause of bleeding [1]. Modern tactical protective gear (a ballistic vest, a kevlar helmet) protect the torso and the head of a soldier. At the same time, limbs remain exposed to direct trauma. Bleeding from limbs is the most common, potentially reversible cause of death in the battlefield. Combat medics can manage it by applying direct pressure to the place of bleeding and using a pressure dressing such as emergency bandage, Olaes or a tactical tourniquet.

Conventional pressure is not, unfortunately, effective against bleeding into body cavities. This type of bleeding requires careful observation and management of the injured and, what is even more important, immediate evacuation of the injured to a level 2 field medical facility for the purposes of care and appropriate surgical treatment.

A hemorrhage [2] is defined as the loss of:

- 1.5 ml/kg bodyweight/min of blood within 20 minutes,
- 150 ml/kg bodyweight/min of blood within 1 hour.

Taking appropriate therapeutic actions has an influence on the dynamics and effects of bleeding. These actions include:

- identification of a massive bleeding
- applying the scoop and run approach in the case of an internal hemorrhage,
- applying the stay and play approach in the case of an external hemorrhage,
- performing correct local hemostasis (direct compression, a tactical tourniquet, wound packing, a local hemostatic agent, a pressure clamp),

Table 1. Classification of blood loss by American College of Surgeons (for a 70 kg, male)
Tabela 1. Klasyfikacja utraty krwi Amerykańskiego Towarzystwa Chirurgów (dotyczy mężczyzny o masie ciała ok. 70 kg)

	Class I	Class II	Class III	Class IV
blood loss (ml)	<750	750-1500	1500-2000	>2000
blood loss (% blood volume)	<15	15-30	30-40	>40
Pulse rate (per minute)	<100	100-120	120-140	>140
Blood pressure	Normal or decreased	Decreased	Decreased	Decreased
Capillary refill time	Normal	Normal	Extended	Extended
Respiratory rate (per minute)	14-20	20-30	30-35	>35
Urine output (ml/h)	>30	15-30	5-15	Negligible
Mental status Fluid replacement	Anxious Crystalloid	Anxious Crystalloid	Anxious, confused Crystalloid and blood	Confused, lethargic Crystalloid and blood

- influencing internal hemostasis (Tranexamic acid, TXA),
- preventing hypothermia,
- hypotensive fluid resuscitation (and fluids, if necessary)
- immobilization of fractures,
- pain management (ketamine vs. opioids)

A combat medic is expected not only to dress bleeding properly, but also, depending on the trauma sustained by a soldier, to predict possible blood loss. It is estimated that an adult may lose:

- 1000-1500 ml of blood from a damaged lung
- 2000 ml of blood from a damaged liver,
- 2000 ml of blood from a damaged spleen,
- 3000-5000 ml of blood in the case of pelvic trauma,
- 1500-2000 ml of blood due to a fractured femur,
- 1000 ml of blood due to a crus fracture,
- 800 ml of blood due to a humerus fracture,
- 400 ml of blood due to the fracture of a forearm bone.

A combat medic has to be familiar with this knowledge in order to plan appropriate treatment and implement a suitable fluid therapy and approach (scoop and run or stay and play) [3].

Hemorrhagic shock leads to tissue hypoxia and acidosis [4], thus increasing metabolic disturbances and worsening the patient's condition.

The classification of blood loss-related symptoms by the American College of Surgeons (ACS) from 1997 is a useful tool for combat medics. It allows them to classify the injured into four groups according to clinical symptoms, evaluate the approximate volume of blood loss and recommend the best form of fluid replacement.

Based on the analysis of previous armed conflicts, a tourniquet has been regarded in the second half of the twentieth century as an unsafe tool to stop bleeding due to a number of complications related to the ischemia of limb muscles and nerves, and the frequent ineffectiveness of the device, usually resulting from its inappropriate physical properties. It appears that now, thanks to recent changes in its design and positive recommendations after its use in Iraq (Operation Iraqi Freedom) and Afghanistan (Operation Enduring Freedom), a tourniquet is experiencing a revival. There are two types of tactical tourniquets recommended for the contemporary battlefield: CAT (Combat Application Tourniquet) and SOFTT-W (Special Operation Forces Tactical Tourniquet-Wide).

In the event of an exchange of fire (under fire), the first necessary action is to apply a tactical tourniquet to manage a life-threatening bleeding (Fig. 1 and 2). If actions taken as part of the tactical combat casualty care (TCCC) (direct compression, a pressure dressing) did not stop the bleeding, a medic should keep the pressure on the bleeding until surgical intervention, which should not exceed 2 hours [5,6].

According to the TCCC guidelines, a combat medic should apply a tactical tourniquet:

- during the care under fire phase – on a uniform, as proximally as possible on a wounded limb (applied by the wounded soldier or by a combat medic),
- during the tactical field care phase, in a safe (hidden) place – 2-3 inches above the wound, directly on the skin, if hemorrhage is impossible to stop by compression dressing or hemostatic agents (i.e. post-traumatic amputations).

Figure 1. CAT tourniquet
Rycina 1. Staza taktyczna CAT

Figure 2. SOFTT-W tourniquet
Rycina 2. Staza taktyczna SOFTT-W

- if applying a tourniquet does not stop the bleeding, check the pressure of the tourniquet or apply another tourniquet proximally (above the first one),
- since blood vessels may be hidden in the soft tissue between bones, hemostasis may be ineffective when applying compression to a forearm or a lower leg. If this is the case, it is recommended to apply a tourniquet to an arm or a thigh (one bone of which is along the limb axis) [5.7].

Tightening the tourniquet should stop the blood flow (no pulse) in a limb below the tourniquet. To indicate that the tourniquet has been applied, a combat medic should also mark the forehead or the cheek of the wounded soldier with a large letter "T", and also mark the tourniquet and the soldier's skin with the time of tightening and include the time in documentation. In the case of prolonged evacuation, consider releasing pressure from the limb after 2 hours, but before doing so, use a combat gauze (QuikClot, Celox) as a local hemostatic agent. Apply pressure for at least 3 minutes using the combat gauze for direct contact with the wound and a normal gauze as a top layer. Release the tightened tourniquet only if the wounded soldier has a normal hemodynamic response to the administered fluids, which is reflected in the recovery of normal peripheral pulse and the improvement of mental status (if the soldier does not additionally suffer from a head trauma). In other words, if the wounded soldier is under the risk of a fatal bleeding, the priority is to save the life and not the limb. At any rate, keeping the tourniquet tightened for longer than 2 hours does not always lead to a limb amputation. The risk of complications resulting from limb ischemia and reperfusion injury is, however, greater in that case.

A tactical tourniquet is effective in stopping a limb bleeding but it should be used only when other measures do not stop the bleeding (according to the evaluation by a trained medic).

Kragh et al. [6] have demonstrated that the use of a tactical tourniquet has direct influence on survival in 87% of the studied patients($p < 0.001$) and prevents the occurrence of hemorrhagic shock in 90% of the studied patients ($p < 0.001$). They have also shown that the fatality rate was higher among cases where the tourniquet was applied with delay (11% under pre-hospital conditions and as much as 24% after admission to hospital, $p = 0.05$). In 5 cases there were indications for the use of a tourniquet but other measures were applied, which turned out to be ineffective. As a consequence, the patients did not survive.

Kragh et al. [8] have also revealed that the application of 428 tourniquets in 232 patients (to 309 wounded limbs) did not increase fatality rate among the patients (lack of dependence) and did not lead to amputation. Only 4 patients (1.7%) suffered from complications in the form of residual paresthesia. The percentage of fasciotomies was 28% in patients whose time of tourniquet application was ≤2 hours (75 of 272 patients) and 36% in patients whose time of tourniquet application was >2 hours (9 of 25 patients, $p = 0.4$).

Nevertheless, the American College of Surgeons allows medics to use a tourniquet as part of Advanced Trauma Life Support only as a last resort, when direct pressure fails, accepting the tourniquet as a measure of choice in the case of post-traumatic amputation [9]. It also recommends using pneumatic pressure in hospital conditions. Swan's study [10] compares the effectiveness of tourniquets with direct compression to blood vessels in pressure points (commonly learned as part of first aid) in 10 healthy volunteers. The endpoint of the study was the loss of signal of distal blood flow in the vessel, as monitored by the Doppler device. Results of the study indicate that

Figure 3. QuikClot Combat Gauze

Rycina 3. Gaza hemostatyczna QuikClot

Figure 4. Celox Gauze

Rycina 4. Gaza hemostatyczna Celox

while the application of a tourniquet is fully effective, using pressure points is ineffective at controlling bleeding.

What is crucial in this matter is to provide medical personnel and battlefield operators with training on tourniquet application to control limb bleeding, which should minimize the percentage of preventable deaths caused by massive external bleeding in the battlefield.

Hemostatic agents used in the battlefield

There are two substances in use currently:

- Kaolin - zeolite (QuikClot),
- Chitosan (Celox, HemCon, WoundStat, ChitoGauze, ChitoFlex).

Kaolin is an inert volcanic mineral containing silicon and clay, which is impregnated in the form of a combat gauze [Fig. 3]. It is non-toxic and it does not cause allergy. The currently used third generation of wound dressings with kaolin does not trigger adverse exothermic reactions that lead to tissue burns. The mechanism of hemostatic action is based on the activation of an internal coagulation cascade. Kaolin absorbs water from the surrounding area, activates factor XII, platelets and facilitates the formation of fibrin. Since the mineral is not biodegradable and removing it from the wound used to be problematic (it was used in the form of granules), it is currently used in the forms of a rolled or a Z-folded QuikClot combat gauze [Fig. 3] and a clotting sponge (QuikClot ACS+) [11,12].

Chitosan is manufactured from crustacean shells. It is a linear polysaccharide used in the form of granules. The mechanism of hemostatic action is based on the formation of a pseudo-clot and a gel dressing as a result of the exchange of electric charges between the substance and erythrocytes. Chitosan is a biodegradable material. Lysozyme breaks it down to glucosamine. It is used in the form of granules (Celox D), a dispenser with granules for penetrating wounds (Celox A), a gauze impregnated with the active substance (Celox Gauze [Fig. 4]) and adhesive dressing (HemCon). Advantages of chitosan include effectiveness at stopping bleeding in patients treated with warfarin derivatives or heparin and effective use in hypothermic patients, as the substance retains its hemostatic properties in contact with blood whose temperature lowers to 13-18°C [11,12].

Local hemostatic agents should be used in body areas where a tactical tourniquet cannot be applied (the torso) and in the cases of junctional hemorrhage (occurring in the area of the neck, the axillary fossa or the groin). They are a better alternative to a tourniquet when it is necessary to stop local bleeding from a limb, even though they cannot replace the tourniquet in all cases.

The use of a hemostatic agent must be accompanied by the application of constant pressure for at least 3-5 minutes.

The American army presently recommends QuikClot and HemCon as hemostatic agents [7,11]. Soldiers in Polish military contingents are equipped with an individual medical kit (IPMed) which includes QuikClot (*combat gauze*) and Celox (*gauze*). Tactical operators and combat medics undergo training to learn what measure and what form of the measure they should use to achieve effective hemostasis.

Figure 5. Combat Ready Clamp (CRoC)

Rycina 5. Combat Ready Clamp (CRoC)

Figure 6. Junctional Emergency Treatment Tool (JETT)

Rycina 6. Junctional Emergency Treatment Tool (JETT)

Figure 7. Abdominal Aortic & Junctional Tourniquet (AAJT)

Rycina 7. Abdominal Aortic & Junctional Tourniquet (AAJT)

Pressure clamps

Estimates suggest that damage to great vessels in the pelvis is the cause of approximately 25% of hemorrhages. Bleeding from great vessels requires direct pressure [1,13,14]. In order to ensure effective action and release the hands of the medic applying the pressure, 3 systems to stop bleeding are currently in use:

Figure 8. Israeli emergency bandage

Rycina 8. Opatrunek izraelski

- Combat Ready Clamp (CRoC [Fig. 5.]),
- Junctional Emergency Treatment Tool (JETT [Fig. 6]),
- Abdominal Aortic & Junctional Tourniquet (AAJT [Fig. 7]).

Their action is based on the external mechanical compression of groin tissues and the common iliac artery from one (CRoC) or two (JETT) sides or on the pneumatic pressure, the purpose of which is to compress the abdominal aorta and iliac arteries by increasing abdominal press (AAJT).

TCCC guidelines recommend using a pressure clamp or the local application of a hemostatic agent, combined with applying direct pressure to the groin, depending on whether a device is unavailable or ready for use [5].

Pressure dressing

External bleeding is frequently the effect of trauma, both in the battlefield and in the civilian environment. Luckily, not every bleeding is heavy, which means that taking such aggressive measures as the application of a pressure clamp or a local hemostatic agent is not always a necessity.

The Emergency Bandage, also called the Israeli bandage, is a recognized measure for stopping bleeding [Fig. 8]. Manufactured for the army in four sizes (including the size for dressing abdominal wounds), the Emergency Bandage is elastic and contains a one-layer or a two-layer gauze pad with a clamp on top that is used to exert directional pressure.

Another practical measure is Olaes Modular Bandage (Fig. 9), which is designed as a "3 in 1" pressure solution. The elastic roll of the bandage features a plastic pressure pad and a gauze to pack a wound. The bandage also has sewn in Velcro® control strips, which prevent the roll from accidental unwrapping.

Figure 9. OLAES Modular Bandage
Rycina 9. Opatrunek OLAES

Wound packing

Some believe that direct pressure and appropriate wound packing with gauze is more important in stopping bleeding than the influence of a local hemostatic agent [12,15]. This is why tactical emergency training puts emphasis on the development and improvement of manual abilities to appropriately pack a wound using gauze, regardless of whether a hemostatic agent is used to manage bleeding wounds or not.

Tranexamic acid (TXA)

This active substance has been known for years and is currently experiencing a revival thanks to recommendations by the Committee on the Tactical Combat Casualty Care. It belongs to fibrinolysis inhibitors (dissolving blood clots) and prevents plasminogen from activation to plasmin. Indications for use in the battlefield are the following: symptoms of hemorrhagic shock, one or more severe amputations and penetrating wounds of the torso or multiple sources of bleeding. TCCC guidelines recommend administering 1 g of tranexamic acid (Exacyl®) in 100 ml of physiological NaCl solution or lactated Ringer's solution as quickly as possible and no later than 3 hours after trauma. The second dose of TXA (1 g) should be applied after administering Hextend (HAES, a colloidal solution) or after alternative fluid therapy [5]. It is used by medics under combat conditions.

Hypotensive fluid resuscitation

Tactical medics examining a shock may find the following evaluation parameters particularly useful: the mental state, the presence of radial pulse and its rate. Other useful (but not required) parameters include blood pressure, respiration rate, capillary refill time, anxiety and the sense of deadly threat [3,7].

Guidelines regarding the administration of crystalloid solutions are in contrast to restrictive guidelines for fluid therapy under combat conditions (intravenous, without fluids or transfusing small volumes of colloids).

TCCC guidelines and US Army procedures for prehospital management of the injured soldier with identified hemorrhage dictate the following:

- if the bleeding has been stopped and there are no symptoms of shock, do not transfuse fluids;
- if the bleeding has been stopped and there are symptoms of shock, administer a 500 ml bolus of Hextend (HAES) intravenously; repeat after 30 minutes if shock symptoms persist (do not administer more than 1000 ml of Hextend),
- do not transfuse fluids in the case of uncontrolled internal (abdominal, thoracic) bleeding [5,7]. Hypotensive fluid resuscitation aims to maintain approximately 75% of the value of normal blood pressure, so that systolic blood pressure does not exceed 90 mm Hg and MAP is 40-50 mm Hg.

Reducing intravenous fluid administration prevents the occurrence of coagulopathy resulting from dilution [3,7].

In the case of hypotensive patients with penetrating trauma of the torso and severe head trauma, it is recommended to administer hypertonic NaCl solution in hydroxyethyl starch (HyperHAES) as part of fluid resuscitation [16,17].

Normal rules for fluid resuscitation and crystalloids (see Table 1) should be applied:

- in hemodynamically stable patients,
- after stopping isolated external bleeding that is not compression resistant,
- in severe head traumas (maintain the systolic blood pressure of <110 mm Hg),
- in burns,
- in the case of crush syndrome.

Hypothermia

Lowering body temperature by 1°C results in a 10-percent decrease in the ability to form a clot. Hypothermia, along with coagulopathy and acidosis, is a major pathomechanism contributing to the death of the injured person due to bleeding. Since warm fluids are not available under combat conditions, thermal equipment, such as the Ready Heat Blanket, and protective evacuation equipment, such as the Blizzard Survival Blanket and the Hypothermia Prevention and Management Kit (HPMK), is used to insulate the injured soldier and protect him or her against heat loss. Hypothermia prevention is a key factor in preventing the occurrence of systemic coagulation disturbances and fatal causes of bleeding diathesis [18].

Immobilization of fractures

External stabilization of fractures (if possible, by the use of traction in the case of a fractured limb and compression in the case of pelvic fracture) significantly reduces bleeding and the need for analgesics. It is one of the priorities in the management of bleeding patients with fractures; a combat medic should immobilize a fracture after the careful

examination of the injured patient and the performance of emergency procedures (stopping the bleeding, clearing the airways, relieving a tension pneumothorax).

Pain management under combat conditions

The latest TCCC guidelines do not recommend administering opioids to patients with shock symptoms because opioids may disturb natural compensation mechanisms and worsen the patient's condition [19].

In the case of moderate to severe pain, and if the patient does not suffer from hemorrhagic shock and is not under the threat of shock, a medic should administer 800 mg of oral transmucosal fentanyl citrate (OTFC).

However, when the patient has symptoms of hemorrhagic shock or is under the threat of the shock, opioids should not be administered; instead, ketamine should be administered at the dose of 50 mg (intramuscular or by the use of an autoinjector) or 20 mg (intravenous or intramedullar gradual administration). A medic may repeat an intramuscular dose after 30 minutes and an intravenous dose after 20 minutes. The endpoint of the therapy is pain relief or the occurrence of nystagmus in the patient [5].

Summary

Delaying emergency procedures for stopping bleeding increases the risk of cardiovascular failure and decompensation in patients with rapid bleeding, even if a patient has been provided with fluid therapy. Therefore, guidelines for combat and tactical care indicate that stopping limb or junctional hemorrhage (occurring in the area of the neck, the axillary fossa or the groin) is a priority and should be performed even before clearing the airways. The indication results from an assumption that a human body handles short-term hypoxia more easily than the effects of hemorrhagic shock, bearing in mind major limitations of the tactical environment, delay in evacuation and limited access to blood preparations. Medical training of soldiers puts strong emphasis on the ability to apply a tactical tourniquet correctly, pack a wound and use modern hemostatic agents, which are included in the soldier's personal equipment.

Bleeding into body cavities, on the other hand, requires immediate evacuation of the patient in order to implement surgical procedures for the management of bleeding. Tactical care of the injured soldier requires the prudent use of fluid therapy, the prevention of hypothermia and the administration of an appropriate analgesic.

References

1. Holcomb JB: Causes of death in US Special Operations Forces in the global war on terrorism: 2001-2004. Ann Surgery, 2007; 245: 986-991
2. Keel M, Trentz O: Pathophysiology of polytrauma. Injury, 2005; 36: 691-709
3. Machała W, Brzozowski R, Wiśniewski T, et al.: Nowe spojrzenie na leczenie ostrych krwotoków [A new approach towards the management of severe hemorrhages]. Pielęgn Anest Intens Op, 2013; 1: 29-41
4. Rodriguez RM, Rosenthal MH: Ethiology and pathophysiology of shock. In: Critical care medicine - perioperative management. London, Lippincott & Wilkins, 2003: 192-205
5. Tactical Combat Casualty Care, Guidelines 2013. Available at: http://www. usaisr.amedd.army.mil/assets/pdfs/TCCC_Guidelines_131 028.pdf (access: ????)
6. Kragh JF, Walters TJ, Baer DG, et al.: Survival with emergency tourniquet use to stop bleeding in major limb trauma. Ann Surgery, 2009; 294: 1-7
7. Emergency War Surgery, Third United States Revision. Department of Defense USA, 2004
8. Kragh JF, Walters TJ, Baer D.G, et al.: Practical use of emergency tourniquets to stop bleeding in major limb trauma. J Trauma, 2008; 64 (2 Suppl.): 38-49
9. Committee on Trauma, American College of Surgeons: ATLS: Advanced Trauma Life Support Program for Doctors. Chicago, American College of Surgeons, 2008
10. Swan KG Jr, Wright DS, Barbagiovanni SS, et al.: Tourniquets revisited. J Trauma, 2009; 66: 672-675
11. Cox ED, Schreiber MA, McManus J, et al.: New hemostatic agents in the combat setting. Transfusion, 2009; 49 (5 Suppl.): 248-255
12. Littlejon LF, Devlin JJ, Kircher SS, et al.: Comparison of Celox-A, Chito-Flex, WoundStat and Combat Gauze hemostatic agents versus standard gauze dressing in control of hemorrhage in a swine model of penetrating trauma. Acad Emerg Med, 2011; 18: 340-350
13. Eastridge BJ, Hardin M, Cantrell J, et al.: Died of wounds on the battlefield: causation and implications for improving combat casualty care. J Trauma, 2011; 71: 4-8
14. Eastridge BJ, Mabry RL, Sequin PG, et al.: Death on the battlefield (2001--2011): implications for the future of combat casualty care. J Trauma, 2012; 73: 431-437
15. Watters JM, Van PY, Hamilton GJ: Advanced hemostatic dressings are not superior to gauze for care under fire scenarios. J Trauma, 2011; 70: 1413--1419
16. Wade CE, Grady JJ, Kramer GC: Efficacy of hypertonic saline dextran fluid resuscitation for patients with hypotension from penetrating trauma. J Trauma, 2003; 54: 144-148
17. Schrager JJ, Branson RD, Johannigman JA: Lessons from the tip of the spear: medical advancements from Iraq and Afghanistan. Resp Care, 2012; 57: 1305-1313
18. Watts DD, Trask A, Soeken K, et al.: Hypothermic coagulopathy in trauma: effect of varying levels of hypothermia on enzyme speed, platelet function, and fibrinolytic activity. J Trauma, 1998; 44: 846-854
19. Butler F: Battlefield trauma care then and now: a decade of TCCC. SOMA Conference, USA, 15.12.2012

Analysis of the work done by the Warsaw and Płock Helicopter Emergency Medical Service (HEMS) teams regarding help given to patients with serious bodily injuries transported to the Trauma Centre in Warsaw between the years 2011-2013

Analiza działania zespołów HEMS Warszawa i Płock w zakresie pomocy pacjentom z ciężkimi obrażeniami ciała transportowanymi do Centrum Urazowego w Warszawie w latach 2011-2013

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Abstract. The analysis referred to the help which the HEMS (Helicopter Emergency Medical Service) teams extended to patients with serious bodily injuries who were transported by HEMS choppers on duty in the Warsaw and Płock air bases to the Trauma Centre of the Military Institute of Medicine (Wojskowy Instytut Medyczny-WIM) in Warsaw. Between 1 January 2011 and 31 December 2013 both helicopters flew 310 patients to the WIM Trauma Centre. Out of these the Warsaw HEMS team transported 274 people and the one from Plock 36 patients, accounting for 88.4% and 11.6% of the total number of patients respectively. In the 310 cases analyzed 22 were secondary missions, and 288 primary missions. The average time of the whole flight operation to the scene of the accident was 61.4 mins for the Warsaw HEMS team and 78.2 mins for the one from Płock. The diagnoses that were most frequently entered into medical records according to the ICD code were multiple organ injury and head injury. The patients transported to the Trauma Centre were mostly men, accounting for 79.7 of the cases. Over half of the patients were under 40 years of age. A worsening of their condition was observed in 11 patients out of 217, as measured according to the Glasgow scale. The results measured according to the RTS were close to those shown by the Glasgow scale.
Keywords: emergency medical services. Helicopter Emergency Medical Service (HEMS), medical transport

Streszczenie. Analizie poddano działania zespołów Śmigłowcowej Służby Ratownictwa Medycznego (Helicopter Emergency Medical Service-HEMS) w stosunku do pacjentów z ciężkimi obrażeniami ciała, którzy zostali przetransportowani śmigłowcami HEMS dyżurującymi w bazach w Warszawie i Płocku do centrum urazowego (CU) Wojskowego Instytutu Medycznego (WIM) w Warszawie. Łącznie oba śmigłowce od 1 stycznia 2011 r. do 31 grudnia 2013 r. przetransportowały do centrum urazowego WIM 310 pacjentów, z czego zespół HEMS Warszawa przetransportował 274 osoby, co stanowi 88,4%, a zespół HEMS Płock-36 pacjentów, co stanowi 11,6%. Na 310 analizowanych przypadków 22 stanowiły transporty międzyszpitalne, a 288 - loty na miejsca nagłych zdarzeń. Średni czas całej operacji w locie do wypadku dla zespołu HEMS Warszawa wyniósł 61,4 min, a dla zespołu HEMS Płock 78,2 min. Z kolei w transporcie międzyszpitalnym średni czas dla zespołu HEMS Warszawa wyniósł 98,9 min, a dla HEMS Płock 115,1 min. Najczęściej wpisywanymi do dokumentacji medycznej zespołu HEMS rozpoznaniami według kodu ICD były: uraz wielonarządowy oraz uraz głowy. Pacjentami transportowanymi do CU najczęściej, bo aż w 79,7% przypadków, byli mężczyźni. Ponad połowa pacjentów była w wieku poniżej 40 lat. Pogorszenie zaobserwowano u 11 z 217 pacjentów, opierając się na badaniu w skali Glasgow (GCS). Wyniki badania w skali oceny ciężkości urazu (Revised Trauma Score - RTS) były zbliżone do wyników badania w skali Glasgow.
Słowa kluczowe: ratownictwo medyczne. Śmigłowcowa Służba Ratownictwa Medycznego (HEMS), transport medyczny

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Introduction

HEMS helicopters are an integral part of modern emergency medical systems. Using an emergency helicopter to help a patient with serious bodily injuries may bring measurable benefits for the therapeutic process. The experience of the Helicopter Emergency Medical Service in Poland indicates that patients fulfilling the criteria for transport to a trauma center who use the services of an emergency helicopter reach the center much faster than when a medical emergency team transports the patient to the nearest hospital. The presence of an emergency physician on board the helicopter also improves the quality of emergency activities and medical transport, particularly when the condition of a patient is severe. The key factor for the optimal provision of both hospital and pre-hospital emergency service is the appropriate coordination of emergency activities from the moment a medical dispatcher receives a call, to the fast and appropriate disposal of resources, proper coordination of emergency activities at the scene of the accident, to appropriate decisions regarding transport to the most suitable treatment center. Another relevant matter (which may be slightly forgotten) is the transfer of precise information on the patient's condition by means of telephone or radio communication from the emergency team to the trauma center team, allowing for the optimal preparation of the emergency room for the admission of a patient with serious bodily injuries.

Aim

The aim of the paper is to evaluate the action of Helicopter Emergency Medical Service (HEMS) teams in the therapeutic process of patients with serious bodily injuries who were transported to a trauma center.

Material and Methods

The study encompassed all flights of HEMS helicopters from air bases in Warsaw and Płock that resulted in the transport of a patient to the Trauma Center at the Military Institute of Medicine in Warsaw, Poland, between 1 January 2011 and 31 December 2013. Medical dispatchers directed the helicopters in accordance with the adopted standards, which means that the crew of an HEMS helicopter reached the scene of the accident either as the first medical emergency team or as support for a ground medical emergency team or the helicopter was used to transport a patient between hospitals (a secondary mission). The statistical analysis included the overall number of flights by HEMS teams from Warsaw and Płock in the studied period that resulted in the transport of patients to the Trauma Center at the Military Institute of Medicine in Warsaw, Poland. The analysis also considered whether patients were provided with medical help before the arrival of HEMS teams. Another aspect of the analysis is the time of action of HEMS teams at various stages of an emergency operation, namely time between ordering an intervention and arriving at the scene of the accident, the time of action of an HEMS team at the scene of the accident, the time of transport to the trauma center and time between ordering an intervention and handing over a patient to a trauma center team (Warsaw and Płock HEMS teams were considered separately in this area of the analysis). The analysis also took account of diagnoses at the stage of pre-hospital emergency activities, which were based on ICD codes. Another area of the study focused on the identification of the sex and the age of patients with serious bodily injuries, who were transported to the trauma center. The RTS scale was used to analyze patient examination, assuming that the first examination was carried out by an HEMS team upon the first contact with the patient and the second examination took place at the time of handing over the patient to a trauma center team. A parallel analysis was carried out in reference to the RTS scale (first contact with the patient, handing over the patient to the trauma center). The last area of the analysis involved the evaluation of emergency activities occurring before the arrival of an HEMS team and emergency activities carried out by an HEMS team at the scene of the accident for: cardiac massage, defibrillation, intubation, thoracic drainage, peripheral or central injection, preparing a patient for transport on a spinal board and providing the patient with a cervical collar.

Results

In the period between 1 January 2011 and 31 December, HEMS teams from Warsaw and Płock transported a total of 310 patients with serious bodily injuries to the Trauma Center at the Military

Table 1. Air transport to the Military Institute of Medicine in the years 2011-2013
Tabela 1. Transporty lotnicze do Wojskowego Instytutu Medycznego w latach 2011-2013

	HEMS Warsaw		HEMS Płock	
	N	%	N	%
2011	85	89.5%	10	10.5%
2012	103	85.1%	18	14.9%
2013	86	91.5%	8	8.5%
total	274	88.4%	36	11.6%

Institute of Medicine: HEMS Warsaw – 274 patients (88.4%), HEMS Płock – 36 patients (11.6%) (see Table 1). The year 2012 is characterized by the largest number of transports; the percentage of patients transported by HEMS Płock was from 8.5% in 2013 to 14.9% in 2012.

While provision of medical help before the arrival of an HEMS team occurred in 298 of 310 (96.1%) of the analyzed cases, provision of medical help after the arrival of an HEMS team constituted only 12 (3.95%) cases. 22 of the 310 analyzed flights were secondary missions (flights between hospitals) and the remaining 228 flights were primary missions (emergency flights). In the case of secondary missions, the average times of flights to the place of destination and the average times of action at the place of destination were similar in HEMS Warsaw and HEMS Płock teams; the average time of transport by HEMS Płock was approximately 11 minutes longer than one by HEMS Warsaw, which adds to the 16-minute difference between the teams in the overall time of action (measured from the moment of ordering a mission to transporting a patient to the trauma center). Times of all stages of emergency missions were shorter in HEMS Warsaw than in HEMS Płock. The overall mission time was approximately 17 minutes shorter (see Table 3).

Patients with the pre-hospital diagnosis of multi-organ trauma and head trauma were the most frequent types of patients transported by the HEMS teams (Figure 1).

The teams transported mostly men (79.7%). Patient age distribution is presented in Figure 2.

More than half of the patients were under 40 years old. Table 4 includes data on the condition of patients during the first contact and at the moment of arrival at the hospital, which was measured according to the Glasgow Coma Scale (GCS). The condition of most patients did not change during the preliminary procedures and transport. Worsening was observed in only 11 (5.1%) of 217 patients whose files contained data on condition that were specified according to the GCS [1] (Table 4).

217 patients received the Revised Trauma Score both during the first contact and at the time of their reception by a trauma center team. The RTS did not change in 182 (83.9%) patients, increased in 18 (8.3%) patients and decreased 17 (7.8%) in the period between the first contact and reception by a trauma center team (Figure 3).

The analysis of procedures carried out before the arrival of an HEMS team and by an HEMS team during the study period revealed that there were 4 cases in which patients underwent cardiac massage before the arrival and 6 in which an HEMS team performed the procedure. The analysis of medical records indicates that while none of the 310 patients who were transported to the

Table 2. Duration of the particular stages of the missions, secondary missions
Tabela 2. Czasy poszczególnych etapów misji, loty międzyszpitalne

	team	N	average	SD	min.	max.
Time of a flight to the place of destination	HEMS Warsaw	10	40.0	14.5	26.0	68.0
	HEMS Płock	8	40.9	16.5	24.0	69.0
Time of action at the place of destination	HEMS Warsaw	10	41.0	15.3	21.0	73.0
	HEMS Płock	8	43.1	13.1	24.0	58.0
Time of transport	HEMS Warsaw	14	22.5	7.7	9.0	44.0
	HEMS Płock	8	31.1	7.5	23.0	47.0
Overall time	HEMS Warsaw	14	98.9	31.0	63.0	185.0
of action	HEMS Płock	8	115.1	16.3	90.0	143.0

Table 3. Duration of the particular stages of the missions, primary missions
Tabela 3. Czasy poszczególnych etapów misji, loty ratunkowe

	team	N	average	SD	min.	max.
Time of a flight to the place of destination	HEMS Warsaw	231	22.5	6.4	7.0	43.0
	HEMS Płock	24	26.5	9.6	12.0	49.0
Time of action at the place of destination	HEMS Warsaw	231	22.6	10.2	6.0	61.0
	HEMS Płock	24	27.8	20.4	13.0	114.0
Time of transport	HEMS Warsaw	260	16.3	5.2	4.0	32.0
	HEMS Płock	28	24.7	11.4	10.0	55.0
Overall time of action	HEMS Warsaw	260	61.4	14.9	31.0	112.0
	HEMS Płock	28	78.2	24.9	53.0	176.0

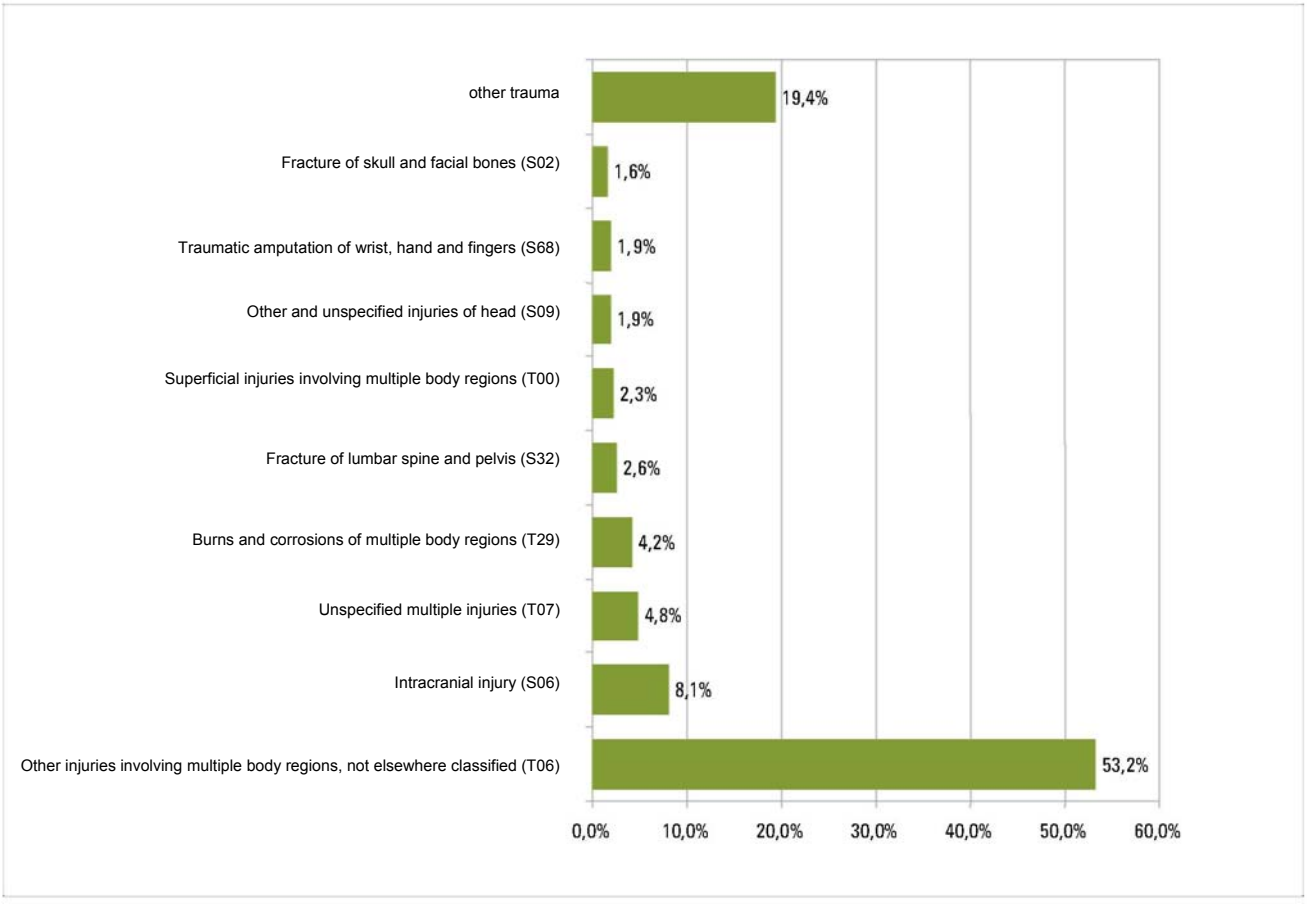

Figure 1. Reasons for calling HEMS teams

Rycina 1. Powody wezwań Lotniczego Pogotowia Ratunkowego

Trauma Center in Warsaw underwent defibrillation, 68 of them underwent intubation before the arrival of an HEMS team and 59 underwent tracheal intubation by an HEMS team. Thoracic drainage was performed 5 times before the arrival of an HEMS team and 6 times by an HEMS team; peripheral injection was performed 181 times before the arrival and 87 times by an HEMS team; ground emergency teams provided patients with spinal boards and cervical collars 251 times and HEMS teams did so 19 times (Table 5).

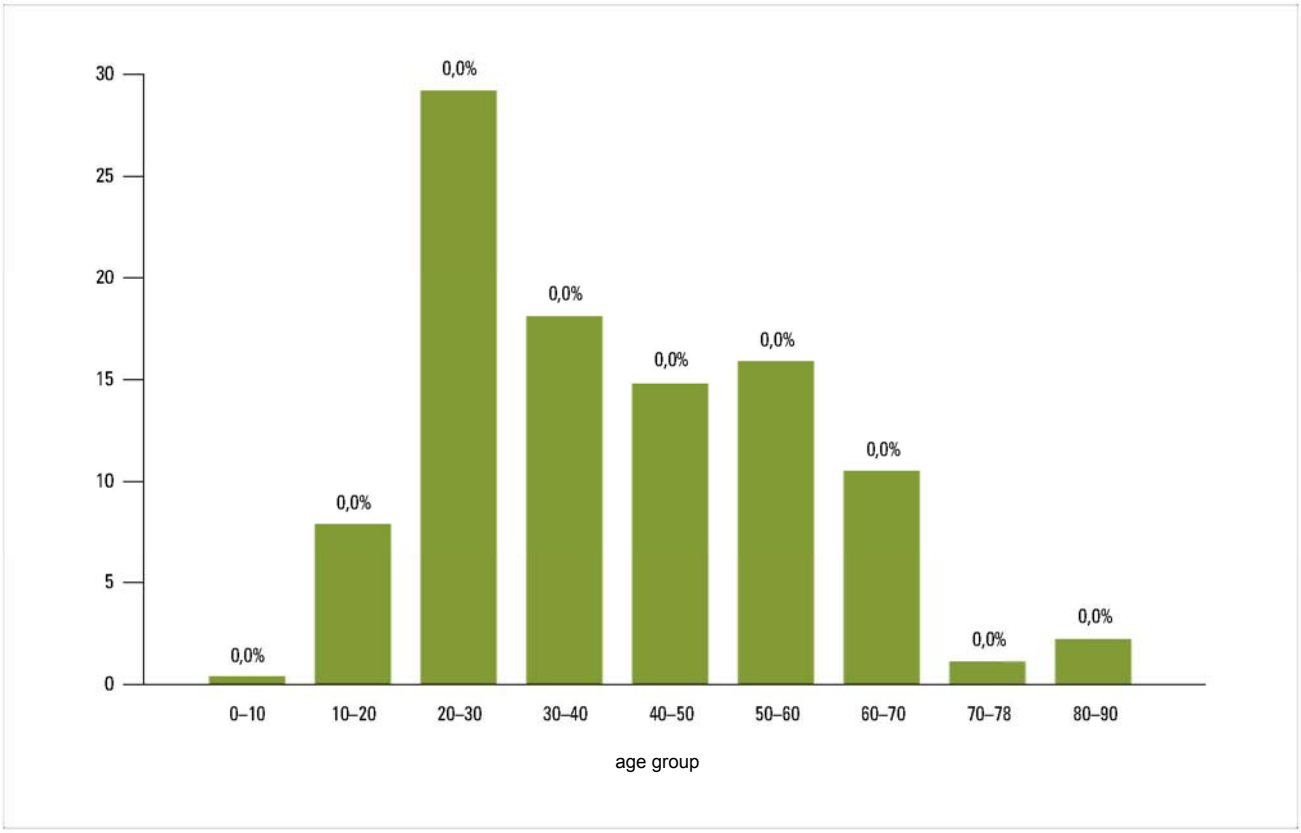

Figure 2. Age of the patients

Rycina 2. Wiek pacjentów

Table 4. The state of the patient measured according to the Glasgow scale at the first contact and at the time of arrival at the Trauma Centre (CU)
Tabela 4. Stan pacjenta mierzony w skali Glasgow przy pierwszym kontakcie oraz przy przekazaniu do CU

at the first contact		at the reception by a trauma center team					
		3	**4-5**	**5-8**	**9-12**	**12-15**	**total**
3	**N**	27	0	0	0	1	28
	%	96.4%	.0%	.0%	.0%	3.6%	12.9%
4-5	**N**	4	3	0	0	0	7
	%	57.1%	42.9%	.0%	.0%	.0%	3.2%
5-8	**N**	3	0	2	1	0	6
	%	50.0%	.0%	33.3%	16.7%	.0%	2.8%
9-12	**N**	2	1	1	14	4	22
	%	9.1%	4.5%	4.5%	63.6%	18.2%	10.1%
12-15	**N**	0	0	0	0	154	154
	%	.0%	.0%	.0%	.0%	100.0%	71.0%
total	**N**	36	4	3	15	159	217
	%	16.6%	1.8%	1.4%	6.9%	73.3%	100.0%

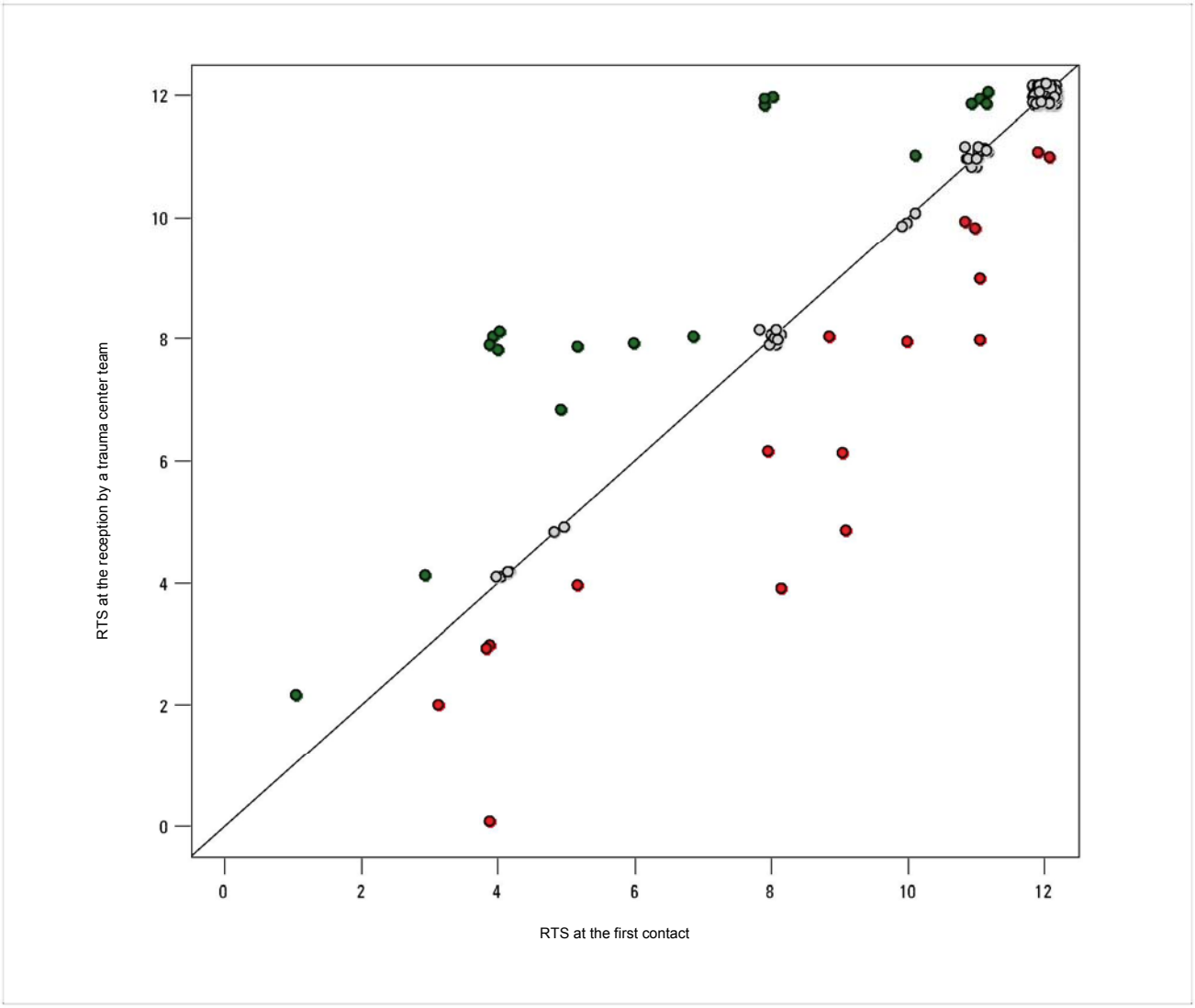

Figure 3. The state of the patient measured according to the RTS at the time of the first contact and on arrival at the Trauma Centre

Rycina 3. Stan pacjenta mierzony w skali RTS przy pierwszym kontakcie oraz przy przekazaniu do CU

Discussion

The use of HEMS teams in emergency missions to help patients with serious bodily injuries may be considered in several aspects: an HEMS team may be the only team receiving the order to manage a case; both an HEMS team and a ground emergency team may receive such order; an HEMS team may receive the order to help a ground emergency team; an HEMS team may receive the order to transport a patient between hospitals. The orders may come either from a medical dispatcher or the leader of emergency medical services and depend on information that a medical dispatcher collected about a given case or on the leader's evaluation of the patient's condition and circumstances of the event [2]. In the case of secondary missions (transport between hospitals), it is the doctor of a patient who makes the decision to use an HEMS helicopter as a means of medical transport. The development of trauma centers in Poland created new opportunities for the treatment of patients with serious bodily injuries. Organizational assumptions for the development of trauma centers demonstrated the need to carry out diagnostic and therapeutic activities in one center that includes an emergency room and departments necessary to provide a patient with comprehensive medical services.

The analysis of participation of HEMS teams in emergency missions to help patients with serious bodily injuries indicates quite clearly (and it is a positive indicator) that most of the patients reach the trauma center directly from the place of the event since only 22 of the 310 missions carried out by the HEMS teams were secondary and 288 of them were primary (flight to the scene of an

Table 5. Operations conducted before the arrival of the HEMS team and by the HEMS team
Tabela 5. Zabiegi przeprowadzone przed przybyciem zespołu HEMS i przez zespół HEMS

	Procedure carried out before the arrival of an HEMS team	Procedure carried out by an HEMS team	Total
Cardiac massage	4	6	10
Defibrillation	0	0	0
Intubation	68	59	127
Thoracic drainage	5	6	11
Peripheral or central injection	181	87	268
Spinal board/cervical collar	251	19	270

accident). Future studies on the subject should give due consideration to causes for which patients are directed to centers other than a trauma center because the operation of a medical emergency system in Poland should make progress towards a state where all patients with serious bodily injuries who fulfill criteria for trauma center admission are directed to a trauma center. Studies in other countries also focus on the identification of the role of HEMS in the provision of medical help to trauma patients and they indicate that approximately 30% of the patients reach trauma centers by air. They also take account of benefits resulting from the use of HEMS, particularly in the cases of craniocerebral trauma [3,4]. The analysis regarding the time of participation of an HEMS team in an emergency mission results from numerous factors influencing the mission's duration, such as the time during which a medical dispatcher makes the decision to order an HEMS team (measured from the moment of receiving a call), the distance between the air base and the scene of an accident, the distance between a trauma center and the scene of an accident, the time of a team's action at the scene of an accident, the number of emergency helicopters available in the entire country's area, which translates into the time of flight to the scene of an accident. All these elements influence the overall time of intervention by an HEMS team.

Multi-organ trauma and head trauma were the most frequent diagnoses entered into medical records according to the ICD codes, which usually are the consequence of traffic accidents. Current studies reveal that the positive influence of the use of HEMS on patient survival is probably reduced to unstable patients with multi-organ trauma [5]. The performed analysis of medical records indicates that men constituted the vast majority (79.7%) of patients transported to the trauma center; women constituted 20.3% of the cases. Patient age was another significant indicator, showing that 50% of the study patients were under 40 years old, 30% of whom were between 20 and 30 years old. According to a report from 2012 by the National Institute of Hygiene, National Institute of Public Health, Warsaw, Poland, external causes were, in terms of significance, the fourth cause of deaths in the overall Polish population in 2010 and they constituted the largest threat to life for people between 5 and 44 years old, being responsible for 42% of deaths in this group. 23,626 people (18,292 of men, 5,397 of women) lost their life due to external reasons in 2010 in Poland, which is 61.6 per 100,000 of the population (98.8 in the case of men and 27.3 in the case of women). The significance of external causes as the cause of deaths of men decreased in the years 2009 and 2010; the downward trend has been present in women for years, both in relation to external causes as a mortality rate and as a group in the overall distribution of deaths. External causes of death constitute a threat to men much more than to women and the difference is increasing; standard mortality rate was 4.5 times higher in men than in women in 2010. Among the most important external causes of death in 2010 are traffic accidents, which led to 4,529 deaths (3,535 men and 998 women), and suicides, leading to the deaths of 6,342 people (as many as 5,506 men and 836 women). Falls are, in terms of frequency, the third external cause of deaths, leading to the death of 3,755 people (2,063 men and 1,692 women) in 2010 in Poland [6]. The Glasgow Coma Scale, which was used in the study of the patients, revealed a certain tendency, namely that the largest group of patients suffered from mild to moderate disorders of consciousness and that their state did not change to any large extent during the provision of medical emergency services and during their transport to the trauma center. A similar tendency has been observed using the Revised Trauma Score in the study of the patients. It is worth remembering that the RTS is used to estimate the general state of a patient and the probability of his or her survival. The method for the calculation of the RTS puts emphasis on the GCS score as one of its elements to identify patients with serious craniocerebral injuries as patients who are under the potential risk of high mortality rate.

Individual elements of the Revised Trauma Score, namely the Glasgow Coma Scale (GCS), systolic blood pressure (SBP) and respiratory rate (RR), are calculated according to the following formula:

RTS = 0.9368 (GCS) + 0.7326 (SBP) + 0.2908 (RR).

It is conventionally assumed that patients with RTS < 4 should be qualified for treatment in trauma centers.

The RTS finds its application in pre-hospital emergency services as one of the elements of the secondary segregation (after the implementation of emergency

Table 6. Elements that constitute RTS components
Tabela 6. Elementy składowe RTS

Glasgow Coma Scale	Systolic blood pressure	Respiratory rate	Value assigned to each of the columns
13-15	>89	10-29	4
9-12	76-89	>29	3
6-8	50-75	6-9	2
4-5	1-49	1-5	1
3	0	0	0

activities) of patients at the scene of an accident. In such a case, all values assigned to the particular scopes of the RTS elements are summed up in accordance with the Table 6.

Patients whose sum of elements from the columns reaches a certain value receive a pre-determined treatment and transport priority. The aggregate value between 3 and 10 indicates the most immediate priority (red), 11 – immediate priority (yellow) and 12 – postponed priority (green) [7].

The data obtained in the study indicates that most medical emergency activities occurring at the scene of an accident were carried out before the arrival of an HEMS team. What is worth noticing, however, is the similar number of intubations performed before the arrival of an HEMS team and by an HEMS team; an HEMS team also performed one more thoracic drainage procedure than a ground emergency medical team. All things considered, particular attention should be drawn to the need of carrying out further studies based on a larger number of variables, which will contribute to a more precise identification of the role and the effectiveness of providing help to patients with serious bodily injuries by HEMS teams.

Conclusions

1. HEMS teams transport patients with serious bodily injuries between the scene of an accident and the trauma center much more frequently than between one hospital and another.
2. The immediate ordering of an HEMS team by a medical dispatcher is a significant factor in the reduction of reaction time by an HEMS team.

References

1. Matis G., Birbilis T.: The Glasgow Coma Scale - a brief review. Past, present, future. Acta Neurol Belg, 2008; 108: 75-89
2. Plantz S.H., Adler J.N.: Medycyna ratunkowa [Emergency Medicine]. Wroclaw, WYDAWCA, 1999
3. Schweigkofler U., Reimertz C., Lefering R., et al.: Importance of air ambulances for the care of the severely injured. Unfallchirurg, 2014
4. Galvagno S.M.Jr, Thomas S., Stephens C., et al.: Helicopter emergency medical services for adults with major trauma. Cochrane Database Syst Rev, 2013; 3
5. Ryb G.E., Dischinger P., Cooper C., et al.: Does helicopter transport improve outcomes independently of emergency medical system time? Trauma Acute Care Surgery, 2013: 74
6. Wojtyniak B., Goryński P., Moskalewicz B.: Sytuacja zdrowotna ludności polski i jej uwarunkowania [Health situation of the Polish population and its determinants]. Warszawa, Narodowy Instytut Zdrowia Publicznego -Państwowy Zakład Higieny, 2012
7. Champion H.R., Sacco W.J., Copes W.S., et al.: A revision of the trauma score. J Trauma, 1989; 29

Pain relief in combat conditions

Uśmierzanie bólu w warunkach polowych

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Abstract. Medical care of the patients injured in combat conditions poses considerable challenge. It certainly differs from helping those who are sick or injured in accidents that occur in civilian environment. The major difference lies with suitable care for safety of the rescuers who, just like ordinary soldiers, are exposed to warfare. The basic activities that the rescuers should undertake upon taking combat initiative in a tactical zone include stopping the haemorrhage, clearing the airways and exclusion of pulmonary edema with hypertension. Medical activities that are realized in tactical conditions are divided into five levels in which I - is a pre-hospital level, II - field hospital level. III - specialist hospital level (outside the direct warfare zone) in the country at war and IV - specialist hospital in the home country level (outside the country at war). One of the basic medical techniques undertaken with the injured patients is pain relief procedure. It is implemented at every stage of treatment. In pre-hospital conditions, it has a schedule-based character in which a certain medication in a given dose and at a determined time is to be administered. From level II onwards, analgesic treatment depends on the type of trauma sustained by the patient and the surgical procedures which need to be performed. The author described techniques of pain relief procedures in pre-hospital conditions and during the treatment in the II level field hospital (including own experience) - from Trauma Room, through operating theater to the ICU. The paper presents all anaesthesia techniques performed in the Polish Armed Forces on the basis of medical procedures standards of the US Army - *Joint Theater Trauma System Clinical Practice Guidelines.*
Keywords: activities undertaken in pre-hospital conditions, early ICU treatment, field hospital, general anesthesia, pain relief, pre-hospital care, principles of monitoring in medevac conditions, regional anesthesia, tactical combat casualty care, trauma room

Streszczenie. Niesienie pomocy rannym w warunkach polowych jest sporym wyzwaniem. Różni się ono od udzielania pomocy chorym i poszkodowanym w wypadkach w warunkach cywilnych. Zasadniczą różnicą jest konieczność wykazania należytej dbałości o bezpieczeństwo własne ratowników, którzy jak każdy żołnierz narażeni są na działania bojowe nieprzyjaciela. Podstawowymi czynnościami ratowników po przejęciu inicjatywy bojowej w strefie taktycznej są: opanowanie krwotoku, udrożnienie dróg oddechowych i wykluczenie odmy opłucnowej z nadciśnieniem. Czynności medyczne realizowane w warunkach taktycznych podzielono na pięć poziomów, w których: I - jest poziomem przedszpitalnym, II - szpitalem polowym, III - szpitalem specjalistycznym (poza strefą bezpośrednich działań bojowych) na terenie kraju ogarniętego wojną, IV - szpitalem specjalistycznym w kraju (poza krajem ogarniętym wojną). Jedną z podstawowych technik medycznych stosowanych u rannych jest uśmierzanie bólu. Jest ono realizowane na każdym etapie leczenia. W warunkach przedszpitalnych ma charakter schematu, kiedy to należy podać określony lek w określonej dawce i w określonym czasie. Od II poziomu leczenie przeciwbólowe zależy od charakteru obrażeń, których doznał ranny, i koniecznych do wykonania operacji. Autor opisał techniki uśmierzania bólu w warunkach przedszpitalnych oraz w czasie leczenia rannych w szpitalu polowym II poziomu (wykorzystując również doświadczenia własne) - od *trauma room,* przez salę operacyjną do oddziału intensywnej terapii. W pracy przedstawiono wszystkie techniki znieczulenia, które wykonywane są przez Wojsko Polskie na podstawie m.in. standardów postępowania medycznego Armii USA - Joint Theater Trauma System Clinical Practice Guidelines.
Słowa kluczowe: czynności podejmowane w warunkach przedszpitalnych, postępowanie przedszpitalne, szpital polowy, TC3, *trauma room,* uśmierzenie bólu, wczesne leczenie na OIT, zasady monitorowania w czasie ewakuacji medycznej, znieczulenie ogólne, znieczulenie przewodowe

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Emergency care – pain relief in pre-hospital conditions

Casualties require pain relief at every stage of medical field care, even if morphine is the only analgesic available in the Polish Armed Forces (PAF) at the field stage.

Every PAF soldier is equipped with an individual medical kit (IPMed [Figure 1]) containing, among other things, an autoinjector with 20 mg of morphine (Figure 2). PAF guidelines for the use of morphine recommend administering 20 mg of the drug intramuscularly to alleviate pain resulting from bodily injuries.

The dose is not compliant with the principles of TC3 (*tactical combat casualty care*) implemented in the US Army, the US Air Force and the US Navy. TC3 broadly defines the obligation to bring pain relief, recommending the administration on an "if-needed" basis. The TC3 standard categorizes casualties as:

- able to fight – a casualty falling into this group should receive an initial 15 mg dose of meloxicam (Mobic) via the oral route and two 650 mg doses of acetaminophen (Tylenol) every 8 hours;
- unable to fight – if conscious, a casualty falling into this group should receive meloxicam and acetaminophen via the oral route.

Casualties suffering from severe pain may need to receive an opioid analgesic – morphine or fentanyl.

If intravenous or intraosseus access is possible, a 5 mg dose of morphine (Figure 3) may be administered. In the case of no relief, the dose may be repeated after 10 minutes.

If intravenous or intraosseus access is not possible, the TC3 standard recommends administering an 0.8 mg dose of fentanyl via the transmucosal route. Transmucosal fentanyl (Figure 4) has the form of a lollipop. Use an adhesive bandage to mount the lollipop to the casualty's middle finger and place it in his or her oral cavity. This method virtually eliminates the occurrence of side effects (apnea). When falling asleep, a casualty spontaneously puts the lollipop out of his or her mouth (gravity), regardless of whether in a supine or a safe position (under the condition that the lollipop is mounted correctly, that is, to the hand that is further from the ground).

If pain persists, the TC3 standard recommends administering a 25 mg dose of promethazine via the intravenous, intramuscular or intraosseous route. The dose may be repeated every 6 hours, bearing in mind the synergistic effect of promethazine and opioids and the anti-emetic effect of promethazine.

According to the TC3 standard, all casualties receiving opioid analgesics should be monitored for breathing and antagonist drugs (naloxone) should be available for possible use.

Bringing pain relief to casualties is not a key activity under combat conditions, particularly at level I. Medical care activities that should be performed in any case have been divided into three phases:

- care under fire,
- tactical field care,
- tactical evacuation care.

Figure 1. Individual First Aid Kit (IFAK). Photo by W. Machata

Rycina 1. Indywidualny Pakiet Medyczny (IPMed.). Fot. W. Machata

Figure 2. Autoinjector containing 20 mg of morphine (Polish Armed Forces). Photo by W. Machata

Rycina 2. Ampułkostrzykawka zawierająca 20 mg morfiny (WP). Fot. W. Machata

Activities to be performed as part of the *care under fire* phase:

- take over the combat initiative;
- find a shield against the enemy's fire;
- undertake medical activities either as self-help or, if possible, 'buddy-aid', by evacuating casualties from a burning vehicle, for instance;
- apply hemostatic tourniquets to comply with the *control bleeding first* principle.

Activities to be performed as part of the *tactical field care* phase:

- disarm the casualty;
- clear the airways (using a nasopharyngeal tube, for instance).
- make sure the casualty does not have hypertensive pneumothorax (by carrying out decompressive thoracic needle puncture);
- stop bleeding (control and adjustment of a tactical tourniquet, packing wounds by the use of a hemostatic gauze);
- gain vascular or intraosseus access;

Figure 3. Package containing morphine (TC3, US Army) and Polish morphine (spinal-for subarachnoid cavity (Polish Armed Forces). Photo by W. Machata
Rycina 3. Opakowanie zawierające morfinę (TC3, US Army) oraz morfina polska (spinal - przeznaczona do przestrzeni podpajęczynówkowej), (WP). Fot. W. Machała

- administer tranexamic acid (if hemorrhagic shock is suspected);
- administer fluids intravenously (0.9% NaCl solution, Lactated Ringer's solution, HAES);
- prevent hypothermia;
- dress penetrating wounds of the eyeball;
- monitor the oxygenation of hemoglobin (pulse oximetry);
- examine the wounds and dress them;
- examine the casualty to locate other bodily injuries;
- relieve pain only after performing these activities;
- immobilize fractures and examine the pulse of the immobilized extremities;
- administer an antibiotic.
- examine the surface of possible burns and dress them;
- evaluate the state of consciousness;
- prepare the casualty for evacuation:
  - if possible, place the casualty in an emergency sleeping bag;
  - put safety glasses on;
  - put hearing protectors on;
  - place the casualty on a military stretcher;

Figure 4. Fentanyl lollipop (Aqtic, US Army). Source: Internet
Rycina 4. Lizak zawierający Fentanyl (Aqtic, US Army). Źródło: Internet

  - Mount the SMEED (Special Medical Emergency Evacuation Device) on the stretcher and mount all necessary devices on the SMEED;
  - place the casualty in a helicopter;
  - check the patency of the cannula, start intravenous lines and make a decision on the continuation of the intravenous administration of infusion fluids,
  - declare the readiness for evacuation;
  - the *tactical evacuation care* phase should include the same activities as those performed as part of *tactical field care*.

Care at level II – pain relief in the field hospital

Pain relief in trauma room conditions

The Polish Field Hospital (PFH) of the Polish Armed Forces and the Forward Surgical Team of the United States Armed Forces perform practically the same functions, as both of them are actually field hospitals. The Polish Field Hospital (PFH) comprises a surgeon, an orthopedist, surgical nurses and nurse anesthetists. The PFH is able to carry out life-saving surgical procedures under any type of anesthesia (both general and perineural anesthesia). Moreover, the PFH and the FST can effectively clear the airways of the casualty (intubation, tracheotomy), gain vascular access (both peripheral and central intravenous access and intra-arterial access), provide the casualty with blood treatment (also by the use of the Walking Blood Bank), carry out diagnostics (X-ray, ultrasonography, blood, microbiological, virological and pregnancy tests) and prepare the casualty for transport to a level III hospital (a specialist hospital located outside the country at war, also called a combat support hospital).

A field hospital contains: a trauma room (Figure 5), which is where casualties are

Figure 5. PFH Trauma Room. Photo by W. Machata

Rycina 5. *Trauma room* GZM. Fot. W. Machata

Figure 6. PFH operating theater. Photo by W. Machata

Rycina 6. Sala operacyjna GZM. Fot. W. Machata

Figure 7. PFH Intensive Care Unit (in the photo the author of the paper to the left and lieutenant colonel Witalij Dobrowolski, MD, 2nd anaesthesiologist of the 12th rotation of PMC in Afghanistan)

Rycina 7. Oddział Intensywnej Terapii GZM (na zdjęciu od lewej autor pracy i pptk lek. Witalij Dobrowolski - II anestezjolog XII zmiany PKW w Afganistanie)

transported to by helicopter, after the triage process; a pre-operating room and an operating theater (Figure 6);

- an intensive care unit (Figure 7), which is where casualties with a life-threatening condition and casualties after a surgical procedure are directed and where they remain until their condition becomes stable; after the stabilization, MedEvac transport them to level III hospitals.

A trauma room is a place where the physician re-examines the casualty and decides on whether to perform a surgery or not. This is also where the physician decides on what drugs should be administered, what should be their dose and what should be the time interval for administering particular doses.

Casualties lying on the stretchers after the triage process receive further medical care in the trauma room. A casualty with the most severe injuries is always marked as number one. Patients in a better condition receive subsequent numbers (which correspond with table numbers), usually from 2 to 5. A trauma room is usually prepared to admit at least 4-5 casualties at once (there are 4-5 tables in the room). If the influx of casualties exceeds the above number, the PFH (FST) includes an area where the rest of the casualties are placed. After the casualty is taken to the trauma room and laid on the table, further emergency activities are carried out in accordance with the ATLS and the Joint Theater Trauma System Clinical Practice Guidelines. Patients must be provided with oxygen therapy and their life parameters must be monitored as quickly as possible, both directly and by the use of devices. The routine monitoring of patients in the trauma room encompasses the following parameters: hemoglobin oxygenation (SaO_2);

- heart rate (HR);
- electrical activity of the heart (ECG);
- blood pressure (using the indirect Riva-Rocci method, NiBP, and a direct method, after puncturing the artery, BP)
- respiratory rate (RR);
- skin surface temperature (T).

The monitoring and the emergency activities carried out by a trauma team ensure that the casualty is safe, even if the adverse effects of drugs occur (such as respiratory depression, desaturation). A trauma team comprises:

- a team leader – a trauma surgeon/a general surgeon;
- the head – a nurse anesthetist;
- the right hand – a surgical nurse;
- the left hand – a dressing nurse;
- a recorder – a person responsible for noting down information on the condition of a patient, activities carried out by the team and the administered drugs in a medical report;
- an anesthesiologist.

The dosage schedule for analgesics, anesthetics and muscle relaxants (in the case of which intubation and mechanical ventilation is necessary) depends on two key factors defining the condition of a patient:

- the state of consciousness and:
  - reported pain, if the casualty is conscious;

Table 1. Dosage of anelgesic, hypnotic and muscle relaxing drugs for general anesthesia in patients in hemorrhagic shock
Tabela 1. Dawkowanie leków przeciwbólowych, nasennych i zwiotczających mięśnie w celu wykonania znieczulenia ogólnego u rannych znajdujących się we wstrząsie krwotocznym

General condition	Analgesia	Amnesia	Sleep	Muscle weakness
Circulatory arrest	–	–	–	–
Shock SAP <80mm Hg	Fentanyl (0.5–1 (μg/kg of body weight) Titration	Midazolam 1-2 mg (if BP increases)	– until the expansion of blood volume	– Suxamethonium: 1.5 mg/kg of body weight – Rocuronium: 1.2 mg/kg of body weight
Hypotension: – SAP: 80–100 mm Hg – GCS: 4–9 points	–	–	–	– Suxamethonium: 1.5 mg/kg of body weight – Rocuronium: 1.2 mg/kg of body weight
Hypotension: – SAP: 80–100 mm Hg – GCS: >9 points	Fentanyl (1–2 (μg/kg of body weight)	Midazolam 1-2 mg (an intravenous anesthetic should not be administered)	– Etomidate: 0.1–0.2 mg/kg of body weight – Ketamine: 1 mg/kg of bodyweight – Midazolam: 0.1–0.3 mg/kg of body weight (titrated)	– Suxamethonium: 1.5 mg/kg of body weight – Rocuronium: 1.2 mg/kg of body weight

Table 2. Dosage of anelgesic, hypnotic and muscle relaxing drugs for general anesthesia in patients with severe central nervous system trauma
Tabela 2. Dawkowanie leków przeciwbólowych, nasennych i zwiotczających mięśnie w celu wykonania znieczulenia ogólnego u rannych z ciężkim urazem ośrodkowego układu nerwowego

General condition	Analgesia	Amnesia	Sleep	Muscle weakness
GCS: 3 points Flaccid, non-responsive	–	–	–	–
GCS: 4–9 points – head trauma – arterial hypertension	Fentanyl (1–2 (μg/kg of body weight)	Midazolam 1–2 mg (if an intravenous anesthetic has not been administered)	– Thiopental: 2–5 mg/kg of body weight – Propofol: 1–2 mg/kg of body weight – Midazolam: 0.2–0.3 mg/kg of body weight	– Suxamethonium: 1.5 mg/kg of body weight – Rocuronium: 1.2 mg/kg of body weight
GCS: >9 points – able to fight – BP is normal or high	Fentanyl (1–2 (μg/kg of body weight)	Midazolam 1–2 mg (if an intravenous anesthetic has not been administered)	– Thiopental: 2–5 mg/kg of body weight – Propofol: 1–2 mg/kg of body weight – Midazolam: 0.2–0.3 mg/kg of body weight	– Suxamethonium: 1.5 mg/kg of body weight – Rocuronium: 1.2 mg/kg of body weight

  - suspected pain, if the casualty is unconscious (the character of sustained injuries);
- hemodynamic indices (pointing to hemorrhagic shock, for instance).

The dosage and drug types have been shown in Tables 1 and 2.

Analgesics have been divided into:

- opioid analgesics:
  - morphine,
  - derivatives of piperidine, such as fentanyl,
- non-opioid analgesics:
  - non-steroidal anti-inflammatory drugs (NSAIDs),
  - paracetamol,
  - metamizole.

Opioid analgesics

Opioid analgesics are mostly pharmacotherapeutics that are used to alleviate perioperative pain. Strong opioids are characterized by a wide safety margin (Table 3). They are safe and have little influence on the activity of internal organs.

Derivatives of piperidine are the most commonly used opioid analgesics in the operating theater. They are

Table 3. Safety margin for opioid anelgesics
Tabela 3. Margines bezpieczeństwa opioidowych leków przeciwbólowych

Drug	Therapeutic safety margin [LD50/ED50]
Tramadol	3
Pentazocine	4
Pethidine	6
Morphine	71
Fentanyl	277
Alfentanil	1,080
Sufentanil	26,716
Remifentanil	33,000

Table 4. Strength of various opioids as compared to morphine
Tabela 4. Siła działania różnych opioidów w porównaniu z morfiną

Analgesia	Opioid	Potency
Very high	Sufentanil	1000
	Fentanyl	100-200
	Remifentanil	100-200
	Alfentanil	40-50
	Butorphanol	8-11
Moderate	Methadone	1.5
	Morphine	1
	Nalbuphine	0.5-0,8
	Pentazocine	0.3
Low	Codeine	0.2
	Pethidine	0.1
Very Low	Tramadol	0.05-0.07

characterized by a wide safety margin and high potency, which is significantly greater than the analgesic activity of morphine (Table 4).

According to the author's estimation, intravenous **morphine** (morphinum sulfas, 1-ml ampoules, 0.01 or 0.02 ml/kg) is the most suitable analgesic for application in a trauma room. It has analgesic, antitussive, sedative, antidiarrheal (slowing intestinal spasms) and, unfortunately, emetic effect. It also increases myocardial contraction (morphine is a positive inotropic agent) and changes blood distribution in the lungs (and thus has a beneficial effect in the case of stagnation in pulmonary circulation), which are additional advantages of the drug. It dissolves well in the water and has long latency (which, unfortunately, is a disadvantage).

If injuries are so severe that the casualty is suffering from strong pain, it is necessary to administer a fast acting drug, an instance of which is ketamine.

In this event, morphine may be administered after ketamine and its analgesic effect should be apparent in ten to twenty minutes. **Ketamine** should be administered intravenously at the dose of 0.2-0.5 mg/kg of body weight. Ketamine (Figure 8) induces what is called dissociated anesthesia and effectively relieves pain (except for cases when the pain results from sustaining injuries to structures located within the pleural cavity and the peritoneum). It increases upper airway reflexes and does not cause respiratory depression. The disadvantage of ketamine is that it increases saliva production and has a psychotropic effect (it is necessary to maintain silence, which is rarely possible when working in a trauma room). Ketamine is available in two forms: 10 mg/ml and 50 mg/ml vials. The intravenous administration of ketamine should be made using a 10mg/ml solution. This means that the content of the larger phial should be dissolved by drawing 1 ml of the drug into a syringe and adding 4 ml of a 0.9% Na Cl solution.

Figure 8. Vial with ketamine. Photo by W. Machała
Rycina 8. Fiolka z ketamina. Fot. W. Machała

Note: according to the color coding principles, intravenous anesthetics have yellow labels with blue letters.

It happens that child patients are taken to a trauma room, frequently without established vascular or intraosseous access. In such an event, ketamine should be administered intramuscularly at the dose of 8-10 mg/kg of body weight. It is advisable to use a 50mg/ml solution in that case. The patient should fall asleep after 5-8 minutes; first medical activities (examination, cannulation) may, however, be performed after 3-4 minutes.

Morphine is best administered by titration. Prepare a 20 ml syringe for a 20 ml ampoule and a 10 ml syringe for a 10 mg ampoule. Mark the syringes before drawing the drug.

Figure 9. Ampoule with fentanyl. Photo by W. Machata

Rycina 9. Amputki z fentanylem. Fot. W. Machata.

Note: according to the color coding principles, opioid analgesics have blue labels with white letters.
Draw the content of the 20 mg ampoule into the 20 ml syringe and content of the 10 mg ampoule into the 10 ml syringe. Then fill the 20 ml syringe with 19 ml of a 0.9% NaCl solution and the 10 ml with 9 ml of the solution. The syringe should contain 1 mg/ml morphine after the preparation.

The recommended initial intravenous dose for adults is 2-3 mg. This dose of morphine should saturate the emetic center and prevent the patient from vomiting. After 3-5 minutes, start administering morphine at the dose of 1 mg every several minutes until pain is resolved. The dose that resolves the pain is called a saturation dose. The half-life of morphine is approximately 3.5 hours, which is the time during which the effects of the drug will last.

Another required activity is to specify a maintenance dose. A maintenance dose is administered in single doses (boluses) or as continuous infusion.

The method for specifying a maintenance dose is simple: a maintenance dose is half of a saturation dose and it should be administered intravenously every 3.5 hours.

Continuous morphine infusion should be administered after a saturation dose at the rate of 0.015-0.05 ml/kg/h.

Fentanyl (Figure 9) may also be used in a trauma room to alleviate pain. Fentanyl is a derivative of piperidine and it is freely soluble in fats. It is available in 2 ml and 10 ml (usually 2 ml) ampoules (50 µg/ml). Fentanyl may be administered without dilution. A 10 ml syringe is commonly used. The effects of the drug become apparent shortly after the intravenous administration. The time of fentanyl's action is unfortunately short and it is approximately 25 minutes. Fentanyl should not be continuously infused since this method of administration carries the risk of drug accumulation and the risk of the occurrence of adverse effects.

It is recommended to administer a single 1-2 µg/kg dose of the drug for pain relief purposes. The dose may be repeated every 25-30 minutes and it should be reduced by a half.

In the author's opinion, it is better to use fentanyl in an operating theater in patients undergoing a surgery under general anesthesia than in a trauma room.

Pethidine is not recommended by the author as the drug is not appropriate for alleviating severe pain, even though it is available in a trauma room. This suggestion results from the drug's low potency and active metabolites stimulating the central nervous system.

Nevertheless, if pethidine is to be used, the recommended dose is 1-2 mg/kg and it should be administered *intravenously* (a maximum single dose). The drug is available in 1 ml and 2 ml ampoules (1 ml contains 50 mg of pethidine in both cases).

It is recommended to prepare a 5mg/ml solution of the drug in a syringe. Therefore, the 2 ml ampoule (containing 100 mg of pethidine) should be drawn into a 20 ml syringe and the 1 ml (50 mg) ampoule into a 10 ml syringe; then 18 ml or 9 ml of a 0.9% NaCl solution should be added.

In the case of an intravenous administration, the first dose should be 20-30 mg (in adults) and subsequent doses should be titrated (5 mg each) every several minutes until the pain resolves. The overall dose that a patient receives until the pain resolves is called a saturation dose. A maintenance dose is half of a saturation dose and it should be administered every 3-3.5 hours (also intravenously).

Injured patients in severe general condition

Injured patients in severe general condition and patients above 65 years old should receive reduced doses of analgesics. Good practice suggests reducing the dose by 1/3 or even 1/2; it is also necessary to monitor the therapeutic effect and be prepared to administer a supplementary dose or counteract symptoms related to adverse effects.

Respiratory depression

Respiratory depression may occur in injured patients receiving opioid analgesics. The initial phase of respiratory depression involves a decrease in respiratory rate (even as large as <6/min) and an increase in tidal volume. This is followed by apnea. What is important, the injured patient does not have dyspnea, although his or her blood saturation may be even <50%. If the injured patient is conscious, he or she is able to breathe faster and deeper when requested to do so but forgets about breathing after a while.

The occurrence of respiratory depression in an injured patient receiving an opioid obliges the emergency team to increase sedation and to consider connecting the patient to a ventilator (after intubation) and not administering an antagonist drug (nalaxone).

As can be seen, the pragmatic approach (ventilation) is not always the same as the one that is actually adopted, which would involve the use of nalaxone, an opioid antagonist. Even the application of a small dose

may result in the return of pain that is impossible to relieve by the use of opioids.

Muscle rigidity

Fentanyl may sporadically cause muscle rigidity (the rigidity may occur not only in respiratory muscles, but in all muscles, although it usually occurs in thoracic and abdominal muscles). Muscle rigidity usually occurs:

- after the administration of a single dose (bolus),
- as a consequence of a rapid injection of the drug;
- it is more frequent in elderly patients (over 65 years old) and patients with Parkinson's disease.

A physician cannot predict which patient may start experiencing muscle rigidity but he or she must be prepared for such an event. Adequate preparation for possible complications includes the implementation of effective oxygen therapy (before administering opioids). Once the patient has received opioids, it is necessary to monitor his or her respiratory mechanics (respiratory rate, tidal volume, respiratory movements) because injured patients with muscle rigidity are indifferent to abnormalities, including apnea. The **only** procedure for counteracting muscle rigidity is to immediately administer an intravenous anesthetic and a muscle relaxant. It is impossible to induce active respiration in patients with muscle stiffness that is caused by the administration of opioids (tidal volume is directed neither to the lungs nor to the stomach).

Drug synergy

One cannot fail to mention the matter of synergy (increased potency) of the administered opioids. There is a substantial number of patients who receive sedatives (mostly benzodiazepines) as part of emergency procedures occurring in a trauma room. It may be at times necessary to administer an anesthetic (etomidate or, less frequently, propofol). The combined administration of analgesics and benzodiazepines or intravenous anesthetics may result in respiratory depression and the occurrence of cardiovascular symptoms (bradycardia, hypotonia) and it is therefore recommended to be extremely cautious and prepared for the possible treatment of complications in the case of such concomitant use.

Non-opioid analgesics

The application of non-opioid analgesics in relieving severe, trauma-induced pain is limited both in a trauma room and in the entire level II field hospital. This results most of all from the **ceiling effect**. The term refers to a situation where increasing an analgesic dose does not produce a more effective analgesic effect.

By comparison, opioids can relieve any severe pain because an increase in the dosage of an opioid produces a more effective analgesic effect. Nonetheless, this carries a greater risk of adverse effects (mainly respiratory depression).

At the same time, non-opioid analgesics may be administered in particular cases. They may be used as coanalgesics when the patient receives opioids as part of primary analgesic treatment.

The most commonly used non-opioids are:

- metamizol (available in Poland under the brand name Pyralgin [manufactured by Polpharma], for instance) – 2.5 g intravenously every 12 hours,
- paracetamol (available in Poland under the brand name Perfalgan [manufactured by BMS], for instance) – 1.0 g intravenously every 8 hours.

Pain relief in operating theater conditions

A patient who has been taken to an operating theater qualifies for surgery. This means that it is necessary to induce anesthesia, during which the operating team will dress wounds sustained by the patient.

Preoperative care

It seldom occurs that the anesthesiologist has the luxury to anesthetize a patient with an isolated injury. Multiple injuries are much more common, including head and facial trauma, unstable spinal fracture, abdominal injuries and bone fractures. Co-occurrence of severe hypovolemia and hemorrhagic shock is not rare.

After the examination of the patient's general condition in a trauma room (which is often carried out concurrently with emergency activities), including ophthalmoscopy, otoscopy and per rectal examination, the team determines the patient's blood type, the Rh factor, hemoglobin concentration, hematocrit, electrolyte concentration, performs gasometry, evaluates the prothrombin time and APTT, and carries out the eFAST examination and the X-ray imaging (sides of the neck, thorax, pelvis).

When diagnosing and preparing the patient for anesthesia, it is necessary to implement oxygen therapy (or intubate the patient and start respiratory therapy), gain fail-safe vascular access (both venous and arterial), drain the pleural cavity and pre-determine the scope of the surgery (even in a general manner).

Ordering an appropriate number of blood units, fresh frozen plasma, platelet concentrates and cryoprecipitate is particularly important. It is recommended to administer 1 g of tranexamic acid (Exacyl) and repeat the dose after 8 hours. The decision regarding the use of the Walking Blood Bank (WBB) must also be made at this stage. The Walking Blood Bank may be used if predictions are that there will be a need to transfuse more than 10 units of blood (the amount can be defined as massive blood transfusion).

Choosing an anesthetic method – inducing anesthesia

The key action in this matter is to choose anesthetics and anesthetic methods that will worsen the patient's condition as little as possible.

Unconscious patients with shock should receive only 1-2 mg of midazolam in the beginning of the surgery. Other anesthetics may be used, depending on how the patient's condition changes during the surgery. Passive

preoxygenation (the patient is breathing independently by the use of an appropriately applied mask) should be maintained for as long as possible, unless instructions for the surgery state otherwise.

Both propofol and thiopental should not be used for inducing anesthesia in hemodynamically unstable patients because the drugs directly decrease cardiac output and dilate peripheral blood vessels (thus decreasing the SVR). Hemodynamically unstable patients may receive etomidate.

According to the literature, the use of ketamines is questionable because the drug stimulates the sympathetic nervous system, increasing the blood pressure, cardiac output and heart rate. Apart from that, ketamine is not effective when the patient is in shock as the shock itself causes maximum sympathomimetic stimulation.

Muscle relaxants (succinylcholine) should be used if needed.

Maintaining anesthesia

In order to maintain anesthesia, inhaled anesthetics are used; alternately, propofol may be administered by continuous infusion but this is less common. The patient must receive an opioid analgesic in doses that depend on his or her blood pressure. All inhaled anesthetics depress cardiac systolic function (depending on their concentration). It is advisable to use isoflurane or sevoflurane. All inhaled anesthetics disturb hypoxic pulmonary vasoconstriction (HPV), have a positive effect during one lung ventilation and decrease hepatic and renal blood flow. When carrying out emergency activities, low concentration (0.4% of total volume) of isoflurane may be administered together with fentanyl. This method is connected with the less frequent occurrence of hemodynamic instability.

Muscle relaxants

Vecuronium is recommended for administration as part of maintaining anesthesia.

Preventing hypothermia

Hypothermia increases coagulation disorders (disturbs platelet function, among other things), causes the constriction of peripheral blood vessels (increases SVR), exacerbates acidosis, increases oxygen consumption during body warming, decreases cardiac output and inhibits inflammatory response. It reinforces the occurrence of arrhythmias, particularly when the body temperature is lower than 30°C. Moreover, it inhibits the metabolism of drugs, increases blood viscosity, disturbs erythrocyte deformability, contributes to the intracellular release of potassium and shifts the hemoglobin dissociation curve in the left direction.

These phenomena can be prevented by infusing warm liquids and blood and warming patients by the use of external means, such as mats, mattresses and blankets. Level II hospitals should have the following equipment for use:

- Ready-Heat Blankets, instruments for the rapid infusion of liquids and blood (Level I and Belmont),
- external electrical heaters.

The end of anesthesia

As the surgery and anesthesia come to an end, the patient should be transferred for treatment to the Intensive Care Unit (ICU). It is not advisable to wake the patient after the surgery; the patient should be transferred to the ICU and his or her treatment should include appropriate monitoring, respiratory therapy, pain relief, nutritional and pharmacological treatment, and laboratory, imaging, microbiological test, as well as nursing, rehabilitation and physical therapy.

Pain relief

Appropriate analgesic management is a prerequisite for the provison of correct patient therapy at the ICU. It alleviates the suffering of a patient and reduces the risk of respiratory, circulatory, metabolic and immunological complications.

Opioid analgesics

The administration of opioid analgesics is absolutely recommended in patients in the early post trauma period.

Modification of pain relief therapy should be considered when carrying out ICU therapy. Although the continuous intravenous infusion of opioids (in fixed doses) is compliant with pain relief principles, opioids will not provide the patient with optimal anesthesia under the discussed circumstances; the use of opioids requires experience and it always carries the risk of adverse effects.

Patient-controlled intravenous analgesia (PCIVA)

This method is definitely recommended in conscious patients, who know how intense their pain really is. In order for pain relief to be effective, the patient has to be familiar with the method and be aware of possible complications. Appropriate patient monitoring is also necessary (hemoglobin oxygenation and respiratory rate). The recommended drugs in PCIVA are morphine and fentanyl (Table 5).

Intrapleural analgesia (IPA)

Intrapleural analgesia (IPA) used to be recommended for pain relief in patients with thoracic injuries. This method was at first met with enthusiasm, followed by the period of a more critical approach. Intrapleural analgesia requires the administration of large volume (20 ml) of bupivacaine at the concentration of 0.25% (normally 0.5%) every 4 hours. The volume and the concentration of the drug, the frequency of administration and absorption from a vast surface (pleural cavity) into the bloodstream creates the real risk of bupivacaine's toxic action. The use of IPA is also associated with certain inconvenience as it requires closing the drainage of the pleural cavity before administering the drug and keeping the drain closed for 15-30 minutes once it is put back. If there is an air leak between the lungs and the plural cavity, hypertensive pneumothorax may occur.

Table 5. Morphine and fentanyl - guidelines for PCIVA (adults)
Tabela 5. Morfina i fentanyl - przewodnik do PCIVA (dla dorosłych)

Opioid	Initial dose	Emergency dose	Withdrawal period (min)	Infusion rate
Morphine	0.05–0.1 mg/kg of body weight	0.5–3 mg	8–15	0.5–2 mg/h
Fentanyl	0.5–1 µg/kg of body weight	15–75 µg	5–8	15–60 µg/h

Table 6. Effects, benefits and contraindications for epidural administration of hydrophilic drugs (well dissolving in water)
Tabela 6. Działanie, korzyści i przeciwwskazania do zewnątrzoponowego podawania leków hydrofilnych (dobrze rozpuszczalnych w wodzie)

Predictions	Benefits	Limitations
– slow onset of action – long time of action – good solubility in the cerebrospinal fluid (CSF) – broad distribution in the CSF	– long time of action after administering a single dose – can be administered to the epidural space in the lumbar spine – very small dose if compared to an intravenous dose	– late onset of action (long latency) – unpredictable time of action – considerable risk of adverse effects – late respiratory depression

Continuous epidural analgesia (CEA)

Continuous epidural analgesia (CEA) is probably the most recommended method for bringing pain relief to injured patients. It decreases functional residual capacity (FRC), airway resistance (dilates the airways) and improves pulmonary compliance. Opioids and perineural analgesics may be additionally administered to the epidural space (the opioid dose should be several times smaller than the parenteral dose in that case). Although the dose of opioids is smaller when they are administered to the epidural space, their action is more prominent and lasts longer than in other administration methods.

There are three methods for administering drugs to the epidural space:

- single doses (boluses) – administered at precisely defined intervals,
- continuous infusion,
- patient-controlled epidural analgesia (PCEA).

It may seem controversial to insert the catheter in unconscious trauma patients when there is no possibility of verifying the catheter's location by the use of a test dose (4 ml of 2% lidocaine with 20 µg of adrenaline). It appears, however, that the epidural administration of small concentrations of opioids or opioids and perineural analgesics may be sufficient.

Opponents of this analgesic method believe that hemodynamically unstable patients should not receive epidural analgesia. Some believe that epidural analgesics can make neurological evaluation impossible. The author's opinion, however, is that the catheter should be inserted immediately after a life-saving surgery (if the injured patient required the surgery) or directly after the successful management of a life-threatening condition in the ICU (if the patient did not require the surgery). The adoption of such procedure seems even more reasonable when one takes into account that inserting the catheter into the epidural space will be contraindicated after the patient starts receiving antithrombotics.

If the patient is hemodynamically unstable, perineural analgesia should be withheld; at the same time, it is completely safe to administer opioids (such as 0.1% Morphinum Sulfas Spinal, Fentanyl by Polfa).

Drug selection

The choice of a drug (perineural analgesic) depends on its solubility in fats, the place of the catheter's insertion to the epidural space and the place of nociceptive impulses [Tables 6-9].

Post-operative care of trauma patients

It is often necessary to support the circulatory and respiratory function in trauma patients in order to improve oxygenation, for instance. The therapeutic team often has to face the following inconveniences: appropriate fluid therapy, pain relief, nausea and vomiting, CNS depression (including the state of prolonged unconsciousness), psychomotor agitation and unpredicted drug interactions.

Multi-organ injuries are also frequent, resulting in the necessity to expand the therapeutic team by physicians with different specialities.

All this contributes to a challenge that the therapeutic team has to face when managing disturbances during the first hours and days after trauma, which is only the outset of the road to the patient's recovery, particularly when the team has to prepare the patient for evacuation (usually by air) to a level III hospital.

Table 7. Effects, benefits and contraindications for epidural administration of lipophilic drugs (well dissolving in lipids)
Tabela 7. Działanie, korzyści i przeciwwskazania do zewnątrzoponowego podawania leków lipofilnych (dobrze rozpuszczalnych w tłuszczach)

Predictions	Benefits	Limitations
– rapid onset of action – short time of action – poor solubility in the cerebrospinal fluid (CSF) – limited distribution in the CSF	– rapid onset of action (short latency) – minor risk of adverse effects – perfect for patient-controlled epidural analgesia (PCEA)	– rapid absorption into the systemic circulation – short time of action – the action of the drug is present only in the area of its administration (thoracic area only)

Table 8. Pharmacology of epidurally administered opioids
Tabela 8. Farmakologia opioidów podawanych drogą zewnątrzoponową

Opioid	Relative solubility in fats	Dose	Onset of action (min)	Time of action (h)
Morphine	1	1-5 mg	30-90	6-24
Pethidine	28	30-100 mg	15-25	4-8
Fentanyl	580	50-200 µg	5-15	2-4

Table 9. Dosage of bupivacaine and bupivacaine with fentanyl mixture into epidural cavity of thoracic spine
Tabela 9. Dawkowanie do przestrzeni zewnątrzoponowej w odcinku piersiowym mieszaniny bupiwakainy i bupiwakainy z fentanylem

1 mg/ml bupivacaine and 0.05 mg/ml morphine – infusion				
Patient's age (years)	**Initial dose of morphine (mg)**	**Volume of 0.25-0.5% bupivacaine (ml)**	**Infusion rate (ml/h)**	**PCEA dose (ml), 20-min delay**
15-44	4	5-8	6	3-4
45-65	3	4-6	5	2.5-3
66-75	2	4-5	3	1.5-2
>76	1	3-4	2	1-2
1 mg/ml bupivacaine with/without 5 µg/ml fentanyl – infusion				
Patient's age (years)	**Initial dose of fentanyl (µg)**	**0.25-0.5% bupivacaine, volume (ml)**	**Infusion rate (ml/h)**	**PCEA dose (ml), 10-min delay**
15-44	100	5-8	6	4
45-65	100	4-6	5	3-4
66-75	75	4-5	4	2-4
>76	50	3-4	3	1.5-2

References

1. Brizgys R.V., Morales R., Owens B.: Effects of thiopental requirements and hemodynamic response during induction and intubation. Anesthesiology, 1985; 63: A377
2. Cartwright P, Prys-Roberts C, Gill K, et al.: Ventilatory depression related to plasma fentanyl concentrations during and after anesthesia in humans. Anesth. Analg., 1983; 62: 966-974
3. Freye E., Levy J.V.: Opioids in medicine. MIASTO, Springer, 2008
4. Katoh T., Ikeda K.: The effects of fentanyl on sevoflurane requirements for loss of consciousness and skin incision. Anesthesiology, 1998; 88: 18-24
5. McClain D.A., Hug C.C.: Intravenous fentanyl kinetics. Clin. Pharmacol. Ther., 1980; 28: 106-114
6. Power I., Kam P.: Principles of physiology for the anesthetist. London, Hodder Education, 2008
7. Prys-Roberts C., Hug C.E.: Pharmacokinetics of anesthesia. Blackwell, Oxford Scientific Publications, 1984
8. Rosow C.E.: Cardiovascular effects of opioid analgesia. Mt

Sinai J. Med., 1987; 54: 273-276
9. Scott J.C., Stanski D.R.. Decreased fentanyl and alfentanil dose requirements with age: A simultaneous pharmacokinetic and pharmacodynamic evaluation. J. Pharmacol. Exp. Ther., 1987; 240: 159-166
10. Streisand J.B., Bailey P.L., LeMaire L., et al.: Fentanyl-induced rigidity and unconsciousness in human volunteers. Anesthesiology, 1993; 78: 629-634
11. Tagaito Y., Isono S., Nishino T.: Upper airway reflexes during a combination of propofol and fentanyl anesthesia. Anesthesiology, 1998; 88: 1459-1466
12. Westmoreland C.L., Sebel P.S., Gropper A.: Fentanyl or alfentanil decreases the minimum alveolar anesthetic concentration of isoflurane in surgical patients. Anesth. Analg., 1994; 78: 23-28
13. Parsons D.: Battlefield medicine: A new perspective. Infantry, 2004; 93: 16-17
14. Butler F.K. Jr, Hagmann J., Butler E.G.: Tactical combat casualty care in special operations. Mil. Med., 1996; 161: 3-16
15. Committee on Tactical Combat Casualty Care: Tactical Combat Casualty Care Guidelines. Government Printing Agency, 2010
16. Auerbach P.S.: Wilderness medicine. Elsevier Mosby, 2012
17. Tactical Combat Casualty Care in the Canadian Forces: lessons learned from the Afghan war. Can. J. Surg., 2011; 54: 118-123
18. Committee on Tactical Combat Casualty Care: Tactical Combat Casualty Care Guidelines. Government Printing Agency 2012
19. PHTLS: Prehospital Trauma Life Support. Military Version. Elsevier Mosby, Elsevier Health Sciences, Mosby Co CV 2005

Diagnosis and procedure in hypovolemic shock

Rozpoznanie i postępowanie we wstrząsie hipowolemicznym

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Abstract. Massive and acute blood loss is a major cause of death of wounded who have suffered injuries in the combat conditions - along with upper airways obstruction and pulmonary edema with hypertension. Blood loss, which often results in a shock, leads to ischemia of tissues. Among the procedures that should be implemented by the rescue team, the following must be mentioned: stopping the hemorrhage and taking life-saving procedures including restoration of intravascular blood volume. The authors presented the principles of conduct with the injured who were diagnozed with hemorrhage. The paper describes mechanical techniques of blood stopping in pre-hospital conditions (combat application tourniquet, JETT, hemostatic dressings), principles of vascular access and fluids infusion. Among the vascular access techniques, both intraosseous and intravenous access were described. In terms of infusion fluids, crystalloids, colloids and hypertonic infusion solutions were characterized. In the paper, the reader will find answers to the questions of when to initiate Walking Blood Bank and what parameters indicate positive effects of performed actions.
Keywords: ATLS, colloids, combat application tourniquet, crystalloids, fluids monitoring, hemorrhage, hypertonic infusion solutions, hypovolemia, monitoring of volemic status, shock, small volume resuscitation, TC3

Streszczenie. Masywna i ostra utrata krwi jest główną przyczyną śmierci rannych, którzy odnieśli obrażenia ciała w warunkach taktycznych - obok niedrożności górnych dróg oddechowych i odmy optucnowej z nadciśnieniem. Utrata krwi, będąc nierzadko główną przyczyną wstrząsu, prowadzi do niedotlenienia tkanek. Wśród czynności, które powinien wdrożyć zespół ratunkowy, należy wymienić: zatamowanie krwotoku i podjęcie czynności ratowania życia, w tym przywrócenie objętości wewnątrznaczyniowej. Autorzy przedstawili zasady postępowania z rannymi, u których rozpoznano krwotok. W pracy opisano mechaniczne techniki tamowania krwotoku w warunkach przedszpitalnych (staza taktyczna, JETT, opatrunki hemostatyczne) oraz zasady uzyskiwania dostępu naczyniowego i przetaczania płynów. Wśród technik uzyskania dostępu naczyniowego przedstawiono zarówno dostęp doszpikowy, jak i dożylny. W odniesieniu do płynów infuzyjnych - scharakteryzowano krystaloidy, koloidy i hipertoniczne roztwory krystaloidów. W pracy czytelnik znajdzie odpowiedzi na pytania, kiedy należy myśleć o uruchomieniu Walking Blood Bank i jakie parametry świadczą o pozytywnym efekcie podjętych czynności.
Słowa kluczowe: ALTS, hipowolemia, koloidy, krwotok, krystaloidy, monitorowanie wolemii, opatrunki hemostatyczne, resuscytacja małą objętością, roztwory hipertoniczne, staza taktyczna, TC3, wstrząs

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Introduction

Statistics on multiple and multi-organ trauma are grim. More than a half of casualties die at the place of an accident [1-3] and 40% die due to a haemorrhage [4], which most frequently occurs before the arrival of an emergency team or during transport. Two thirds of those who survive (the remaining 50%) reach the hospital in a condition that directly threatens their lives. 25% of them die with symptoms of hypovolaemic shock, acute respiratory syndrome, and as a consequence of central nervous system damage and coagulopathy [5-7]. The last of the conditions mentioned above may be present in the form of acute post-traumatic coagulopathy or disseminated intravascular coagulation (DIC).

Haemorrhage

Trauma most frequently leads to vascular damage and a haemorrhage. A haemorrhage [8] is defined as the loss of:

- 1.5 ml of blood/kg bw/min within 20 minutes,
- 150 ml of blood/kg bw/min within 1 hour.

How much blood does a human have?

In order to discuss the effects of blood loss and the principles of restoring intravascular volume, one has to be aware of how much blood circulates in the human body. Blood volume in different life stages [9]:

- a preterm neonate – 100 ml/kg bw,
- a neonate – 90 ml/kg bw,
- a preschool child – 80 ml/kg bw,
- a school-age child – 75 ml/kg bw,
- an adult – 70 ml/kg bw.

The key purpose of fluid therapy is to improve tissue oxygenation, largely as a result of the restoration of normal blood pressure values. One of the reasons for lowered blood pressure is blood loss.

Shock

Large-volume blood loss leads to tissue hypoxia. Tissue hypoxia (a condition where the cells are supplied with an inadequate amount of oxygen) is defined as shock [10,11].

The author adopts the Hinshaw and Cox classification [10] that differentiates between hypovolaemic shock, obstructive shock, cardiogenic shock and distributive shock. The classification further divides hypovolaemic shock into haemorrhagic and non-haemorrhagic shock and haemorrhagic shock into visibly apparent and occult shock.

Such perception of haemorrhagic shock results from practice since it cannot be determined whether blood is light or dark (an artery or a vein?) under poor lighting conditions or when the patient is hypoxic. Blood outflow in patients with low blood pressure may not be pulsating.

It also seems that the classification into apparently visible and occult shock is far more pragmatic than a classification into external and internal shock. When providing casualties with help under adverse conditions (night, poor weather conditions, threats faced by a medic and a casualty, and, above all, impermeable clothing worn by a casualty), haemorrhage fulfills the criteria of external shock (blood flows through damaged integuments). Impermeable clothing, however, makes it impossible for the blood to flow out (the haemorrhage is therefore external but it is not visible).

Shock triggers cardiovascular, neuroendocrine, inflammatory and immune responses; it also has consequences on the cell level. Hypovolaemic shock decreases preload. In effect, a compensatory mechanism in the form of a sympathetic response occurs, resulting in the constriction of resistance vessels in viscera, the skin and skeletal muscles (cool and clammy skin, tachycardia). At approximately the same time, venous vasoconstriction occurs (activation of the renin-angiotensin-aldosterone system [RAAS]). While the cardiovascular response is immediate, the neurohormonal response takes place with a 10-60 minute delay.

An adult may lose:

- 1000 ml of blood due to a chest injury (one-sided),
- 2000 ml of blood from a damaged liver,
- 2000 ml of blood from a damaged spleen,
- >5000 ml of blood due to a pelvic fracture,
- 800 ml of blood due to a humerus fracture,
- 400 ml of blood due to the fracture of a forearm bone,
- 2000 ml of blood due to a femur fracture,
- 1000 ml of blood due to a crus fracture.

The volume of lost blood is a valuable piece of information for a medic. It allows for the planning of treatment both at the place of an accident and in a hospital, where preparations are made thanks to information received from the emergency team. A medic may attempt to evaluate blood loss on the basis of clinical symptoms only in young and healthy patients. They have better tolerance of blood loss than older people and their compensation mechanisms are not disturbed.

The American College of Surgeons has created probably the most known classification for the estimation of blood loss (Table 1). The classification takes into account seven clinical symptoms (heart rate, blood pressure, pulse pressure, capillary refill, respiratory rate, urine output, mental state) and divides casualties into 4 classes. This allows medics to presume how much blood a casualty has lost and which fluids may be appropriate for fluid resuscitation.

Principles for emergency casualty care

The key principle for emergency casualty care is to save life, extremities and sight. The first activity to undertake is to stop the haemorrhage. This means that if there is a suspicion that hypovolaemia was the cause of circulatory arrest, the scheme for providing a casualty with emergency care can be presented as CBABC (control bleeding/airway/breathing/circulation).

Visible haemorrhage can be stopped by applying direct pressure to a wound or by using pressure dressing:

- the Combat Application Tourniquet, if a casualty sustained an upper or a lower extremity injury;
- the Junctional Emergency Treatment Tool, if a casualty sustained an injury of both lower extremities;

Table 1. Blood loss classification according to American College of Surgeons (1997)
Tabela 1. Klasyfikacja utraty krwi wg Amerykańskiego Towarzystwa Chirurgów (1997)

	Class I	Class II	Class III	Class IV
Blood loss (ml)	<750	750-1500	1500-2000	≥2000
Blood loss (% blood volume)	<15	15-30	30-40	≥40
Pulse rate (per minute)	<100	>100	>120	≥140
Blood pressure	Normal	Normal	Decreased	Decreased
Capillary refill time	Normal	Extended	Extended	Extended
Respiratory rate	14-20	20-30	30-35	>35
Urine output (ml/h)	≥30	20-30	5-15	Negligible
Mental status	Anxious	Anxious	Anxious, confused	Confused, lethargic
Fluid replacement	Crystalloid	Crystalloid	Crystalloid and blood	Crystalloid and blood
Estimate values for a 70 kg male				
ATLS guidelines for doctors. American College of Surgeons, 1997				

Table 2. Characteristics of cannula with recommendations from the Intravenous Nurses Society and the United Kingdom Expert Panel
Tabela 2. Charakterystyka kaniuli wraz z rekomendacjami Intravenous Nurses Society i United Kingdom Expert Panel

Gauge	External / internal diameter (mm)	Fluid / blood flow (ml/min)	Colour	Recommendations by the Intravenous Nurses Society	Recommendations by the United Kingdom Expert Panel	Gauge
12 13	2.8 2.58	449/ 335/		–	– massive infusions during resuscitation – rapid infusion (including at the place of an accident)	12 13
14	2/1.7	270/172	Orange/ red/ brown	–	– massive blood transfusion (mostly during surgery)	14
16	1.7/1.4	200/118	Grey	– patients after trauma – surgical patients – for blood transfusion	– massive blood transfusion (mostly during surgery)	16
17	1.4/1.2	125/76	White	–	– intravenous infusion and transfusion	17
18	1.2/1.0	80/45	Green	– patients after trauma – surgical patients – for blood transfusion	– intravenous infusion and transfusion	18

- haemostatic powder (QuikClot);
- haemostatic gauze (QuikClot Gauze, Celox Gauze, ChitoGauze).

Vascular access

Vascular access is of key significance. Securing vascular access is a prerequisite for the administration of drugs and the infusion of fluids and blood components. In order to secure vascular access, an intravenous cannula should be used. A perfect cannula should have the following characteristics:

- a chamber that makes blood visible immediately after reaching the vessel;
- a device preventing the cannula from further insertion and facilitating the mounting of a cannula on the skin (wings);
- a needleless, multi-lumen port.

A perfect cannula should have a needle with a point type that does not cause too much pain for the patient. It also should be made of a material that makes it easier to insert it to the vessel and reduces

the risk of infections and thrombosis. Other important features include the ease of mounting the cannula on the skin and protection against accidental removal of the cannula from the vessel. A cannula must also be safe for use (low risk of pricking oneself with the stylet of the needle and lack of contact between the person who performs the cannulation procedure and the patient's blood).

One may obviously assume that short, large-gauge cannulas, which are inserted into the external jugular vein, the femoral vein or one of the large veins of the upper extremity, are the best for the infusion of large fluid volumes. Table 2 presents the characteristics of available cannulas and recommendations for use developed by the Intravenous Nurses Society and the United Kingdom Expert Panel.

Advanced Trauma Life Support (ATLS) guidelines recommend using two peripheral cannulas with the gauges of 14 and 16. Tactical Combat Casualty Care (TC3) developed by the U.S. Army recommends using one cannula with the gauge of 18.
TC3 also recommends not applying cannulas to injured extremities.

If the wound:

- is located below the midriff, at least 1 cannula should be inserted into the confluence of the superior vena cava.
- is located above the midriff, at least 1 cannula should be inserted into the confluence of the inferior vena cava.
- affected the chest and the abdomen, cannulas should be inserted into the confluences of both venae cavae.

Another recommendation by TC3 is to consider the routine cannulation of the internal jugular vein and the subclavian vein
or the optional cannulation of the subclavian vein in patients with cervical immobilization (only in an emergency room or in a trauma room).

If it appears necessary to cannulate the internal jugular vein or the subclavian vein, TC3 allows for cannulation in the area of larger injuries and for the use of the Seldinger technique to cannulate the internal jugular vein and the subclavian vein.

A water test may also be carried out in the case of the cannulation of central veins.
Venous cannulation may sometimes be difficult to perform at the place of an accident (as part of pre-hospital care). If the expected time for reaching vascular access exceeds 90 seconds, it is advisable to gain intraosseous access. In order to do so, a medic may use:

- the FAST device – the sternum,
- the BIG (Bone Injector Gun) device – tibial tuberosity,
- the IZ IO device – the humeral head.

It is important to remember about the possible intraosseous administration of: vasopressin (V), lignocaine (L), atropine (A), naloxone (N), epinephrine (E) and amiodarone (A). The abbreviation VLANEA makes it easier to memorise the names of the drugs. A casualty may also receive crystalloids (a 0.9% NaCl solution, saline, Ringer's solution) and colloids (such as a 6% HAES) via intraosseous gravity infusion (the infusion is not pressurised). Never administer hyper-osmotic solutions (such as those containing concentrated glucose or NaCl).

For what purpose and when should medics infuse fluids in patients with acute hypovolaemia?

The primary elements of life-saving care in patients with diagnosed hypovolaemic (haemorrhagic) shock are: stopping bleeding, increasing the oxygen stream by the application of oxygen therapy, securing vascular access, expanding intravascular volume and administering tranexamic acid at the dose of 1.0 g (repeat the dose after 8 hours) [12]. The purposes of fluid infusion (fluid resuscitation) are the following:

- to increase the oxygenation of tissues as quickly as possible,
- to prevent the occurrence of biochemical disturbances,
- to protect the renal function,
- to avoid complications related to fluid infusion (choosing the most appropriate preparation).

Well-performed fluid resuscitation results in the restoration of intravascular volume and blood components (haemoglobin concentration), allowing for the transfer of oxygen and the counterbalancing of coagulation disturbances. All this is carried out in order to prevent the development of secondary shock (which is the effect of conversion from primary shock due to blood loss). Secondary shock is characterised by:

- increased capillary permeability,
- the loss of plasma volume,
- tissue swelling,
- interstitial swelling (the lungs, the kidneys),
- multi-organ failure.

A perfect infusion fluid

At this point one may pose a question: is there a perfect infusion fluid for the expansion of intravascular volume in the treatment of acute hypovolaemia? If so, what requirements should such a fluid meet? Characteristics of a perfect infusion fluid:

- improves perfusion even after small volume of the fluid has been infused;
- has a beneficial effect on the extraction of oxygen in tissues (oxygen supply and consumption);
- appropriate composition, also in relation to pH and electrolyte concentration;
- appropriate time of action (not too short),
- sterile, stable, ready for use, inexpensive.

Table 3. Crystalloids-characteristics
Tabela 3. Krystaloidy-charakterystyka

	meq/l								
Preparation type	**Na^+**	**K^+**	**Cl_+**	**Alkali**	**Ca^{2+}**	**Mg^{2+}**	**pH**	**kcal/l**	**Osmolarity**
Plasma	138	5	108	27	5	3	7.4	12	Isotonic
5% glucose	–	–	–	–	–	–	4.5	200	Hypotonic
Jonosteril Basic	49.1	24.9	49.1	10	–	2.5	4.5–5.5	200	Hypertonic
10% glucose	–	–	–	–	–	–	4.5	400	Hypertonic
0.9% NaCl	154	–	154	–	–	–	6.0	–	Isotonic
Ringer's lactate	130	4	109	28	3	–	6.5	–	Isotonic
Ringer's solution	130	4	109	28	3	–	–	200	Hypertonic

Crystalloids and colloids

When choosing infusion fluid for the expansion of intravascular volume, one should characterise two major types of infusion fluids, namely crystalloids and colloids. Crystalloids are solutions containing electrolytes or low-molecular weight carbohydrates (Table 3).

Guidelines for the management of hypovolaemic shock (Table 1) advise using crystalloids as primary fluids to expand intravascular volume. Crystalloids are recommended for use in all evaluation classes of blood loss. One of the most significant causes for the use is the role of Na+ (the neuroendocrine response). Renal ischaemia, β-adrenergic receptor stimulation and the increased concentration of Na+ cause the release of renin. This in turn leads via the RAAS to:

- the constriction of visceral and peripheral vessels,
- the release of aldosterone, ADH and ACTH.

Note: as crystalloids diffuse through the capillary membrane and 1 hour passes, only 1/5 of the administered volume remains in the vessels. The remaining part (4/5) is transferred into the extravascular space.

Crystalloids may be administered in order to meet a casualty's basic demand for fluids, counterbalance fluid loss and counteract particular disturbances.

The inconvenience of administering crystalloids is that 4/5 of the administered volume is transferred into the extravascular space and it does not expand intravascular volume. The presence of sodium in infusion fluid causes swelling due to changes in osmolarity. Swelling disturbs tissue perfusion and oxygenation as a result of capillary pressure. Intestinal swelling leads to motility disorders and promotes the occurrence of nausea and vomiting. Swollen structures heal longer and are more resistant to the action of analgesics. Moreover, the presence of chlorine in infusion fluid may cause hyperchloraemic acidosis. Finally, infusion fluids have low pH and it is therefore necessary to counterbalance acidosis to be able to infuse large volumes of the fluids.

The author would like to emphasise that limitations regarding the negative influence of crystalloids on a living organism (which are scientifically well-documented) should not be adopted uncritically when providing hypovolaemic patients with life-saving care. Fluids (a 0.9% NaCl solution, Ringer's lactate, and other, balanced crystalloids) must be infused according to standards provided in the further part of this section because this is the only way to save a severely injured patient at the time when blood products are not yet available.

Colloids are macromolecular substances used in plasma replacement and intravascular volume expansion (Table 4). They may be divided into:

- natural colloids: human albumin, plasma protein solutions, fresh frozen plasma (FPP);
- artificial colloids: hydroxyethyl starch (HAES), gelatine solutions.

Colloids build up oncotic pressure (they are capable of binding an appropriate volume of water). They cannot freely pass through capillary membranes (and thus they remain in the lumen of a vessel for a longer time) and their volume effect depends on: molecular size,

- degree of the dispersion of a solution,
- oncotic pressure,
- viscosity,
- decomposition and excretion.

Colloids are divided into preparations (Table 5):

- increasing plasma volume (their oncotic pressure is higher than plasma pressure, which results in the transfer of fluid from the interstitium to the lumen of the blood vessels);
- functioning as plasma replacement fluids (their oncotic pressure is the same as plasma pressure and therefore their infusion increases the intravascular volume by the infused volume).

The year 2012 saw the publication of reservations about hydroxyethyl starch (HAES) and its harmful impact on the renal function. This prompted the withdrawal of HAES from the market and the reanalysis of the colloid's effects. Based on Article 31 and Article 107 of Directive 2001/83/EC, the implementing Directive of the European Commission about marketing authorizations in respect of medicinal products containing HAES (infusion solutions) has been published on 19 December 2013. It includes the following contraindications for the administration of HAES:

- hypersensitivity,
- sepsis,

Table 4. Colloids – characteristics
Tabela 4. Koloidy - charakterystyka

	Plasma	HemoHES 6%	Voluven (Fresenius)	Tetraspan (BBraun)	Volulyte (Fresenius)	Hextend (Hospira)
Na^+(mmol/l)	142	154	154	140	137	143
K^+ (mmol/l)	4.5	–	–	4	4	3
Ca^{2+} (mmol/l)	2.5	–	–	2.5	–	5
Mg^{2+} (mmol/l)	.85	–	–	1	1.5	.9
HCO_3^-(mmol/l)	24	–	–	–	–	–
Lactate (mmol/l)	1.5	–	–	–	–	28
Acetate (mmol/l)	–	–	–	24	34	–
Malate (mmol/l)	–	–	–	5	–	–
Osmolarity (mOsm/l)	295	310	308	296	286.5	307
Colloid (g/l)	Protein 30-52	–	Starch 60	Starch 60	Starch 60	Starch 60

Table 5. Volume effect of selected crystalloids and colloids
Tabela 5. Efekt objętościowy wybranych krystaloidów i koloidów

Infused volume [ml]	Type of infusion fluid	Increase in plasma volume [ml]
1000	5% glucose	100
1000	Ringer's lactate	250
250	7.5% NaCl	1000
500	5% albumin	375
100	25% albumin	450
500	Volulyte	500

- burns,
- disorders of the renal function or renal replacement therapy,
- intracranial haemorrhage,
- critical state of the patient,
- overhydration,
- pulmonary oedema,
- dehydration,
- hyperkalaemia (if the solution contains K^+),
- severe hypernatraemia and hyperchloraemia,
- severe disorders of the hepatic function,
- congestive heart failure,
- severe bleeding disorders,
- post-transplant state (organ transplantation).

Small volume resuscitation – HyperHAES

The description of infusion fluids for the expansion intravascular volume should take into account a combination of a hypertonic NaCl solution and HAES. Unfortunately, the combination is no longer marketed in Poland.

Many authors [13-15] believe that if bleeding has been stopped but haemorrhagic shock symptoms occur, the infusion of a concentrated NaCl solution and HAES should be considered. The combination of a small volume of HAES and a concentrated NaCl solution takes part in what is named as small volume resuscitation (SVR).

A hypertonic NaCl solution rapidly expands circulatory blood volume by moving fluid from the extravascular to the intravascular space. Saline (a 7.2% NaCl solution) is responsible for the activation of the mechanism that rapidly moves endogenous fluid. Hydroxyethyl starch (a colloid) binds water, ensuring a long-term volume effect. Endogenous water is drawn mostly from erythrocytes and endothelial cells (blood vessels). Circulatory blood volume rapidly increases after infusion, exceeding the volume of the infused preparation by 3-6 times. What is more, microcirculatory blood flow improves as a result of endothelial dehydration, thus increasing oxygen supply to the tissues.

HyperHAES is a ready-for-use preparation comprising a 6% HAES solution (200/05) and a 7.2% NaCl solution. It is packed in bags containing 250 ml of fluid that is ready for administration; the recommended infusion volume is 4 ml/kg bw. HyperHAES has the following characteristics: Na^+ – 1232 mmol/l, Cl^- – 1232 mmol/l, pH – 3.5-6.0,

- Osmolarity – 2464 mOsm/l,
- Oncotic pressure – 36 mmHg.

The administration of HyperHAES at the volume of 4 ml/kg bw results after 2 to 5 minutes in:

- immediate increase in blood pressure (BP) and cardiac output (CO) and decrease in systemic vascular resistance (SVR);
- immediate increase in microcirculatory flow;
- decrease in the adverse consequences of ischaemia and reperfusion;
- increase in diuresis, which results from the improvement of organ perfusion;
- pain, which is why the infusion fluid should be administered into large veins, preferably by using central access;
- tissue necrosis in the case of the extravasation of the infusion fluid.

HyperHAES may be administered only after stopping bleeding because decreasing SVR increases bleeding.

It is worth adding that HyperHAES has rather high osmolarity, making it a perfect preparation for the treatment of patients with craniocerebral trauma accompanied by cerebral oedema.

Contraindications for the administration of HyperHAES include:

- hypersensitivity to hydroxyethyl starch,
- hypervolaemia,
- untreated congestive heart failure,
- severe hepatic failure,
- haemostatic disorders,
- renal failure with anuria,
- delivery,
- hyperosmia,
- dehydration,
- severe hypo- or hypernatraemia,
- severe hypo- or hyperchloraemia,

Fluid infusion

Fluid therapy can be implemented at any stage of medical care (at the stage of pre-hospital care, in an emergency room, during surgery and as part of treatment in the Intensive Care Unit). What is important is that the therapy is carried out in a sensible way.

There are two strategies for providing a casualty with care at the place of an accident [3,16]. The first strategy is called "scoop and run" and it involves basic life-saving procedures:

- dressing an external haemorrhage:
  - a (tactical) tourniquet, if the wound affects extremities (Figure 1);

Figure 1. Combat aplication torniquet (CAT). Photo by W. Machała
Rycina 1. Opaska zaciskowa (tzw. staza taktyczna). Fot. W. Machała

  - packing the wound with haemostatic gauze (Celox Gauze, QuikClot Gauze) and applying pressure dressing (Figure 2 and Figure 3);
  - using haemostatic powder (QuikClot) as an alternative to haemostatic gauze, if there is no possibility of packing the wound and applying pressure dressing (Figure 4);
- clearing the airways without the use of equipment and starting ventilation by the use of a bag valve mask;
- starting external cardiac massage;
- immobilising the cervical spine;
- immobilising fractures.

The second strategy, "stay and play", involves advanced life-saving procedures, including: definite airway clearance (by the use of equipment);

- pleural decompression thoracostomy (Figure 5);
- cricothyrotomy/tracheotomy by the use of the Portex ® Cricothyroidotomy Kit (PCK);
- Vascular access and fluid infusion:
  - intravenous (IV);
  - intraosseous (IO): sternal (>12 years old), such as FAST I (Figure 6), and tibial (no age limitations) (Figure 7).

It appears therefore that only the "stay and play" strategy involves gaining vascular access and fluid infusion.

Refraining from fluid infusion for the sake of transporting a casualty with internal (abdominal or thoracic) haemorrhage as quickly as possible to the hospital is compliant with the "primum non nocere" principle ("first, do no harm"). Such course of action is based on the assumption that a medic should not waste time on inserting a cannula into a vein (under extremely adverse conditions) and infusing fluids that increase blood pressure and bleeding from the injured vessels, and speed up the patient's decompensation, ultimately leading to death. The patient has greater chances of survival when an emergency team transports him or her to a hospital where there is a trauma team that is prepared for surgery thanks to information received from the emergency team.

Figure 2. Celox-Gauze haemostatic gauze. Photo by W. Machata

Rycina 2. Gaza hemostatyczna Celox-Gauze. Fot. W. Machata

Figure 3. QuikClot haemostatic gauze. Photo byW. Machata

Rycina 3. Gaza hemostatyczna QuikClot. Fot. W. Machata

Figure 4. QuikClot hemostatic granular powder. Photo by W. Machata

Rycina 4. Proszek hemostatyczny QuikCloth. Fot. W. Machata

Figure 5. Needle for pleural decompression thoracostomy (3.25"; 14Ga). Photo by W. Machata

Rycina 5. Igta do torakopunkcji igtowej odbarczającej (3,25 cala; 14 Ga). Fot. W. Machata

If medics managed to stop bleeding (by applying a tactical tourniquet), pack the wound, and apply pressure dressing or use haemostatic powder [17-19], it is further necessary to:

- start oxygen therapy;
- secure at least two intravenous access sites;
- start infusing 1000 ml of a 0.9% NaCl solution or Ringer's lactate, if the systolic blood pressure is <90 mm Hg (<110 mm Hg in patients with brain injury);
- maintain the mean arterial pressure (MAP) at 40-50 mmHg;
- avoid the use of catecholamines since the key factor for hypotension in severe hypovolaemia is a decrease in preload, and catecholamines increase afterload;
- effectively relieve pain (by administering analgesics);
- manage the patient's psychomotor agitation (possibly resulting from hypoxia);
- maintain the patient's normothermia using external heating such as Ready-Heat II Temperature Management Blankets (Figure 8), infusing warm fluids or using Hypothermia Prevention Management Kits (HPMKs); as a result of a chemical reaction, Ready-Heat Temperature Management Blankets warm up within several minutes to the temperature of 53°C and maintain the temperature for 8 hours;
- maintain the patient's normothermia and avoid hypoxia and acidosis to decrease the risk of coagulation disorders;
- transport the patient to the hospital as quickly as possible, after informing the hospital's trauma team about the state of the patient and the necessity to carry out further emergency procedures.

Authors of Polish recommendations [20] emphasise that the expansion of intravascular volume with blood derivatives should take into consideration the balance of the derivatives in relation to plasma composition, their osmolarity, buffer system and the presence of calcium ions. This is compliant with the position of the European Society of Anaesthesiology (ESA) recommending balanced crystalloid solutions as first-line fluids [21].

Figure 6. Intraosseous infusion set FAST. Photo by W. Machata

Rycina 6. Zestaw doszpikowy (mostek) FAST. Fot. W. Machata

Figure 7. Intraosseous needle (tibial bone). Photo by W. Machata

Rycina 7. Igła doszpikowa (kość piszczelowa). Fot. W. Machata

Nonetheless, **USA Army guidelines**, which are presented as part of the TC3 standard, are different to the Polish recommendations in this respect, stating that: if the patient is conscious and has a detectable pulse, vascular access should be secured and a crystalloid should be infused at the rate of 250ml/h by the use of a three-way valve;

- if there are visible bleeding wounds or the patient is unconscious and the pulse cannot be detected:
  - stop the bleeding (direct pressure, a tourniquet, haemostatic powder, haemostatic gauze);
  - infuse 500 ml of a 6% HAES and try to achieve a MAP of 40-50 mmHg, carry out hypotensive fluid resuscitation and try to achieve a SAP of 70-80 mmHg;
  - if the pulse appeared in the radial artery and the patient's state improved, stop the infusion;
  - if no improvement has been observed within 30 minutes, infuse another 500 ml of a 6% HAES.

Tactical casualty care procedures indicate that patients with stopped bleeding who do not have shock symptoms should not undergo fluid infusion therapy [13,20] (Table 6). If the bleeding has been stopped but shock symptoms have developed, a 6% HAES should be infused. When, however, uncontrolled internal (abdominal, thoracic) bleeding is suspected, fluid infusion is contraindicated.

These guidelines result from an observation that it is usually young and healthy people (soldiers) who lose blood (a colloid) as a result of an injury. For that reason, a rapid substitution of blood with another colloid (HAES) should improve the state of the patient. Fluid infusion in uncontrolled bleeding can only precipitate death, hence the refraining from the infusion of any fluids whatsoever in patients with suspected uncontrolled thoracic or abdominal bleeding.

Pain relief

The cardiovascular response to shock is related to the increased release of adrenaline (the adrenal medulla) and noradrenaline (nerve endings of the sympathetic nervous system). The activation of the sympathetic nervous system results in:

- the stimulation of β_1-adrenergic receptors in the heart and an increase in:
  - the contractility of fibres,
  - cardiac output,
  - heartbeat,
  - oxygen consumption,
- the activation of β_1-adrenergic receptors:
  - the constriction of peripheral arterioles,
  - SVR,
  - blood pressure,
  - vasoconstriction,
- gluconeogenesis (GNG),
- glycogenolysis.

This means that the administration of analgesics may lower blood pressure. At the same time, analgesics should still be administered to casualties at doses that are smaller but still relieve pain. It may be necessary under the circumstances to administer noradrenaline infusion at the dose of 0.05-0.2

Table 6. Pre-hospital treatment of patients with hemorrhagic shock (US Army procedure)
Tabela 6. Postępowanie przedszpitalne u rannych znajdujących we wstrząsie krwotocznym (procedura armii USA)

Physical state	Management
Stopped bleeding (no symptoms of shock)	Do not infuse fluids
Stopped bleeding (with symptoms of shock)	1000 ml of HAES (Hespan)
Uncontrolled internal (abdominal, thoracic) bleeding	Do not infuse fluids

Figure 8. Ready-Heat chemical temperature managementblanket. Photo by W. Machata

Rycina 8. Chemiczny koc termiczny- Ready-Heat. Fot. W. Machata

mg/kg bw/min, even though there is no recommendation for the administration of catecholamines in hypovolaemic shock. The use of noradrenaline results from the necessity to maintain perfusion.

Patient management at the ER

Once the ER team admits a patient to the hospital, it is obliged to carry out a full examination (including the eFAST examination – the ultrasonography of the abdominal cavity and pleural cavities), collect blood to carry out additional tests (blood typing and deciding on blood transfusion for life-saving purposes) and diagnose shock.

It is recommended at this stage to determine the concentration of oxygen that would not increase pO_2 >200 mmHg (hyperoxia should thus be avoided) [21]. When carrying out the procedures, the team should take into account diagnostic obstacles that related to the state of the patient and the circumstances of the admission, including [17,18]:

- concomitant CNS injuries,
- age,
- physique (extremely asthenic or athletic), drugs taken by the patient (most of all, beta blockers disturbing reflexive tachycardia that is secondary to hypovolaemia),
- hypothermia,
- the use of a direct electrical cardiac stimulation (a pacemaker),
- clothing (special/waterproof/Velcro/shoes/a motorcyclist's outfit) which makes it impossible to quickly examine skin integrity,
- the possible occurrence of injuries resulting from the effects of intoxicants (alcohol, pharmaceutical drugs, recreational drugs).

The ER team must quickly diagnose the patient and stop his or her bleeding with consideration to what is called as the great five of haemorrhages:

- I. external:
  - clinical examination;
  - invasive blood pressure measurement; it is permissible to insert a cannula into the femoral artery to collect blood on a periodic basis when the patient is under the state of shock (gasometry and constant monitoring of BP);
- II. chest:
  - clinical examination, eFAST, a chest x-ray (CXR).
  - drainage of the pleural cavity (even without X-ray verification, if bleeding into the pleural cavity is suspected), which should be performed within what is called the triangle of safety (Figure 9); insert the drain bluntly (not on a trocar);
- III. abdomen:
  - clinical examination;
  - eFAST, diagnostic peritoneal lavage (DPL), CT, laparoscopy, laparotomy;
- IV. pelvis:
  - clinical examination,
  - X-ray, CT, angiography;
- the Long Bones.

The key issue after admitting the patient is to decide whether to diagnose or to operate [24,25].

- The patient is haemodynamically stable: imaging diagnosis.
- The patient is not haemodynamically stable:
  - if a full spiral CT is available, carry out the following procedures within 2 minutes: imaging diagnosis, fluid transfusion, deciding on damage control surgery (life-saving procedures, abbreviated laparotomy/thoracotomy).

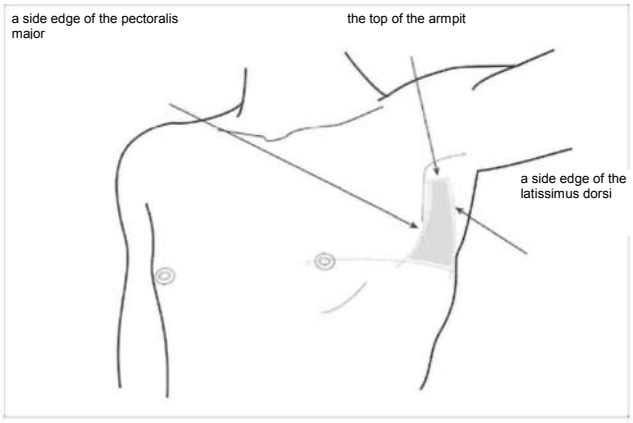

Figure 9. Triangle of safety - for introduction of drain to the pleural cavity

Rycina 9. Trójkąt bezpieczeństwa - dla wprowadzenia drenu do jamy opłucnej

– if a full spiral CT is not available, the team should immediately decide to carry out damage control surgery.

Fluid therapy at the ER

The author is in favour of implementing standards and guidelines when the patient is in a life-`threatening condition since allowing for discretion about therapy at this stage does not provide the patient with safety and it puts him or her under the unnecessary risk of avoidable complications. The US Army [22] has developed a division taking into account the patient's response to fluid resuscitation (Table 7). It requires infusing Ringer's lactate (2000 ml in adults, 20 ml/kg in children). The division can be used to consider indications for the infusion of crystalloids, blood, blood components and even surgery on the basis of pulse and blood pressure response to the infused volume.

Similarly to the next discussed division, this division applies **only** to young and internally healthy patients. The next division, which is also by the US Army, comprises early and late criteria for fluid therapy in casualties with hypovolaemic shock [22] (Table 8). After stopping the patient's bleeding, medics should try to maintain specific values of blood pressure, the pulse, the haematocrit (HCT), lactate concentrations, cardiac output (CO) and the parameters of the acid–base homeostasis that are the minimum needed to provide the patient with perfusion and a continuous oxygen stream. Although values falling into the category of 'early aims' differ from normal values (except for haematocrit), which are present in the category of 'late aims', they still do not expose the patient to the risk of life-threatening disorders.

In order to infuse fluids, normal infusers can be used. They have the length of 150 cm. Intravenous cannulas have specific flow rates. Specifications regarding a flow rate are reliable only if fluid is infused from the height of 150 cm.

Table 7. Predicted emergency procedures depending on response to fluid resuscitation with lactated Ringer's solution (adults: 2000 mL; children: 20 mL/KG); US Army
Tabela 7. Przewidywane czynności ratunkowe w zależności od odpowiedzi na resuscytację płynową mleczanem Ringera (dorośli: 2000 ml; dzieci: 20 ml/kg mc); Armia USA

Changes	Fast response	Temporary response	No response
Vital functions	Restoration of normal values	Temporary improvement followed by ↓BP and ↑HR	Maintenance of abnormal values
Estimated blood loss	10-20%	20-40%	>40%
The necessity to infuse larger volume of crystalloids	Unlikely	Highly probable	Highly probable
The necessity to transfuse blood	Unlikely	More probable	Necessary
The necessity to transfuse blood components	Unlikely	Highly probable	The necessity to carry out emergency infusion
The necessity to perform surgery	Possible	Probable	Necessary

Table 8. Aims of fluid therapy (US Army)
Tabela 8. Cele płynoterapii (armia USA)

Parameter	Early aim	Late aim
SAP (mmHg)	90	>100
HR ('/min)	<120	<100
HCT (%)	>25	>20
Lactates	The value should be lower than one from the first test	Normal
Cardiac output (CO)	Depends on blood pressure	As high as possible
Acid–base homeostasis	– there is no respiratory acidosis – metabolic acidosis is acceptable	Normal

A fluid rate may be increased by the use of a pressure cuff with a bag containing infusion fluid.

However, it is better to use special devices in emergency care that infuse fluids and warm them to match the patient's body temperature, namely:

- the Belmont infuser (Figure 10), allowing for the infusion of fluid at the temperature of 39.1°C and the maximum volume of 750 ml/min;
- Level I (Smiths Medical, Figure 11) that warms fluids to the temperature of 40°C and infuses them, thanks to the application of the DL-300 system, at the maximum volume of 1000 ml/min;
- Ranger (3M), allowing for the infusion of fluids at the volume of 500 ml/min.

One should remember that packed red blood cells (PRBC) should not be combined with preparations containing calcium (filter coagulation in the chamber of fluid lacus [Figure 12]).

Monitoring – laboratory diagnostics

It is necessary to monitor the patient's core temperature (>35°C) in the ER.

Recommended lab tests [20,21]:

- arterial blood gasometry:
  - pO_2 (keeping the value <200 mmHg through FiO_2 regulation),
  - pH (keeping the value >7.2),
  - BE (keeping the value <10 mEq/l),
- blood count:
  - haemoglobin concentration (keeping the value of 7-9 g/dl),
  - platetlet count (PLT) > 50 g/l,
  - haematocrit,
- biochemical:
  - lactate concentration (keeping the value <5 mmol/l),
    Ca^{2+} concentration (keeping the value >0.9 mmol/l),
- coagulation:

Figure 10. Fast flow fluid and blood infussion system - Belmont. Photo by W. Machała

Figure 10. Aparat do szybkiego przetaczania płynówi krwi- Belmont. Fot. W. Machała

Figure 11. Fast flow fluid and blood infussion system - Level I. Photo by W. Machała

Figure 11. Aparat do szybkiego przetaczania płynów i krwi - Level I. Fot. W. Machała

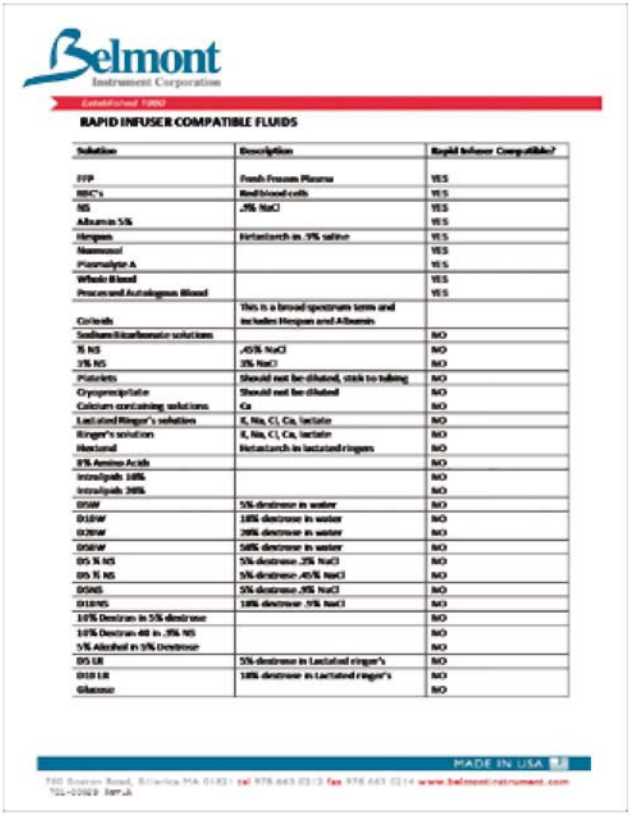

Figure 12. Fluids recommended for infusion by Belmont fast flow fluid system

Figure 12. Płyny polecane do przetaczania w aparacie do szybkiego przetaczania płynów Belmont

– fibrinogen (keeping the value of 1.5-2 g/l).

Monitoring: indirect monitoring and clinical indicators of normal perfusion

The hospital is a place where a patient with shock should be appropriately monitored [26]. The appropriate monitoring allows the hospital team to modify therapy, which also pertains to fluid infusion and the administration or refraining from the administration of specific drugs. Clinical indicators of normal perfusion are the following:

- mental state;
- mean arterial pressure (MAP), translating into perfusion pressure (including cerebral and visceral perfusion pressure; capillary refill;
- peripheral perfusion (the subsidence of 'marbled skin', the restoration of normal body temperature);
- normal lactate concentration in the serum;
- results for arterial blood gasometry;
- haemoglobin concentration,
- electrolyte concentration, particularly including the Ca^{2+} concentration, which should be frequently monitored during blood loss compensation and substituted as quickly as possible by administering a 10% $CaCl_2$ solution since the Ca^{2+} concentration is one of the three factors (along with acidosis and hypothermia) responsible for coagulation disorders;
- diuresis.

The following should be taken into consideration when monitoring the patient's intravascular volume expansion [26-28]:

- heart rate,
- blood pressure,
- the use of:
  – a cardiac output monitor (the Swan-Ganz catheter) [29];
  – PICCO (transpulmonary thermodilution; calibrated stroke volume);
  – Vigileo (non-calibrated stroke volume).

It is not recommended to perform haemostatic monitoring with a Swan-Ganz catheter; it also seems unreasonable to monitor central venous pressure in the discussed case [21].

The hospital team should monitor the following parameters to evaluate shock and response to fluid infusion [21]:

- cardiac output (CO),
- stroke volume variation (SVV),
- pulse pressure variation (PPM),
- superior vena cava saturation.

Massive blood transfusion

Blood loss compensation consists in the transfusion of blood or blood components. It may be assumed that massive blood transfusion [8] occurs if it appears necessary to transfuse 50% of the circulatory blood volume within 3 hours or the total circulatory blood volume within 24 hours.

According to the military health service, massive infusion occurs when it appears necessary to transfuse at least 10 units of whole blood within 24 hours.

When to transfuse blood

Patient qualification for blood transfusion should be based on the circumstances of the accident and the patient's state. The following injuries usually require massive blood transfusion:

- injury to a major artery in the inguinal or axillary area;
- proximal amputation of an extremity due to injury to a major blood vessel; two or more trauma amputations of extremities;
- severe hypothermia related to blood loss; extensive damage to soft tissues leading to blood loss;
- major abdominal injuries or a pelvic fracture a rear dehiscence.

The decision on blood transfusion should also take into account:

Table 9. Proportions of infussed blood components in massive hemorrhage – Statement of the Polish Expert Group
Tabela 9. Proporcje przetoczenia składników krwi w masywnym krwotoku – Stanowisko Polskiej Grupy Ekspertów

PRBC [units]	FFP [units]	PC [units]	CRYO [units]
10	5	2 therapeutic = 10	5

- anaemia, in the case of which haemoglobin concentration is <7 g/dl (9 g/dl in patients with identified ischaemic heart disease);
- age, if the patient is over 65 years old,
- haematocrit, if its value is <25%,
- increased demand for oxygen.

It is recommended in these cases that blood components which are used for the treatment of a severe haemorrhage should constitute no less than 50% of the total volume of fluids administered to the patient as part of the treatment of massive blood loss [20].

The Polish Group of Experts recommends [20]:

- transfusing >5 units of PRBC in combination with FFP at the ratio of at least 1 unit of FPP to 2 units of PRBC;
- transfusing packed platelets at the volume of at least 1 unit in patients who received at least 5 units of PRBC; 1 therapeutic unit of packed platelets = 5 units of pooled concentrate = $3x\ 10^{11}$ PLT;
- transfusing cryoprecipitate (CRYO), if >5 units of PRBC have been transfused, the ratio being 1 unit of CRYO to 2 units of PRBC.

This means that 5 units of CRYO, 2 therapeutic units of PLT and 5 units of FFP should be transfused to every 10 units of PRBC (Table 9).

Joint Theatre Trauma System Clinical Practice Guidelines, which are a set of procedures for providing casualties with medical care in the US Army [30], recommends transfusing all blood components at the ratio of 1:1:1:1 (PRBC:FFP:PLT:CRYO) in patients with massive blood loss. The transfusion starts with a pack of 4:4:4:4. If the transfusion of more than 10 blood units is needed, the Walking Blood Bank should be initiated. This will allow the medical team to transfuse fresh whole blood (FWB).

Table 11 [9] shows the expected increase in volume of blood components after the transfusion of packed red blood cells, packed platelets, fresh frozen plasma and cryoprecipitate (in an adult).

Table 10. Expected increase in volume of blood components after blood products substitution
Tabela 10. Przewidywane zwiększenie wartości składników krwi po substytucji preparatów krwi

Product name	Dose	Result of transfusion
Packed red blood cells	10-15 ml/kg bw	↑ Hgb by 2-3 g/dl
Packed red blood cells	1 unit	↑ Hct by approx 3%
Packed platelets	5-10 units	↑ PLT by 50,000-100,000
Fresh frozen plasma	10-15 ml/kg bw	INR↑ 15-20%
Cryoprecipitate	1-2 units/kg bw	↑ fibrinogen by 60-100 mg/dl

Coagulation disorders

Whole blood loss and its compensation by means of large-volume infusion is related to the risk of coagulopathy (anatomically unlocated bleeding) [20]. PRBC transfusion also creates the risk of coagulopathy (particularly when transfusing >5 units, if fresh frozen plasma [FPP] and platelets [PLT] have not been administered priorly) [20]. Coagulopathy may develop in the form of:

- acute coagulopathy of trauma shock (ACoTS),
- disseminated intravascular coagulation (DIC).

Diagnosis of coagulation disorders should take into account: circumstances of the accident (temperature of the surrounding environment, hypoxia, hypotension time), lost blood volume, the volume, the type and the temperature of infused fluids, oxygenation, pain relief and the results of additional tests: platelet count, fibrinogen and D-dimer concentration and the International Normalized Ratio (INR).

One may presume about the character of coagulation disorders by assigning a particular number of points to the results of additional tests [31,32]:

platelet count:
  - <50,000 – 2 points,
  - 50,000-100,000 – 1 point,
- fibrinogen:
  - <1 g/dl – 1 point,
- D-dimers:
  - >4 mg/l – 3 points,
  - 0.39-4 mg/l – 2 points,
- INR:
  - >2.3 – 2 points,
  - 1.4-2.3 – 1 point.

If the total number of points is 5 or more, DIC may be suspected.

If APTT and/or INR value exceeds, respectively, 35 s and/or 1.2, acute coagulopathy of trauma shock is possible.

Such presumptions are extremely relevant since they focus on coagulation disorders occurring as a

consequence of haemorrhage and trauma shock, which are exacerbated as a result of [31-33]:

- deterioration of the general condition (concomitant diseases and previously administered drugs),
- transfusion of 2000 ml of fluids,
- hypoperfusion,
- hypothermia,
- acidosis,
- hypercatecholaminaemia,
- electrolyte disorders.

Management of post-haemorrhagic coagulopathy

Recommended management of post-haemorrhagic coagulopathy includes the administration of [20]:
antifibrinolytic – tranexamic acid (Exacyl) at the dose of 20-25 mg/kg bw;
protamine sulfate – only in patients treated with unfractionated heparin;
prothrombin complex concentrate (PCC, factors II, VII, IX, X; Octaplex, Prothromplex) at the dose of 20-40 units/kg bw in patients with prothrombin deficiency or as a replacement for FFP in patients requiring the lowering of fluid infusion volume and patients with an overdose of a vitamin K antagonist, if:

- symptoms of haemorrhagic diathesis are present,
- an increase in APTT and INR has been observed,

- fibrinogen (at the concentration of <1.5 g/l) under the dose of 25-50 mg/kg bw;
- recombinant activated coagulation factor VII (rFVIIa; NovoSeven) – as an off-label indication in cases where the applied therapy fails and under the following conditions:
  - pH >7.2,
  - body temperature >35°C,
  - fibrinogen concentration >1 g/l,
  - PLT >50 g/l.

It may be worth mentioning at this point that the cell-based model of coagulation, which presents platelets, tissue factor, Ca^{2+} and recombinant activated coagulation factor VII (rFVIIa) as key elements in normal coagulation, is becoming more and more popular (and it is based on scientific evidence) [34]. The cell-based model of coagulation [34] assumes that coagulation occurs in three stages (initiation, amplification and propagation), rejecting the coagulation cascade from 1964 that differentiates between the intrinsic and the extrinsic pathway.

Completion of fluid resuscitation

The life of a trauma patient is usually saved when the medical team has managed to compensate the patient's lost intravascular volume. It may be theoretically assumed that fluid resuscitation may be completed after the following conditions are achieved:

- effective oxygen therapy, resulting in the increase of SpO_2 >97%,
- intubation and mechanical ventilation resulting in:
  - the subsidence of oxygenation disorders (FiO_2 <0,6, assuming that SpO_2 must be >97%),
  - the subsistence of ventilation disorders ($ETCO_2$ <60 mmHg),
- circulatory volume compensation (colloids, crystalloids, blood products):
  - central venous pressure (CVP): approx. 20 mmHg,
  - haemoglobin concentration: 10-12 g/dl,
- effectiveness of the implemented therapy (including catecholamine therapy):
  - the heart rate is between 50-120 BPM,
  - the mean arterial pressure (MAP) is between 70-110 mmHg,
  - increase in $ScvO_2$ >65%,
  - decrease in lactate concentration <2 mmol/l, which is usually linked to normal gasometry (pH and BE).

Conclusions

Treatment of acute haemorrhagic hypovolaemia always creates dilemmas for an emergency team. The dilemmas include:

- fluid resuscitation (massive vs. restrictive); permissive hypotension in uncontrolled bleeding;
- cautious fluid resuscitation, stopping bleeding (surgery), followed by aggressive fluid resuscitation;
- considering the use of HyperHAES,
- Ringer's lactate and/or hydroxyethyl starch and a 0.9% NaCl solution as first-line fluids;
- the administration of tranexamic acid;
- PRBC, if Ht <25%;
- FFP and CRYO, only if coagulation disorders occur;
- considering the administration of NovoSeven/prothrombin complex concentrate (PCC) under certain indications (the Long Bones, the pelvis, the retroperitoneal space);
- maintaining normothermia and infusion of warm fluids;
- frequent carrying out of tests and immediate correction of deficiencies.

References

1. Brongel L., Duda K.: Mnogie i wielonarządowe obrażenia ciała [Multiple and multi-organ trauma]. Biblioteka Chirurga i Anestezjologa. Warsaw, PZWL, 2001: 8-12
2. Sauaia A., Moore F.A., Moore E.E., et al.: Epidemiology of trauma deaths: a reassessment. J. Trauma, 1995; 38: 185-193
3. Haas B., Nathens A.B.: Pro/con debate: is the scoop and run approach the best approach to trauma services organization? Crit. Care, 2008; 12: 224
4. Peden M., McGee K., Krug E., (eds): Injury: a leading cause of

the global burden of disease. 2000. Geneva. Switzerland, World Health Organization, 2002
5. Sauaia A., Moore F.A., Moore E.E., et al.: Early predictors of postinjury multiple organ failure. Arch. Surg., 1994; 129: 39-45
6. Hess J.R., Bronchi K., Dutton R.P., et al.: The coagulopathy of trauma: a review of mechanism. J. Trauma, 2008; 65: 748-754
7. Johansson P.I., Sorensen A.M., Perner A., et al.: Disseminated intravascular coagulation or acute coagulopathy of trauma shock early after trauma? An observational study. Crit. Care, 2012; 15: 272-285
8. Keel M., Trentz O.: Pathophysiology of polytrauma. Injury, 2005; 36: 691-709
9. Cote Ch. J.: Pediatric anesthesia. In: Miller's anesthesia. Vol. II. Philadelphia, Churchill Livingstone, 2009: 2559-2599
10. Hinshaw L.B., Cox B.G.: The fundamental mechanisms of shock. New York, Plenum Press, 1972
11. Rodriguez R.M., Rosenthal M.H.: Etiology & pathophysiology of shock. In: Murray M.J., Coursin D.B., Pearl R.G., Prough D.S., (eds): Critical care medicine - perioperative management. London, Lippincott William & Wilkins, 2003: 192-205
12. Smith J.P., Bodai B.I., Hill A.S., et al.: Prehospital stabilization of critically injured patients: a failed concept. J. Trauma, 1985; 25: 65-70
13. Helm M., Hauke J., Kohler J.: The concept of small volume resuscitation for preclinical trauma management. Experiences in the Air Rescue Service. Unfallchirurg, 2013; 116: 326-331
14. Isreaelian L.A., Lubnin A.: Effect of the combined hypertonic colloidal solution HyperHAES on hemodynamic and oxygen transport parameters, intracranial pressure and cerebral oxygenation. Anesteziol. Reanimatol., 2008; 2: 31-36
15. Cavus E., Meybohm P., Dorges V., et al.: Regional and local brain oxygenation during hemorrhagic shock: a prospective experimental study on the effects of small-volume resuscitation with norepinephrine. J. Trauma, 2008; 4: 641 — 648
16. Berlot G., Bacer B., Gullo A.: Controversial aspects of the prehospital trauma care. Crit. Care Clin., 2006; 22: 457-468
17. Isenberg D.: Does advanced life support provide benefits to patients? A literature review. Prehosp. Disast. Med., 2005; 20: 265-270
18. Smith R.M., Conn A.K.: Prehospital care-scoop and run or stay and play? Injury, 2009; 40 Suppl. 4: S23-S26
19. Jureczko R.: Hemostaza w urazach wielonarządowych [Haemostasis in multi-organ trauma]. Przegl. Urolog., 2004: 5
20. Paluszkiewicz P., Mayzner-Zawadzka E., Baranowski W., et al.: Zalecenia postępowania w masywnym krwotoku pourazowym lub okołooperacyjnym [Recommendations for the management of massive post-traumatic or perioperative haemorrhage]. Sepsis, 2011; 5: 341-351
21. Kozek-Langenecker A.S., Afshari A., Albaladejo P., et al.: Guidelines on the management of perioperative bleeding. Guidelines from the European Society of Anaesthesiology. Eur. J. Anaesthesiol., 2013; 30: 270-382
22. Wilson W.C., Grande C.M., Hoyt D.B., (eds): Trauma. Emergency resuscitation. Perioperative anesthesia. Surgical Management. Informa Healthcare USA. 2007
23. Strategies for Small Volume Resuscitation: Hyperosmotic-Hyperoncotic Solutions, Hemoglobin Based Oxygen Carriers and Closed-Loop Resuscitation. http://ftp.rta.nato.int/public/Pubfulltext/RT0/MP/RT0-MP-HFM-109///MP-HFM-109-07.pdf
24. Sanchez G.P., Peng E.W.K., Marks R., et al.: Scoop and run strategy for a resuscitative sternotomy following unstable penetrating chest injury. Interact. Cardiovasc. Thorac. Surg., 2010; 10: 467-469
25. Shanmuganathan K., Matsumoto J.: Imaging of penetrating chest trauma. Radiol. Clin. North Am., 2006; 44: 225-338
26. Marik P.E., Monnet X., Teboul J.L.: Hemodynamic parameters to guide fluid therapy. Annals of intensive care 2011; 1: 1. http://www.annalsofintensivecare. com/content/1/1/
27. Tagami T., Kushimoto S., Yamamoto Y., et al.: Validation of extravascular lung water measurement by single transpulmonarythermodilution: human autopsy study. Crit. Care, 2010; 14: 162
28. Sakka S.G., Klein M., Reinhart K., et al.: Prognostic value of extravascular lung water in critically ill patients. Chest, 2002; 122: 2080-2086
29. Weil M.H., Henning R.J.: New concepts in the diagnosis and fluid treatment of circulatory shock. Anesth. Analg., 1979; 58: 124-130
30. Joint Theatre Trauma System Clinical Practice Guidelines - JTTSCPG - http://www.usaisr.amedd.army.mil/clinical_practice_guidelines.html
31. Johansson P.I., Sorensen A.M., Perner A., et al.: Disseminated intravascular coagulation or acute coagulopathy of trauma shock early after trauma? An observational study. Crit. Care, 2012; 15: 272-285
32. Taylor F.B. Jr, Toh C.H., Hoots W.K., et al.: Towards definition, clinical and laboratory criteria, and a scoring system for disseminated intravascular coagulation. Thromb. Haemost., 2001; 86: 1327-1330
33. Shaz B.H., Winkler A.M., James A.B., et al.: Pathophysiology of early trauma-induced coagulopathy: emerging evidence for hemodilution and coagulation factor depletion. J. Trauma, 2011; 70: 1401-1407
34. Ibister J.P.: The normal haemostatic system. Crit. Care Resuscit., 2008; 10: 261-263

Procedures in the case of bodily injuries in pre-hospital practice - records of medical rescue operations

Postępowanie w obrażeniach ciała w praktyce przedszpitalnej - zapis medycznych czynności ratunkowych

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Abstract. The development of a policy regarding ways of dealing with trauma victims constitutes one of the most important areas of research aiming to specify the optimal model of procedures undertaken in such cases, i.e. one which would
be a compromise between conducting indispensable rescue operations and the time in which the casualties reach hospital. Assessing particular procedures depends on the possibility to compare data. In many countries such a process is implemented thanks to the existence of a Trauma Registry which comprises information on all the stages of dealing with an injured person. In the Polish health service such a uniform trauma registry does not exist. Moreover, it is difficult to compare data on pre-hospital medical rescue operations. The authors of the present publication conducted an analysis of three selected registers providing data on pre-hospital operations and synthesized them, also from the point of lack of significant medical data. A suggestion has been put forward to modify the medical data record providing information
on the rescue operations performed by the Polish Medical Air Rescue, in a way that would present data in the best possible way. Such a change would be useful both for the purpose of improving information flow about the victims and later analyzing the process of their therapy.
Keywords: Trauma Registry, medical data record of rescue operations

Streszczenie. Taktyka postępowania z ofiarami urazów stanowi jeden z istotnych kierunków badań mających na celu określenie optymalnego modelu postępowania, stanowiącego kompromis pomiędzy niezbędnymi czynnościami ratunkowymi a czasem dotarcia poszkodowanego do szpitala. Ocena wartości poszczególnych sposobów postępowania uzależniona jest od możliwości porównania danych. W wielu krajach proces ten realizowany jest dzięki funkcjonowaniu rejestru urazów *[Trauma Registry)* - zawiera on informacje dotyczące wszystkich etapów postępowania z chorymi urazowymi. W polskim systemie ochrony zdrowia taki jednolity rejestr urazów nie istnieje, problemem jest także porównanie danych dotyczących analizy działań medycznych na poziomie przedszpitalnym. Autorzy niniejszego opracowania dokonali analizy zapisów z trzech wybranych rejestrów dotyczących postępowania przedszpitalnego, dokonując ich syntezy również pod kątem braku istotnych danych merytorycznych. Zaproponowano zmodyfikowaną kartę medycznych czynności ratunkowych SP ZOZ Lotniczego Pogotowia Ratunkowego (SP ZOZ LPR) jako optymalny sposób zapisu danych, zarówno na potrzeby przepływu informacji o poszkodowanym, jak i późniejszej analizy jego procesu terapeutycznego.
Słowa kluczowe: karta medycznych czynności ratunkowych, rejestr urazów

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Introduction

The proper pre-hospital management of patients with injuries is indisputably crucial for the victim's chance of survival [1-3]. In practice, a number of procedure standardization systems are used. Among them, the following should be distinguished: Pre-Hospital Trauma Life Support (PHTLS) and International Trauma Life Support (ITLS), primarily applicable in civil practice, and Tactical Combat Casualty Care (TCCC), used widely under the conditions of the battlefield. Comparison of civilian and military systems is limited by fundamental obstacles related to the heterogeneity of injuries and environment.

Apart from this, the issue of various pre-hospital strategies called 'stay and play' and 'scoop and run' has been discussed for many years [4,5]. So far, a simple answer to the question about the right strategy has not been found. In fact, it must be a compromise between the following factors: patient's condition (type and severity of injury), distance from the nearest hospital emergency department (HED) or the appropriate specialist centre, and transport capabilities (land team, helicopter). Obviously, in the case of severe injury the time of rescue operations should not exceed the standard 'golden hour', but in Poland it has been formally assumed that the patient eligible for treatment in the trauma centre should reach it within 1.5 hours [6].

Currently in Poland, the evaluation of pre-hospital (and also further) management meets the main difficulty that is the lack of a Trauma Registry (registry of injuries, i.e. centralized database for dealing with casualties of accidents and their follow-up). This situation only allows the assessment of management at various stages, without the actual opportunity to verify the effects of the total strategy.

Currently, the system of pre-hospital trauma care in Poland is rather clear in terms of units, which are medical emergency teams - Medical Rescue Team and Medical Air Rescue (in certain cases, other specialized teams and units cooperating with the system, e.g.Tatra Voluntary Rescue, Mountain Rescue or Water Rescue). The trauma hospital care is based on: Hospital Emergency Departments (HED) closest to the scene of the event, trauma centres, specialized HED for children, burn treatment centres and institutions within the Nationwide Replantation Service.

Experience and analysis of the strategies of various system units suggest the need for uniform standard procedures in order to optimize patient management tools, while preserving the time-frame. This applies to both the procedures performed at the scene of the event (indirectly affecting the time) as well as decisions regarding the destination of transport (the nearest HED vs distant trauma centre).

The possibility of effective evaluation of pre-hospital procedure in relation to the mechanisms of injury, patient assessment and trauma examination, the applied procedures and operating time is still a problem.

The analysis of rescue medical operations shows some shortcomings in terms of recording the particular elements of pre-hospital actions, which is a major obstacle when trying to evaluate the quality of system units and to draw conclusions for the possible modifications of procedures [7].

As regards the keeping of medical records, the optimal solution can be the one used by the Medical Air Rescue. However, it also has some shortcomings. The authors of the study, based on experience and performed analyses, suggested trends for changing medical records, so that it could provide the complete information necessary when transferring the patient and required to keep the trauma registry.

Aim of the study

The aim of the study was to identify the needs for further research that may contribute to the development of a uniform policy of dealing with trauma victims at the pre-hospital level. The aim of the study was to identify different experience of the emergency services (Medical Rescue Team, Medical Air Rescue) and the experience of MEDEVAC in Afghanistan, particularly regarding standardization of data collection and recording, which would allow comparison of data for further analysis necessary to develop an optimal policy, and possibly contribute to the creation of the trauma registry system. A suggested solution may be a modification of keeping records, currently used by the Medical Air Rescue.

Material

A comparison of three groups of data obtained from Medical Rescue Teams securing the south-western part of the Warsaw agglomeration (Operational Region 06 of the Mazovian Voivodeship), the Medical Air Rescue securing Mazovia (Warsaw, Plock), and data from the Medical Support Group operating in Ghazni under the Polish Military Contingent in Afghanistan (GZM).
The analysis included all forms of documenting patient management in the context of possible to obtain data and their comparability.

Results

Independent Public Health Care, Medical Air Rescue

The database includes 298 cases (the period from 1 January 2011 to 31 December 2013). This number corresponds to the interventions at the scene of the event in case of injuries. On the basis of documentation, it was possible:

- to determine the number of interventions of the Medical Air Rescue (MAR) as the first team being at the scene of the event, and the number of MAR

interventions at the presence of the land Medical Rescue Team (MRT) at the scene of the event,
- to assess the procedures performed by MRT (including intravascular access security, intubation, stabilization of the spine, and other actions taken by MAR),
- to calculate the Revised Trauma Score (on admission and transfer of the patient to a trauma centre),
- to assess the extent of the procedures performed by MAR (also the used drugs)
- to assess the time (from notification to reaching the site, duration of actions at the scene of the event, and the total time from notification to transferring the patient to a trauma centre).

Shortcomings:
- lack of precise information on the mechanism of the event,
- incomplete data concerning the extent of injuries,
- lack of information on the type of the calling team (specialist or basic team),
- insufficient data on the drugs administered by the MRT at the scene of the event,
- lack of knowledge about the time from the first notification of the MRT to reaching the scene of the event by MAR.

Emergency medical services - Operational Region 06 (Mazovian Voivodeship)

The submitted trauma patients database includes 246 medical cases, from 1 July 2013 to 31 December 2013. According to this database, the identifiable information includes:
- complete documentation regarding the time from notification to reaching the scene of the event,
- type of teams taking actions (specialist or basic, and possible help of MAR)
- place, where the patient was transferred,
- performed medical procedures, including used drugs.

Shortcomings:
- lack of detailed information on the mechanism of the event,
- lack of a complete record of trauma examination,
- indication of a single diagnosis of the (usually) most severe injury.

Medical Security Group, the Polish Military Contingent in Afghanistan

The database currently includes 257 combat injury casualties from the period from 8 June 2010 to 31 December 2012. In this group, 211 casualties were taken to hospital using the medical evacuation (MEDEVAC) transport, while 46 - using the random casualty evacuation (CASEVAC) transport. The difference is important, because in the case of CASEVAC, the information about the pre-hospital actions and evacuation time is extremely limited. The database was developed on the basis of Trauma Records, which allow:
- precise identification of the mechanism of injury,
- assessment of the extent of injury (full trauma assessment)
- RTS evaluation
- evaluation of the time from injury to arrival at hospital,
- recording the endotracheal intubation, or possible cardiopulmonary resuscitation,
- recording the use of a tactical tourniquet
- and drugs given at the pre-hospital level (in particular, morphine sulfate injection).

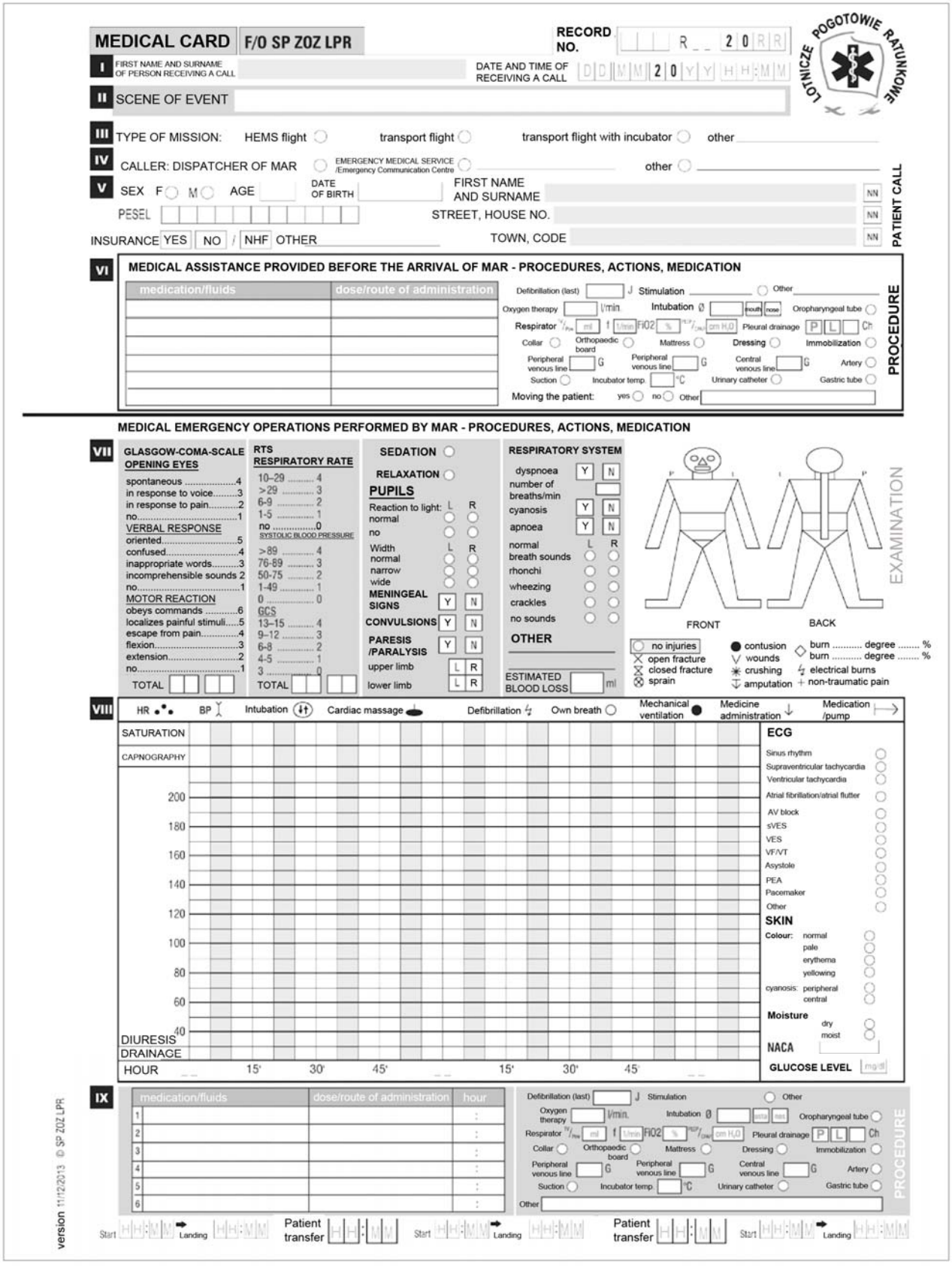
Shortcomings:
- lack of data on the initial casualty examination and primary trauma assessment,
- incomplete data on pre-hospital procedures (e.g. use of hemostatic dressings).

Discussion

Each database refers to a different specifics of dealing with trauma patients. The actions of Medical Air Rescue teams reflect dealing with a selected group of casualties, who are ultimately referred to trauma centres. In this case, most of the actions were focused on help the MRT providing the primary treatment to casualties. In this group, the severity of injuries was greater than for MRT actions, but in the overall evaluation of the documentation there are some shortcomings, especially concerning the mechanism of injury, the result of trauma assessment performed by MRT at the scene of the event, and, which is very important, the assessment of time from the initial calling MRT to reaching a trauma centre by the patient. These shortcomings mainly result from the description of rescue operations undertaken by the individual units of the system.

Data from medical records of MRT rescue operations allows for precise determination of the time of call, reaching the scene of the event and transfer of the casualty to hospital. Data concerning the preformed medical procedures allows the evaluation of actions and administered medication. A weakness of the medical records used by MRT is a result of casualty assessment and the dynamics of changes in vital signs (values at the moment of transfer) [2].

The last of group of evaluated medical records (GZM) contains the full patient information at the time of admission. This applies to both the mechanism of the event and detailed trauma assessment (at the time of admission), as well as to RTS values. However, there is no data concerning the details of rescue operations at the scene of the event. This is understandable, especially that a significant part of the actions requires rapid evacuation and is associated with the need to use MEDEVAC in order to leave the scene of the event. A frequent need to transport many casualties at the same time has an impact on the quality of records kept by MEDEVAC paramedics.


MEDICAL CARD
F/0 SP ZOZ LPR
RECORD NO.
LOTNICZE POGOTOWIE RATUNKOWE
I FIRST NAME AND SURNAME OF PERSON RECEIVING A CALL
DATE AND TIME OF RECEIVING A CALL
II SCENE OF EVENT
III TYPE OF MISSION: HEMS flight transport flight transport flight with incubator other
IV CALLER: DISPATCHER OF MAR EMERGENCY MEDICAL SERVICE /Emergency Communication Centre other
V SEX F M AGE DATE OF BIRTH FIRST NAME AND SURNAME
PESEL STREET, HOUSE NO.
INSURANCE YES NO / NHF OTHER TOWN, CODE
PATIENT CALL
VI MEDICAL ASSISTANCE PROVIDED BEFORE THE ARRIVAL OF MAR - PROCEDURES, ACTIONS, MEDICATION
medication/fluids
dose/route of administration
PROCEDURE
MEDICAL EMERGENCY OPERATIONS PERFORMED BY MAR - PROCEDURES, ACTIONS, MEDICATION
VII GLASGOW-COMA-SCALE
OPENING EYES
RTS
RESPIRATORY RATE
SYSTOLIC BLOOD PRESSURE
SEDATION
RELAXATION
PUPILS
MENINGEAL SIGNS
CONVULSIONS
PARESIS /PARALYSIS
RESPIRATORY SYSTEM
OTHER
ESTIMATED BLOOD LOSS
EXAMINATION
FRONT
BACK
VIII HR BP Intubation Cardiac massage Defibrillation Own breath Mechanical ventilation Medicine administration Medication /pump
SATURATION
CAPNOGRAPHY
DIURESIS
DRAINAGE
HOUR
ECG
SKIN
NACA
GLUCOSE LEVEL
IX medication/fluids
dose/route of administration
hour
Patient transfer
Start
Landing
version 11/12/2013 © SP ZOZ LPR

DESCRIPTION OF PATIENT HEALTH

DIAGNOSIS ICD Code

COMMENTS

STATEMENT OF PATIENT

Being informed and aware of the possibility of direct threat to my health and life, I do not agree to accept the proposed medical aid, including possible transport carried out by the HEMS/EMS MAR team. I also declare that I received sufficient information about the state of my health and answers to my questions.

Date D D M M 2 0 Y Y Hour H H : M M Signature of patient or his/her legal representative

Name of witness (optional) Signature of witness (optional)

SUMMARY: Transferred to the medical emergency team

Transport to hospital

Support provided on site ○ MAR medical record issued ○

Mission interrupted/cancelled ○ Transport abandoned ○ False call ○

Death before arrival of the team ○ Death at the scene ○ Death during transport ○

Death certificate issued ○ Time of death H H : M M

MAR doctor's signature and stamp

Signature and stamp of a doctor taking the patient

After reviewing the patient's condition I confirm the transfer of the patient along with documentation from the Medical Air Rescue.

Hour H H : M M

Date D D M M 2 0 Y Y

Doctor's signature and stamp

Independent Public Health Care, Medical Air Rescue, 5 Księżycowa St, 01-934 Warsaw, Dispatcher tel.: 22 22 95 999, fax: 22 22 99 993, www.lpr.com.pl
Part I of the ministerial code 99-00372 Part V of the ministerial code 01

TRAUMA CENTRE

Criteria for patient referral to a **trauma centre** compliant with the Regulation of the Ministry of Health of 18 June 2010 on trauma centers:
§5
A person in a state of sudden health hazard is eligible for treatment in a trauma centre, if he/she is a trauma patient according to Article 3 Section 12 of the Act of 8 September 2006 on State Emergency Medical Services, who meets the following criteria:

1) at least two of the following anatomical injuries *:

- ☐ penetrating wounds of the head or body or blunt trauma with signs of damage to the internal organs of the head, chest and abdomen,
- ☐ amputation of the limb above the knee or elbow,
- ☐ extensive crushing of limbs,
- ☐ spinal cord injury,
- ☐ breaking the limbs with vascular and nerve damage,
- ☐ breaking at least two proximal long bones of limbs or the pelvis;

2) at least two of the following disorders of physiological parameters*:

- ☐ systolic blood pressure equal to or below 80 mmHg,
- ☐ pulse of at least 120 beats per minute,
- ☐ respiratory rate below 10 or above 29 per minute,
- ☐ state of consciousness in the Glasgow Coma Scale (GCS) equal to or less than 8,
- ☐ arterial oxygen saturation equal to or less than 90%.

*mark where applicable

The above differences make it necessary to create a consistent model for recording the management of trauma patients at the pre-hospital level. It should ensure the easiest possibly transfer of necessary information, and at the same time, enable the collection of data in a common format [1,5,7].

Regarding the studies on the trauma care system in Poland, a suggestion has been put forward to extend the medical data records providing information on the rescue operations performed by the Medical Air Rescue teams.

Criteria of patient referral to a trauma centre are compliant with the Regulation of the Minister of Health of 18 June 2010 on trauma centres:

A person in a state of sudden health hazard is eligible for treatment in a trauma centre, if he/she is a trauma patient according to Article 3 Section 12 of the Act of 8 September 2006 on State Emergency Medical Services, who meets the following criteria:

1) *at least two of the following anatomical injuries*:*
   a) *penetrating wounds of the head or body or blunt trauma with signs of damage to the internal organs of the head, chest and abdomen,*
   b) *amputation of the limb above the knee or elbow,*
   c) *extensive crushing of limbs,*
   d) *spinal cord injury,*
   e) *breaking the limbs with vascular and nerve damage,*
   f) *breaking at least two proximal long bones of limbs or the pelvis;*
2) *at least two of the following disorders of physiological parameters *:*
   a) *systolic blood pressure equal to or below 80 mmHg,*
   b) *pulse of at least 120 beats per minute,*
   c) *respiratory rate below 10 or above 29 per minute,*
   d) *state of consciousness in the Glasgow Coma Scale (GCS) equal to or less than 8,*
   e) *arterial oxygen saturation equal to or less than 90%.*

The version of MAR medical data record (see above) contains information intended to support making decision on patient eligibility for transport to a trauma centre. According to the authors, there is a need for further modification of medical rescue records by including the data specifying the emergency procedure for trauma patients. This applies particularly to the mechanism of injury, recording the initial assessment results and determination of the time from the initial notification, as far as the casualty is transferred from MRT.

Conclusion

The reliable assessment of the actions of system units at the pre-hospital level requires a uniform system for recording medical emergency treatment at all stages of rescue operations. This can be achieved by means of a modified medical record used successfully by the Polish Medical Air Rescue.

The key link that allows obtaining high-quality data is the qualified medical staff. Therefore, staff training on keeping medical records is necessary.

A uniform Trauma Registry in Poland will be a great tool to assess the quality of system activities in the care of trauma patients.

References

1. Lossius HM, Kruger AJ, Ringdal KG, et al. Developing templates for uniform data documentation and reporting in critical care using a modified nominal group technique. Scand J Trauma Resusc Emerg Med, 2013; 21: 80
2. Dinh MM, Oliver M, Bein K, et al. Level of agreement between pre-hospital and emergency department vital signs in trauma patients. Emerg MedAustralas, 2013;25:457-463
3. Beuran M, Paun S, Gaspar B, et al. pre-hospital trauma care: a critical review. Chirurgia (Bucur), 2012; 107: 564-570
4. Smith RM, Conn AK. pre-hospital care - scoop and run or stay and play? Injury, 2009;Suppl. 4: S23-S26
5. Lerner EB, Shah MN, Cushman JT et al. Does mechanism of injury predict trauma centre need? Prehosp Emerg Care, 2011; 15: 518-525
6. Art. 39c paragraph. 1 of the Act of 8 September 2006 on the State Emergency Medical Services. Journal of Laws, No.
7. Laudermilch DJ, Schiff MA, Nathens AB, et al. Lack of emergency medical services documentation in associated with poor patient outcomes: a validation of audit filters for pre-hospital trauma care. J Am Coll Surg, 2010; 210: 220-227

Triage in Mass Casualty Incidents

Segregacja medyczna w zdarzeniach masowych

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Abstract. Triage is widely used in emergency medical system. It plays a special role in mass casualty incidents and catastrophies. It is not possible to perform effective triage without taking into consideration emergency resources and management. The simulation of a mass casualty incident proved the influence of these elements on the effectiveness of providing assisstance to the victims. Having no access to the information on hospital capacities on site of the event triage can not give satisfactory results. This can be changed by computerising emergency medical system.

Streszczenie. Segregacja medyczna jest powszechnie wykorzystywana w ratownictwie medycznym. Szczególnego znaczenia nabiera w zdarzeniach masowych i katastrofach. Współcześnie nie da się efektywnie prowadzić segregacji medycznej bez uwzględnienia zasobów ratownictwa medycznego i zarządzania jego działaniami. Przeprowadzona symulacja zdarzenia masowego wykazała wpływ tych elementów na efektywność segregacji i udzielania pomocy poszkodowanym. Bez dostępu do informacji o możliwościach leczniczych szpitali segregacja na miejscu zdarzenia nie daje oczekiwanych rezultatów. Informatyzacja systemu ratowniczego zmienia tę sytuację.
Słowa kluczowe: podejmowanie decyzji, segregacja medyczna, system wspomagania dowodzenia, triage, zarządzanie
Key words: decision-making, disaster management, management support system, triage

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Introduction

Changes of the model and the pace of life associated with the nature of work, shopping, leisure and entertainment make it necessary to stay in places of assembly. Progressive development of civilization results in the construction of increasingly large buildings, including residential houses and public buildings, hotels, tourist centers, shopping centers and facilities for entertainment, such as sports stadiums, concert halls, etc. The mass transport is growing steadily. The growing number of registered vehicles increases traffic. The capacity of means of transport - buses, airplanes, passenger ships, is increasing, as well as passenger traffic on communication routes and tourism. The increasing popularity of mass events results in the accumulation of hundreds of thousands or even millions of people in a small area. The changing social situation increases conflicts, which result in demonstrations and manifestations of the most dissatisfied groups.

In conflict situations, the clashes between hostile factions are becoming more frequent and brutal. The tense international situation and possible armed conflict carry the risk of migration of the population, and growing social unrest as well as ethnic and religious conflicts. The constant threat from international terrorist groups or local criminal terror generates additional danger. The development of industry, particularly chemical, and nuclear energy generates a different type of risk associated with bulk hazardous materials. Changes in the risk profile force the preparation of emergency services, which would be appropriate to the needs. Emergency medical service focuses on saving the life and health of a single person. In the face of changing conditions, medical rescue teams are forced to provide a larger number of patients with simultaneous support. In many exceptional situations, emergency medical services are trying to do as much as possible for the greatest number of victims, not being able to provide the maximum assistance every person in need. In daily practice, emergency medicine is essential for saving human life and health. It is focused on a single patient. Nowadays, an increasing role in emergency medical service and general public safety is played

by disaster medicine. This is a medical specialty dealing with the organization of medical assistance in situations deviating from the routine, unusual in everyday practice. The ability to determine the needs related to patient's clinical condition, injuries and mechanism of injury (or illness) plays a key role in the management of medical care in both emergency and disaster medicine.

Specificity of mass casualty incidents

According to L. Brongel, more than 3.5 million people suffer injuries in Poland every year. Most of these injuries are superficial and do not require hospital care. Nearly 350 thousand of people are hospitalized, and about 30 thousand die as a result of injuries [1]. In medical emergency there are three basic types of incidents classified as accidents. An incident in which a single person experiences a trauma, and emergency services provide routine care, in accordance with established procedures, is defined as an individual incident. In the case of a larger number of casualties, the operations can also be carried out on a routine basis. In medical emergency such an incident is called a multiple incident. Each casualty receives full necessary assistance, however, some victims have to wait for help. Individuals who cannot wait for help are treated immediately, receiving full support in accordance with the current protocols of procedures. The incident, in which it is impossible to provide sufficient assistance to the most needy, is defined as a mass casualty incident. Therefore, not the number of casualties determines the nature of the incident, but the disproportion between the needs of victims in critical life-threatening condition and the possibility to help them by rescuers working at the scene of the incident. This reference to patients in life-threatening condition is critical in defining a mass casualty incident. During a mass casualty incident, emergency services do not have sufficient manpower and resources to assist all who need it most. In routine incidents (individual and multiple), competence of the rescue staff is critical for the success of rescue operations. The ability to manage aid and use all the efforts and resources to rescue those who are most in need of help, is crucial during mass casualty incidents. In these types of incidents it may be impossible to save all of the victims, but we should save those who can be saved. Triage protocols developed for this type of specific incidents serve this purpose.

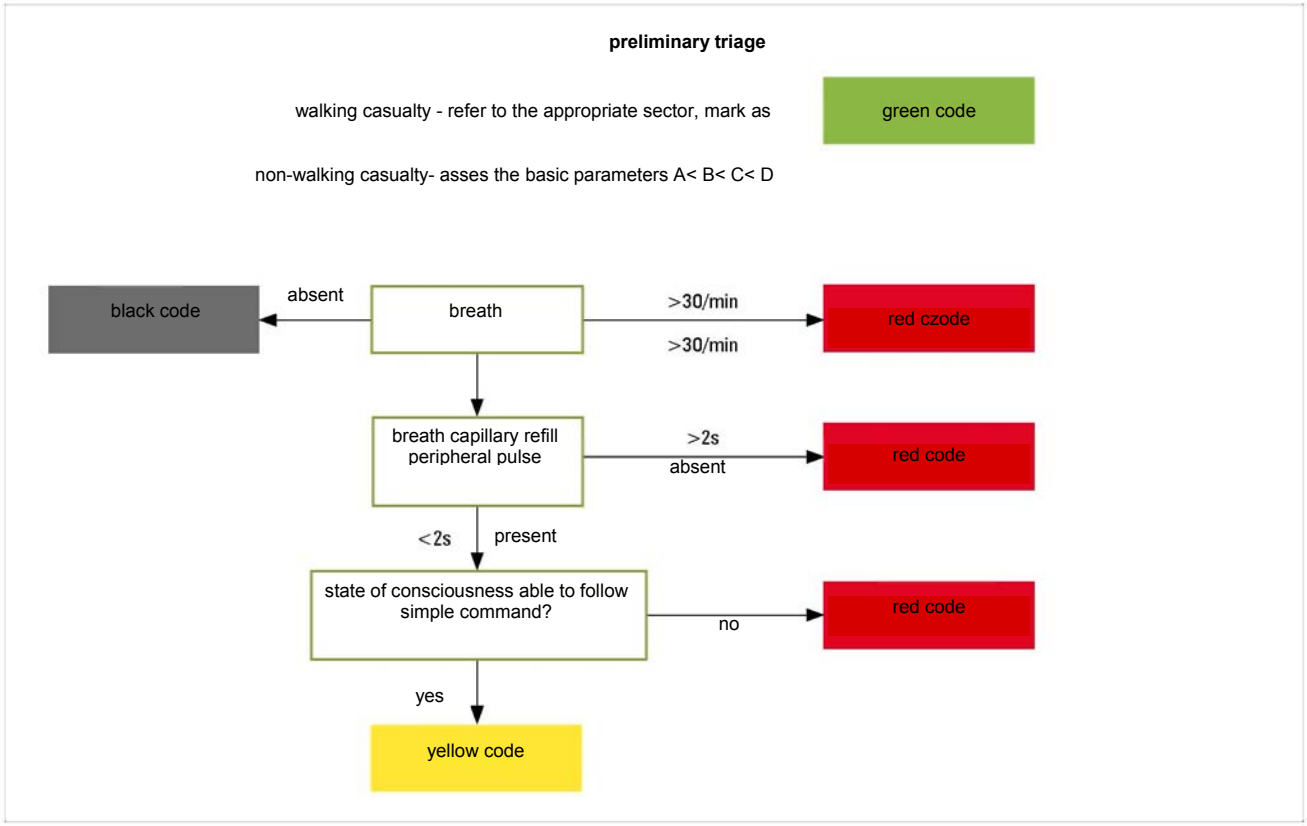
Management of medical aid

The functioning of the emergency medical system is regulated by the Act of 8 September 2006 on the State Emergency Medical Services [2]. Regardless of the legal and organizational aspects of the emergency medical system, there is the National Rescue and Firefighting System (NRFS) in Poland. Its organization and scope of activities is regulated and defined by separate legal regulations [3]. Rescue operations in the case of mass casualty incidents require an integrated action and joint management of both services. The management of emergency services includes a skilful use of available forces and resources in order to accomplish a specific task. Today it is impossible to consider triage without taking into account elements related to the organization and management of emergency operations. Available human resources and the management of medical staff have an impact on the implementation of triage and making decisions about the future of the casualties. Organization and management of the process of help, regardless of the extent and nature of the incident, can be based on the principle of 3T (triage, treatment, transport). During large incidents, tactical rearguard (place of gathering of forces and resources) and function of management (coordination) of the entire medical aid are particularly important. The functioning of each component and the quality of management have an impact on the effectiveness of medical interventions [4]. During the Crimean War in the mid-nineteenth century, the Russian surgeon Nikolay Pirogov saw the importance of the organization of aid and its superiority over the competence of the available medical staff.

Medical segregation - triage

Triage is a basic process in the management of medical aid, which is based on the functioning of emergency services. *Triage* is a French term commonly used for medical segregation. It is assumed that this procedure was popularized by Baron Dominique Larrey, the chief surgeon of Napoleon's army. [5]

The concept of triage has various definitions in the Polish emergency medical service. It is generally accepted that triage is a process of separation casualties based on the degree of threat to life and scope of required medical attention, or prioritization of medical rescue operations [6-8]. This definition suggests that it is carried out in the case of at least two casualties. A more precise definition seems to be suggested by the author of the publication, defining triage as a process of assessing the degree of threat to life and extent of required assistance to assign the patient to a particular group with the assigned range of required aid and duration of treatment. Such a definition indicates the need for triage even in a single patient in order to make the right decision for further proceedings. This apparently small change in approach is also important for triage in large accidents (see below). In everyday practice triage is divided into pre-hospital and hospital. Triage usually includes assessment protocols adapted to



Rycina 1. Initial triage chart
Figure 1. Schemat wstępnej segregacji

the type of incident [9]. A specific type of segregation is triage in a mass casualty incident.

Initial triage in mass casualty incidents

The aim of initial triage is to find in the group of casualties those in a life-threatening condition. The sorting person focuses on the assessment of vital functions and mechanism of injury (ABCDE[1]). This initial process is of fundamental importance. The specificity of mass casualty incidents can force making a decision solely on the basis of the results of assessment of vital signs. In the mass casualty incident, triage procedure allows the identification of a unique group of victims, defined as "probably cannot
be saved" [10]. This group of casualties is not selected in traditional triage, used in everyday practice. The most popular initial triage protocols in the world are: American START (Simple Triage And Rapid Treatment), British SIEVE and Australian CareFlight Triage. They slightly differ in the method of assessment and selected vital parameters [11]. The first step in assessing the vital functions is to evaluate unaided movement (walking). The group of walking patients is assigned with the green code. Patients unable to walk require individual assessment in order to qualify them to one of three groups - black, red or yellow. An example of initial triage protocol is illustrated in Figure 1. The above mentioned triage algorithms do not include changes taking place in the emergency service, concerning the initial treatment of trauma patients. Popularization of CBA[2] rescue algorithm, changing the order of evaluation of vital functions in relation to the ABC, will undoubtedly force changes in initial triage systems.

Proper triage in mass casualty incidents

The purpose of proper triage at the scene of a mass incident is to identify medical and transport priorities. The order of transport is determined, taking into account the time to reach a medical facility, destination, means of transport, standard of transport, protection of medical staff, etc. Depending on the nature of the incident and the mechanism of

[1] 1 ABCDE: **A** - *airway,* **B** - *breathing,* **C** - *circulation,* **D** - *disability,* **E** - *exposition*

injury, a specific for the incident triage protocol is used. This may be a traditional trauma triage, as well as chemical (toxicological) triage, and biological or radiation triage in the incidents complicated by the effects of hazardous materials [12]. Two or more parallel triage protocols may be necessary. The specificity of mass casualty incidents, especially the disproportion between transport capacity and the needs of victims, will require isolation of a group of patients who, despite life-threatening conditions will not be transported to hospital, at least not first. The decision-making scheme at re-triage is shown in Figure 2. For the purpose of the secondary triage, algorithms were developed based on the physiological parameters and anatomical assessment (nature, location, extent of injury, etc.). The presence of physicians at the site of the incident allows the assessment of victims and making decisions based on medical knowledge and experience. Paramedics make decisions based primarily on protocols. The proper triage may be carried out directly at the scene of the incident, but it is generally performed in a medical facility. In the first variant, the management of information about patient condition and aid faces numerous problems. Moving and grouping patients in one place simplifies the process of secondary triage and treatment. The popularization of ICT allows for visualization on a computer monitor scattered casualties assigned with triage codes, facilitating the management of medical aid. Computerization changes the model of rescue operation management and decision making in emergency.

Medical facility

Distribution of casualties over a large area of the accident or a significant disproportion between the needs and the possibilities to provide aid, requires grouping of patients in one place. This grouping of casualties cannot be accidental. The chaos and mess should not be transferred from the scene of the incident to a medical facility; therefore, a medical facility has separate sectors - red, yellow, green and black, where the casualties are referred after the initial triage. A medical facility is organised on the route of evacuation from the scene of the incident to the ambulance. In fact, in Poland the logistics of rescue operations is the responsibility of the fire brigade. The fire brigade has the right equipment, including tents for casualties, lighting and heating, emergency kits, e.g. PSP-R, supplementing the emergency medical equipment. A medical facility is always organised in a situation when it is not possible to transport all casualties at the same time. A greater extent of the incident and disproportion between the possibility of assistance and needs of casualties is related to a greater importance of a medical facility. In a medical facility, the following procedures are performed: re-triage, stabilization of patient condition, initial treatment of injuries, identification of victims, psychological support and preparation for transport. The scope of actions depends on the nature of the incident and possible operations of rescue services.

colour code	priority of aid
red	**life-threatening condition** immediate aid
yellow	**serious but stable condition** urgent aid
green	**walking patient** delayed aid
blue	**life-threatening condition, doubtful prognosis** wait and see attitude
black	**no signs of circulation**

Figure 2. Color codes in prehospital triage

Rycina 2. Kody barwne stosowane w segregacji medycznej przedszpi-talnej

Triage kits

In situations when difficulties appear with the effective and safe management of patient information, colour codes are used. Colour codes provide information about the patient's condition. The selected colour is assigned to a specific triage group. In pre-hospital rescue operations, especially during mass casualty incidents, four colours are commonly used - red, yellow, green and black (Fig. 3). Sometimes additional colours are also used, e.g. white and blue, or the number of colours is limited to two or maximum three. Colour codes are placed on the triage cards, bands, badges and bracelets. The most popular option is a triage card (e.g. Mettag, SMART). For the purposes of rescue operations, triage kits were developed. Basic items of equipment are common for all kits. Such a kit usually contains triage cards, triage algorithms for adults and children, tables for calculating the number of victims in each triage group, and vests for labeling persons performing triage. Extensive kits contain elements necessary for the management of medical aid, such as spreadsheets, which enable recording and processing summary information on the results of triage, available hospital places, forces and resources of emergency medical services, communication channels, forces and means of support, operating times, etc.

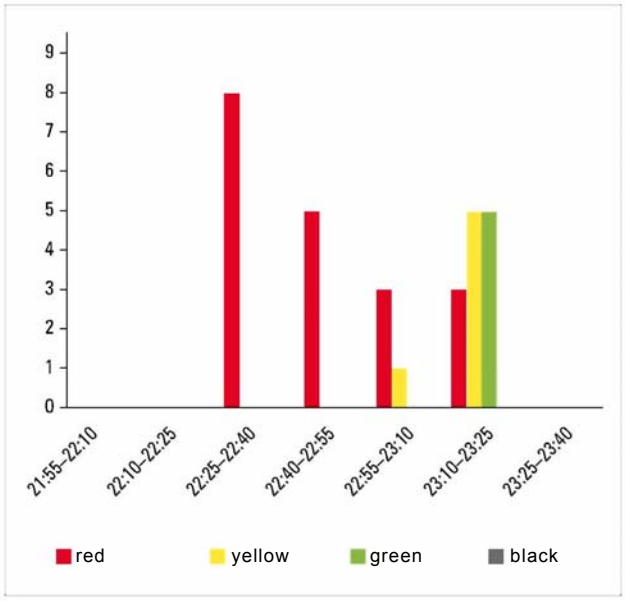


Figure 3. Transporting victims-version A

Rycina 3. Transport poszkodowanych -ścieżka A

ICT and e-triage

In Poland, the computerization of medical emergency services has been developed for years. In countries with a high level of computerization of emergency services, ITC and telemedicine are increasingly used in mass casualty incidents, disasters and during war [13,14]. A large number of different information coming from and to the scene of the incident requires reception, collection, sorting, analysis, decision-making and presentation of proposals to function persons. Mobile computing (tablets in ambulances) and ICT perfectly meet these requirements. When using the traditional radio communication, the management is hampered by information noise present in the ether. For the purposes of triage, the computerized system collects information about the location of casualties, their condition at a given time and the dynamics of changes (i.e. e-triage), which is then processed and presented on a computer screen in the form of symbols. The biggest advantage of mobile computers is the ability of quick data processing and making decisions that are then accepted or rejected by the function persons. Initial studies carried out by the author have shown acceleration of the process and increase in triage accuracy when using physiological scales [15]. The inclusion of the hospital base into a computer network of emergency system allows automatic reclassification of data from hospitals and adjustment of victims to current therapeutic potential of the particular operating area and adjacent areas, taking into account the specificity of the medical facility, its standard (trauma center, HED), duration of transport and other factors that affect making decision on patient management. On-line access to information about the therapeutic potential of hospitals, including the critical infrastructure (ICU rooms, operating rooms, decontamination) simplifies and optimizes decision-making [16].

Simulation of a mass casualty incident as a source of information about the system response

Conducting studies on the effectiveness of activities of medical rescue teams in mass casualty incidents is not a simple task. Due to the inability to control the quality of emergency medical services, it is impossible to assess the effectiveness of triage and decision-making. Computerization of the medical rescue system will change this situation. Decision games and simulations of mass casualty incidents are required to perform analyses. The following simulated mass casualty incidents in the 'Gemini Park' Shopping Centre in Bielsko-Biala provided valuable information on the impact of the operations on the effectiveness of triage. The simulation was organized in January 2011, within the VI International Winter EMS Championship in Poland. Due to the nature of the scene of the incident and a large area of the shopping center, the rescue operations took place in two sections, conventionally labelled with symbols A and B. The simulation was dynamic - the condition of patients and their number were changing over time. The simulated actions included 45 medical rescue teams. The simulated hospital base reflected therapeutic possibilities of the Bielsko rescue operational region and the neighbouring areas. The travel time of emergency rescue teams being a support from neighbouring regions, corresponded to time included in the operational plan of the Bielsko emergency medical service. The State Fire Service (JRG No.1) in Bielsko-Biala participated in the rescue operations. Firefighting activities were limited to securing the area and logistics operations. Medical interventions were carried out by emergency medical services only. Each dummy had false injuries and an additional card describing his/her condition and injuries, necessary to perform triage according to the START system. The course of actions was monitored by the Command Support System (CSS) WĄSKO S.A., equipped with an application for managing rescue operations in mass casualty incidents. For the purposes of a simulated incident, 70 dummies were prepared. As this was a simulation of a large incident, the profile of casualties included a large number of victims in the group with life-threatening conditions. For sections A and B, the casualty profile was a mirror image. In total, 40 dummies had the red code, 20 yellow and 10 green. Immediately prior to the simulation, nearly 2,000

people were evacuated from the gallery (organiser's data). At the time of initial triage, all the casualties presented signs of life. Of the 20 most seriously injured patients, half was characterized by injuries that allowed the stabilization of the condition at the scene. In the first wave, five ambulances arrived at the scene of the incident. In coordination with the State Fire Service and the police, the medical services began operations at 09.55 p.m. The simulation was completed at 11.32 p.m. The rescue operations were managed in the standard way. The computer system was only used to control the course of rescue operations. For the purposes of a simulated incident, a separate dispatch center was prepared.

Theory and practice of rescue operations

Rescue operations carried out in a mass casualty incident are aimed to do as much as possible for the greatest number of victims. During a mass casualty incident probably not everyone can be saved. The main goal is to quickly control the incident and begin routine procedures. Arrival of five teams at the scene allowed for the separation of forces and resources for each sector, and organization of actions according to the principle of 3T. The appointment of a single person in charge of all the operations limited the potential of effective management for individual sections. Triage enabled collecting information about the number of casualties and their location at the scene of the incident. As part of the initial triage, it was necessary to perform life-saving operations - stop hemorrhage, open the airway, place the patient in a safe position and possibly perform cardiopulmonary resuscitation. Failure to rescue operations limited triage to assigning colour codes to the casualties. After the initial triage, the next step was to collect information about all the patients and give it to the person in charge of the medical action, and then to the dispatch center in order to prepare the hospital base and arrange transportation to hospitals. The result of triage enabled making decisions about the method of rescue operations in particular sections. At a large disproportion between the forces and the needs, it was necessary to group the casualties in medical facilities in order to perform re-triage and attempt to stabilize patients who were not qualified for transport in the first wave. The subsequent ambulances arriving at the scene were intended for this task.

According to the assumptions, 8 ambulances for each section arrived at the scene of the incident in the second wave. Due to the lack of coordination and management of transport, most of them went to section A (closer to the entrance). It facilitated control of the incident in this section. Consequently, the operations in section A and B were carried out in different ways. The first transport from the scene took place at 10.25 p.m. from section B. The way of transport of casualties from the scene is presented in Graphs 3 and 4. Triage cards (Mettag type) with a unique number and a bar code enabling to download data by the computer system were used during triage. The person in charge of the action had no medical aids, and only used a wearable radio, pen and paper. The initial triage was performed according to the START algorithm. For both sections, attempts were made to control the incident, primarily by arranging transport to hospitals. In section A, most of ambulances that arrived at the scene (see Graph) were used for this purpose. In section B, in the absence of ambulances, the casualties were not grouped in the makeshift medical facility. Throughout the period of the action, the casualties were lying in the place where they had been injured. When arriving at the scene, the teams provided care to individual casualties indicated by the person performing triage, examined them and treated routinely, according to the standard ITLS. They did not pay due attention to patients lying aside, who also needed help. The first treated and transported patients were those closest to the entrance, and the last ones (or not at all) - those located in the back of the room. At some point, in section B, an unlit tent was demanded, at the access to a fully-lit shopping mall, with large area and room temperature. Transport management caused some difficulties. Gathering a large number of ambulances in a small area, lining up as close as possible to each other (tactical rearguard was not separated), resulted in the inability to place the casualties into the ambulances - the rear doors could not be opened. Blocking the exit routes impeded transport to hospitals. Each leaving ambulance was stopped for inspection. The computer system collected data on transported patients. Based on this information, the order and direction of transport of individual patients was determined. In total, 64 casualties were referred to hospitals. All walking patients were provided with assistance (green code). Six casualties, who did not receive any help throughout the action, were considered dead. Sixteen teams leaving the place of simulation had no information to which hospital they were expected to go. Six teams did not have triage cards of patients at the control gate. Six teams in the final minutes of action left the scene of the incident without patients. The allocation of the casualties in hospitals was as follows: hospital No. 1 - 5 casualties, hospital No. 2 - 5, hospital No. 3 - 7, provincial hospital - 16, railway hospital - 8, hospital in Bystra - 5, Injury Center - 2 (no such), lack of information about the hospital - 16 casualties. Hospitals in the area of operation, with the exception of the provincial hospital, are specialized and focused on the treatment of a specific group of patients. Casualties were referred to hospitals on a routine basis, i.e. where they are referred in daily practice. For example, all patients with chest injuries

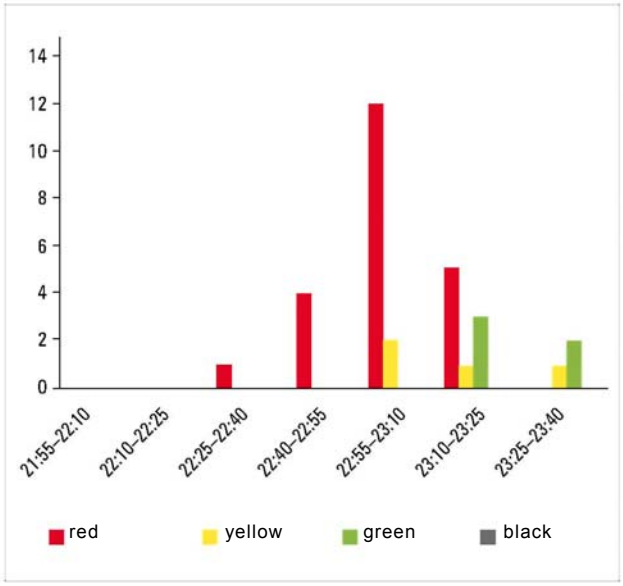


Figure 4. Transporting victims - version B

Rycina 4. Transport poszkodowanych - ścieżka B

were referred to one hospital, with a thoracic surgery department. In this way, the disaster was transferred from the scene to individual hospitals.

Summary

A mass casualty incident is a serious challenge for the rescue system, especially if the incident is as large as the presented simulation. Implementation of the theoretical assumptions encounters great difficulties. A mass casualty incident requires integrated actions between the National Rescue and Firefighting System and the State Emergency Medical Services. These systems complement each other, despite differences in their organization and procedures. The management system implemented by the leading service includes medical interventions according to the principle of 3T. The initial triage protocol, based on the American system START is used by both services. Thus, the triage criteria are consistent, allowing for a uniform assessment of the casualties. The secondary triage is performed by paramedics and rescue doctors present on site. If necessary, firefighters paramedics are able to repeat the initial triage within re-triage before the arrival of emergency medical services. Employment of paramedics in the fire departments changes the scope of provided assistance, bringing it closer to the range used in medical emergency services. During mass casualty incidents it is not possible to perform triage with absolute accuracy. Mistakes in assessment are inevitable, but we can minimize their number by repeating triage. The method of triage depends on the ability to act. Poor organization has a negative impact on the effectiveness of triage. The decision about the tactics of action depends on the result of triage and the availability of manpower and resources, which change over time. The ability to react flexibly plays a crucial role in management.

When allocating casualties to hospitals, it is necessary to take into account their therapeutic capabilities. If necessary, the facilities implement their emergency plans. The initial referral of casualties to several different facilities provides time to mobilize manpower and resources. Habits and customary activities effective in daily practice are not necessarily successful during mass casualty incidents. Knowledge of tactics and, above all, goals to achieve at different stages, plays a key role on the road to success.

Conclusion

Today it is impossible to consider triage without taking into account other elements related to the management of emergency operations in mass casualty incidents. There are too many factors affecting the course of the rescue operations. The knowledge of the triage algorithm and its application in patient assessment does not automatically mean triage success. Fast and accurate analysis of the information about the number of patients and their condition, and comparing the results with the current capabilities of rescue services enable making the right decisions. Actions at the scene of the incident only initiate the process of rescuing and treatment of casualties. Separation of triage from resource management, including hospital resources, has negative consequences for the patient. The presented example shows that triage can be limited to "colouring" patients. No colour code, even red, will not save human life. ICT and telemedicine change the method of patient information management. During mass casualty incidents, they allow for a collection of more information, also facilitating access to such information. They also accelerate the process of analyzing the collected data, developing and presenting the best solutions at the particular moment. Popularization of mobile computer technology (tablets, smartphones) is changing the nature of emergency services and increases their efficiency.

References

1. Brongel L, ed. Golden Hour. Time of life, time of death. Krakow, Krakow's Medical Publishing House, 2007: 33-41
2. The Act on State Emergency Medical Services of 20 October 2006. Journal of Laws 2006 No. 191, item. 1410
3. The Fire Protection Act of 24 August 1991, Journal of Laws 1991, No. 81, item 351
4. Christem H, Maniscalco PM. The EMS Incident Management System. EMS operation for mass casualty and high impact

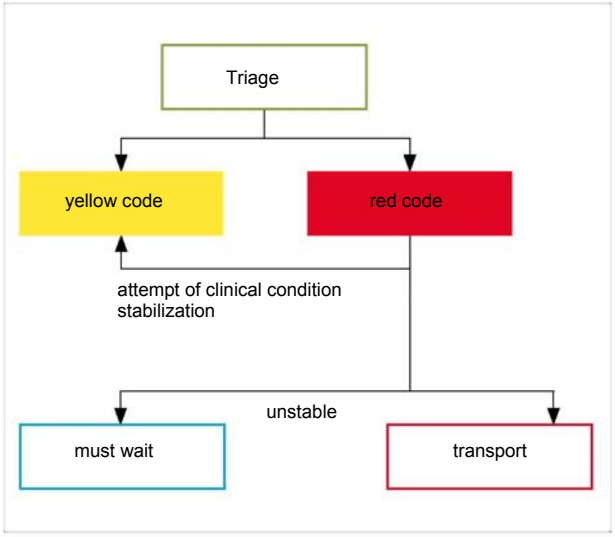


Figure 5. Decision making chart in medical facility (mass casualty incident)

Rycina 5. Schemat podejmowania decyzji w punkcie medycznym (zdarzenie masowe)

incidents. Brady/Prentice Hall Health, 1998:44-61
5. Haywood IR. Triage. Pre-hospital Immediate Care, 1997; 1: 104-111
6. Cieckiewicz J. Triage-medical segregation. [In] Cieckiewicz J, ed. Emergency medical services in mass casualty incidents. Wroclaw, Górnicki Medical Publishing House, 2005: 23-29
7. Gula P. Organization of emergency medical services. Krakow, Medycyna Praktyczna, 2002: 14-15
8. Sowiński R. Multiple and mass casualty incidents from the point of view of a practitioner. Na Ratunek, 2011; 3: 26-32
9. Mackway-Jones K, Marsden J, Windle J. Triage. Rescue medical segregation. Wroclaw, Elsevier Urban & Partner, 2012
10. Aut der Heine E, Irvin RL. Disaster response: principles of preparation and coordination. Mosby, St. Louis, 1989: 81-88
11. Garner A, Lee A, Harrisom K, et al. Comparative analysis of multiple-casualty incident triage algorithms. Ann Emerg Med, 2001; 38: 541-548
12. Moles TM. Emergency Medical Services Systems and HAZMAT major incidents. Resuscitation, 1999; 42: 103-116
13. Chan T, Killeen J, Griswold W, et al. Information technology and emergency medical care during disasters. Acad Emerg Med, 2004; 11: 1229-1236
14. Garshnek V, Burkle FM Jr. Application of telemedicine and telecommunications to disaster medicine: Historical and future perspectives. J Am Med Inform Assoc, 1999; 6: 26-37
15. Trzos A, Rok S, Witkowski P, et al. Evaluation of the effectiveness of education in the field of disaster medicine based on conclusions drawn from the analysis of a simulated mass incident. Education in Emergency Medical Services. Inowroclaw-Poznan, Rescue Forum 2007: 437-442
16. Trzos A. Mobile systems in the Czech medical emergency services. Na Ratunek, 2012; 1: 42-47

Personality and coping stress factors in VR computer-assisted stress inoculation training in the Polish ISAF soldiers

Wpływ czynników osobowościowo-temperamentalnych na trening inokulacyjny z zastosowaniem metody wirtualnej rzeczywistości u żołnierzy PKW

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Abstract. Aim: The main goal of this study was to evaluate the impact of personality, temperament and coping stress factors in Stress Inoculation Training (SIT) in soldiers preparing for their first mission. Material and methods: 120 soldiers were randomly selected from the contingent which consisted of 2000 soldiers and split into two groups of 60 people -experimental (E) and control (C). Soldiers from the E group-split into subgroups-took part in SIT sessions. Both groups filled in inventories such as: Coping Inventory for Stressful Situations (CISS), Revised NEO Personality Inventory (NEO PI-R), and The Formal Characteristics of Behavior-Temperament Inventory (FCB-TI). Both before and after training they also filled in STAI inventory. Results: The statistical analysis results show: 1) Before SIT, in E group there was a negative correlation between X1 value in STAI and briskness, sensory threshold and endurance and positive correlation between X1 value in STAI and emotional reactivity; 2) After SIT In the E group there was a correlation between X1 value in STAI and emotional reactivity; 3) After deployment In the E group there was a correlation between X1 value and emotional reactivity. Conclusions: Results could be taken into account when analyzing individual susceptibility on SIT
Key words: coping stress, personality. Stress Inoculation Training (SIT)

Streszczenie. Cel pracy: Podstawowym celem pracy była ocena wpływu czynników osobowościowych, temperamentalnych i związanych z radzeniem sobie ze stresem na trening inokulacyjny antystresowy przeprowadzony wśród żołnierzy przygotowujących się do wyjazdu na misję. Materiał i metody: Spośród dwutysięcznego kontyngentu wybrano 120 żołnierzy i podzielono ich na 2 grupy po 60 osób: eksperymentalną (E) i kontrolną (K). Żołnierzy z grupy eksperymentalnej podzielono na podgrupy, które wzięły udział w treningu inokulacyjnym. Obie grupy wypełniły kwestionariusze temperamentu i osobowości. Zarówno przed treningiem, jak i po nim oraz po powrocie z misji badani wypełnili również kwestionariusz STAL Wyniki: Analiza statystyczna wykazała: (1) przed treningiem w grupie E stwierdzono ujemną korelację pomiędzy wartością X1 w STAI a żwawością, wrażliwością sensoryczną i wytrzymałością oraz dodatnią korelację pomiędzy wartością X1 a reaktywnością emocjonalną; (2) po treningu stwierdzono dodatnią korelację pomiędzy wartością X1 w STAI a reaktywnością emocjonalną; (3) po powrocie z misji stwierdzono korelację pomiędzy wartością X1 w STAI a reaktywnością. Wnioski: Wyniki powinny być brane pod uwagę przy indywidualnej analizie podatności na trening.
Słowa kluczowe: osobowość, radzenie sobie ze stresem, trening inokulacyjny antystresowy

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Introduction

The aim of this study was to determine the impact of factors such as personality, temperament and style of coping with stressful situations on the susceptibility to stress inoculation training (SIT), which was conducted in 2010 among Polish soldiers preparing for a mission in Afghanistan (VIII change). Stress inoculation training is a kind of training used to prepare the individual for stressful situations and reduce adverse psychological reactions. The intention of the training is to create more resistant soldiers and help reduce PTSD symptoms in soldiers returning from the battlefield.

The virtual reality (VR) technique is commonly used in this training. This technique can increase the effect of training by providing live and configurable stimuli. Numerous studies indicate the effectiveness of the VR method in preventing the effects of post-traumatic stress [3]. This method, developed in the Virtual Reality Medical Center (San Diego), combines exposure in a virtual environment with elements of education and physiological stress control techniques, while using physiological monitoring and feedback. Exposure to a stressor is controlled, gradual and reproducible, enabling a gradual desensitization. The aim of the training was to increase the ability to reduce agitation of solders in order to better cope with stress during service under the Polish Military Contingent.

In the related literature, the issue of the impact of individual characteristics associated with the personality or temperament structure on coping with stress and resistance to its effects is widely discussed [4]. The previous studies have demonstrated that neuroticism [5] and emotional reactivity [6] are the risk factors for traumatic disorders. In contrast, factors protecting against trauma are: the ability to understand and distinguish between emotional states [7] and the need for stimulation [8]. However, with regard to the relationship between personality factors and the ability to plunge into the world of virtual reality, studies have shown a correlation between extraversion, impulsivity and self-transcendence [8]. Other studies have shown the importance of factors such as empathy and internal control [9]. As regards the relationship between the "Big Five" and the ability to immerse in virtual reality, an important role of openness to experience, neuroticism and extraversion has been demonstrated [10]. In our study we wanted to find out what set of individual characteristics related to personality, temperament or style of coping with stressful situations can be associated with the effective use of the VR method.

Material and methods

Study population

The study involved 118 professional soldiers, preparing to take part in the mission in Afghanistan. They were randomized from among the two thousand contingent. The subjects were divided into an experimental group and a control group. The experimental group was further divided into four subgroups including 15 subjects each, which were subjected to SIT for a week, according to the methodology of the Virtual Reality Medical Center in San Diego. Four subjects participated in the survey in an active way, the other watched on the projector screen scenarios of virtual reality physiological parameters of active participants.

The study groups mostly consisted of men (there were only 6 women in the group) aged 21-44 years. The vast majority (95 respondents) had not previously participated in any mission.

Nineteen months after completion of training and one year after completion of the mission, the soldiers were re-examined. The study involved 84 subjects - 80 men and 4 women aged 21-44, 45 in the experimental group and 39 in the control group.

Soldiers participating in the experiment had previously been qualified for the mission by the Military Medical Commission, which found no mental disorders.

Procedure

The study began with a lecture on the symptoms and ways of coping with stress, in which both the experimental and control group participated. After the lecture, the subjects from both groups completed the following questionnaires: Coping Inventory for Stressful Situations (CISS), Formal Characteristics of Behaviour FCZ - KT, Personality Inventory NEO-PI-R and State-Trait Anxiety Inventory (STAI). The next step was division into groups. The subjects in the experimental group were informed by a psychologist about the conditions and purpose of stress inoculation training.

Then, the subjects took part in stress inoculation training, with monitoring of physiological parameters. The training consisted of 10 sessions over five days - two 60-minute sessions a day, in the morning and afternoon. Sessions were conducted according to the procedure standardized for all subjects. The training was consistent with the method developed in the Virtual Reality Medical Center, San

The influence of factors related to personality and temperament on stress inoculation training with using the method of virtual reality in PMC soldiers Diego. On the last day of the experiment, the study and control group completed STAI.

After completion of the mission in Afghanistan and return home - 19 months after the stress inoculation training - the soldiers underwent re-examination, filling in the STAI and PCL-M questionnaires and responding to questions in the standardized interview.

All respondents were informed about the objectives of the study.

Equipment

Three computers and software enabling audiovisual presentation and monitoring of physiological parameters were used for the training.

The first computer provided exposure to virtual reality via VR goggles, headphones and a joystick, allowing the participant to move and perform actions in the virtual world.

By means of the second computer, the trainer operated the control panel and menu that provided the possibility of introducing audiovisual stimuli to the active participant.

The third computer was used to operate the software used for the monitoring of physiological parameters and the feedback system. This computer was connected to devices for measuring physiological parameters: breathing, heart rate, skin conductance and temperature of the fingers.

Equipment used in the study included two computers Dell Inspiron M1710 with the processor Intel Core 2CPV 2GHz, 2G RAM and the graphics card nVIDIA GeForce Go 7900 GS (image and sound VR service). For the measurement of physiological parameters, the computer Dell Inspiron MXC 061 with the processor Intel Core 2CPV 1.99 GHz, 2G RAM was used. The following programmes were used to support the virtual reality: Afghan Kabul, Iraq Convoy, Main PTSD, Convoy PTSD, and Enchanted Forest (made available by the Virtual Reality Medical Center, San Diego).

Formal Characteristics of the Behaviour - Temperament Inventory (FCZ-KT)

The questionnaire FCZ-KT, which is intended for the diagnosis of primary, originally biologically determined personality dimensions, referred to as temperament, was used in the study [11] The features of temperament are tested at two levels.

The first is the energetic level of behaviour, i.e mechanisms responsible for accumulating and releasing energy. Energy temperament characteristics examined by FCZ-KT were [11]: Emotional reactivity (ER) - tendency to an intense response to stimuli, which is manifested as a great emotional sensitivity and low resistance.

- Endurance (EN) - ability to react adequately to strong stimulation and to manage situations involving long-term activity; Activity (AK) - tendency to take highly stimulating actions or looking for external stimulation,
- Sensory sensitivity (SS) - ability to react to weak sensory stimuli.

The second level includes the time characteristics of behaviour that determine the reaction time [11], i.e.: Są to:

- Briskness (BR) - tendency to react quickly, maintain a high tempo in performing actions and change behaviour easily in response to changing environmental conditions.
- Perseverance (PE) - tendency to continue and repeat an action after cessation of the triggering stimulus.

What is important for the functioning of an individual is not only the level of particular traits but also their balance. The effectiveness of regulation is connected with the equilibrium between stimulation input and its relief. In addition, there should also be a balance between the possibility of processing stimulation and its seeking or avoiding. Depending on the balance of temperament traits, a harmonized or non-harmonized structure of temperament may be distinguished.

Coping Inventory for Stressful Situations (CISS)

The CISS questionnaire, which is intended to identify behaviour in stressful situations was also used in the study. The questionnaire consists of 48 simple statements regarding various behaviours in stressful situations. The questionnaire identifies three basic styles, which are characteristic for people in such situations [12]:

- Task-Oriented Coping (TOC) - style of coping with stress based on taking tasks; individuals who earn high scores on this scale, in stressful situations tend to make efforts to solve the problem through cognitive transformation or attempt to change the situation; the main emphasis is put on the task or planning how to solve the problem,
- Emotion-Focused Coping (EFC) - a style characteristic for people who in stressful situations tend to focus on themselves and their own emotional experiences, such as anger, guilt or tension; these people also have a tendency to wishful thinking and fantasizing; such measures are designed to reduce emotional tension associated with the stress situation, but sometimes they can increase the feeling of stress and lead to increased tension or depression.
- Avoidance Coping (AC) - a style focused on coping with stress characteristic for people who in stressful situations tend to avoid thinking about and experiencing this situation; it may take two forms: engaging in replacement activities (ERA), e.g. watching television, overeating, thinking about pleasant things, sleep, or seeking social contact (SSC).

NEO-PI-R Questionnaire

For the purposes of this study, the NEO-PI-R personality inventory was used, which is intended

to diagnose the basic dimensions of personality in accordance with the five-factor model of personality (FFM) by Costa Jr. and R.R. McCrae [13]. According to this model, the five basic personality traits are [13]:

- Neuroticism (N) - the trait that allows to distinguish persons who are adapted, emotionally stable, from those who are misfit and emotionally unstable; high scores obtained for this trait are associated with the tendency to experience negative emotions such as fear, sadness, embarrassment, which hinder adaptation; they are associated with nervousness, low security and poor impulse control,
- Extroversion (E) - the trait specifying involvement in interpersonal relationships and the level of energy,
- Openness to experience (O) - dimension specifying the curiosity of the external and internal world,
- Agreeableness (A) - the trait specifying the behaviour in interpersonal relationships associated with altruism, kindness and willingness to help on the one hand, and tendency to conflicts and rivalry on the other hand,
- Conscientiousness (C) - the trait defining the degree of self-control, reliability and perseverance in the pursuit of goals.

State-Trait Anxiety Inventory (STAI)

The StateTrait Anxiety Inventory (STAI) was used during the study. It is a tool designed for the examination of anxiety understood as the transitional and situation-dependent state of an individual, and anxiety understood as a relatively permanent personality trait. STAI consists of two subscales: the first one (X-1) is used to measure the anxiety-state, while the other (X-2) is for measuring the anxiety-trait [14].

The anxiety-state is associated with a subjective feeling of tension and fear, resulting in stimulation of the nervous system, whereas the anxiety-trait is defined as a permanent behavioural disposition that makes a person perceive objectively harmless situations as threatening, responding to them with a disproportionate to the situation increase in tension and anxiety.

PCL-M

PTSD Checklist-Military (PCL-M) was used in this study. PCL-M is a self-reported scale, measuring 17 symptoms compatible with DSM-IV. This scale has various applications. It is used for the diagnosis of PTSD and to monitor changes in the course of treatment [15].

Results

Level of anxiety

We compared the results of STAI before and after the training, and after returning from the mission in order to verify whether the training had an impact on the level of anxiety. The Mann-Whitney U Test was used. Statistical analysis showed no significant differences between the experimental and control group.

Results of the analysis indicated no differences with respect to the level of anxiety between the group subjected to SIT and the control group, both after the training and after returning from the mission. No difference was observed for both the anxiety-state and the anxiety-trait variable.

In order to verify whether the training had an effect on the experimental group, the statistical analysis was performed, including the Wilcoxon`s signed-rank test. The results were also presented in the article by Maciołek.

The results demonstrated a statistically significant decrease in STAI scores for both variables the anxiety-state and anxiety-trait after the training.

Style of coping with stress, temperament and personality, and the anxiety level

The effect of variables related to personality, temperament and style of coping with stress on the effectiveness of the training expressed as the difference in the level of anxiety level measured by the STAI was analysed. For this purpose, the analysis of the correlation between CISS, FCZ-KT and NEO results and the X1 and X2 scores in STAI was performed. The analysis was performed in relation to the results of STAI obtained before and after the training, and after returning from the mission. The results in the experimental and control group were compared. The results obtained prior the training are presented in Table 1.

The results show a negative correlation between the average anxiety-state and briskness, sensory sensitivity and endurance in the experimental group. In this group we also obtained a significant correlation between the task-oriented style, emotional reactivity and the anxiety-trait; the negative relationship was observed between endurance, activity, extraversion and the anxiety-trait. A particularly strong relationship was demonstrated with respect to the activity.

In contrast, in the control group a negative correlation between neuroticism and openness to experience and anxiety-trait was observed.

The results demonstrated that the two groups differed in terms of the structure of temperament and personality of its members. The subjects in the experimental group were to a greater extent characterized by the harmonized structure of temperament.

Correlation analysis was performed after training. The results are summarized in Table 2. There was a relationship between the anxiety-state and emotional reactivity in the

Table 1. Results of statistically significant correlations between style of coping with stress, temperament and personality, and pre-training anxiety level in the experimental and control group
Tabela 1. Wyniki korelacji istotnych statystycznie pomiędzy stylem radzenia sobie ze stresem, temperamentem i osobowością a poziomem lęku przed treningiem w grupie eksperymentalnej i kontrolnej

	experimental group	control group
STAI XI	BR = -0.33 SS = -0.36 EN = -0.4	N = -0.36 0 = -0.36
STAI X2	TOC = 0.63	
	ER = 0.48 EN = -0.45 AK = -0.6	
	E = -0.37	

Table 2. Results of statistically significant correlations between style of coping with stress, temperament and personality, and post-training anxiety level in the experimental and control group
Tabela 2. Wyniki korelacji istotnych statystycznie pomiędzy stylem radzenia sobie ze stresem, temperamentem i osobowością a poziomem lęku po treningu w grupie eksperymentalnej i kontrolnej

	experimental group	control group
STAI X1	ER = 0.37	
		N = -0.36 A = -0.45
STAI X2		PE = -0.48
		0 = -0.45

experimental group, while the control group showed a negative correlation between the anxiety-state and neuroticism and agreeableness, and between the anxiety-trait and perseverance and openness to experience.

This indicates that emotional reactivity is the characteristic most vulnerable to a difference in the anxiety-state variable.

After returning from the mission, the statistical analysis of CISS, FCZ-KT and NEO results with respect to the results of STAI was performed. The results of the analysis are presented in Table 3.

Results of the analysis indicate a significant relationship between the anxiety-state and emotional reactivity in the experimental group, and the anxiety-trait and emotion-focused coping, avoidance coping and conscientiousness. In the control group, a relationship between the task-oriented style and the anxiety-trait was demonstrated.

Generally, the results indicate the maintained relationship between emotional reactivity and the anxiety-state in the experimental group.

Style of coping with stress, temperament and personality, and the symptoms of post-traumatic stress

After returning from the mission, the statistical analysis of CISS, FCZ-KT and NEO results with respect to PCL-M results for the symptoms of post-traumatic stress was also performed. Results for the experimental group are shown in Table 4, and results for the control group - in Table 5.

Results in the experimental group demonstrated a significant correlation (average correlation) between the severity of post-traumatic stress symptoms, the emotion-oriented style and emotional reactivity, and negative correlation between the severity of PTSD symptoms and endurance. In contrast, in the control group an average correlation between the task-oriented style and severity of post-traumatic stress symptoms was observed. The results suggest that the groups differed in terms of temperament and styles of coping with stress.

Table 3. Results of statistically significant correlations between style of coping with stress, temperament and personality, and post-deployment anxiety level in the experimental and control group
Tabela 3. Wyniki korelacji istotnych statystycznie pomiędzy stylem radzenia sobie ze stresem, temperamentem i osobowością a poziomem lęku po powrocie z misji w grupie eksperymentalnej i kontrolnej

	experimental group	control group
STAI X1	ER = 0.31	
STAI X2	EFC = 0.33 AC = 0.31	TOC=0.34
	S = 0.34	

Table 4. Results of correlation between coping with stress, temperament and personality, and symptoms of post-traumatic stress in the experimental group
Tabela 4. Wyniki korelacji pomiędzy radzenia sobie ze stresem, temperamentem i osobowością a objawami stresu pourazowego w grupie eksperymentalnej

variable	experimental group p <0.05
	PCL-M 2012
style of coping with stress according to CISS	
emotional	0.34
emotional STEN	0.31
task-oriented	-0.04
task-oriented STEN	-0.04
avoidance	0.14
avoidance STEN	0.20
temperament according to FCz-KT	
briskness	-0.11
perseverance	0.05
sensory sensitivity	-0.02
emotional reactivity	0.36
endurance	-0.26
activity	-0.18
personality according to NEO	
neuroticism	-0.01
extraversion	0.09
openness to experience	0.17
agreeablness	0.05
conscientiousness	0.03

Table 5. Results of correlation between coping with stress, temperament and personality, and symptoms of post-traumatic stress in the control group
Tabela 5. Wyniki korelacji pomiędzy stylem radzenia sobie ze stresem, temperamentem i osobowością a objawami stresu pourazowego w grupie kontrolnej

variable	control group p <0.05
style of coping with stress	
emotional	0.34
emotional STEN	0.31
task-oriented	-0.04
task-oriented STEN	-0.04
avoidance	0.14
avoidance STEN	0.20
temperament	
briskness	-0.11
perseverance	0.05
sensory sensitivity	-0.02
emotional reactivity	0.36
endurance	-0.26
activity	-0.18
personality	
neuroticism	-0.01
extraversion	0.09
openness to experience	0.17
agreeablness	0.05
conscientiousness	0.03

Discussion

The obtained results showed that although there was no difference between the experimental and control group, the performed training reduced the tension of the participating soldiers.

Analysis of the relationship between particular predispositions and susceptibility to training showed that the groups were not homogeneous. In the experimental group, the level of anxiety before the test was much more correlated with the structure of temperament, and the results were consistent with those expected. The high level of anxiety was associated with emotional reactivity; however, it was inversely proportional to temperamental traits associated with the harmonized structure.

It seems that this may be related to a defensive attitude presented by the subjects, who in a training situation, could be afraid of fear related to the social exposure and assessment of resistance to stress. It is possible that subjects in the experimental group were forced to use additional energy resources, which resulted in a more pronounced relationship between anxiety and the structure of temperament.

In the experimental group, both after training and after returning from the mission, the feeling of tension was associated with emotional reactivity. It is therefore possible that this temperament factor is the most sensitive to changes experienced by the subjects. Thus, it can be hypothesized that highly reactive individuals had greater susceptibility to training. Taking into account a described in the literature relationship between emotional reactivity and resistance to stress [16], the result would place highly reactive persons in a different light, suggesting that the initial reduction of resistance to stress situation could be modified by a greater influence of preventive actions such as SIT. This hypothesis, however, requires further studies.

After returning from the mission, combat stress symptoms in the experimental group were more related to emotion-oriented style, as well as emotional reactivity and durability. These results, however, should be treated with caution because of the multitude of factors that may affect the observed correlations.

It also seems that it would be interesting to examine the relationship between personality and temperament factors and susceptibility to SIT measured by *low frequency* (LF) and *very low frequency* (VLF) determining the ability to control the physiological arousal. Such a study would allow for a more precise analysis of individual predisposition to SIT.

Conclusion

Our study found no difference between the experimental and control group. The results of the study suggest that, among various personality and temperament factors, emotional reactivity is the most important factor when testing individual susceptibility to inoculation training. This factor was most sensitive to changes experienced by the subjects during training. It seems that highly reactive individuals were characterised by a greater susceptibility to training. This hypothesis, however, requires further studies.

References

1. Wiederhold B, Wiederhold M. Virtual reality for posttraumatic stress disorder and stress inoculation training. J CyberTherapy Rehabilit, Spring 2008, Volume 1
2. Meichenbaum D. Stress Inoculation Training: A preventative and treatment approach. [In] Lehrer PM, Woolfolk RL, Sime WS, eds. Principles and practice of stress management. Guildford Press, 2007: 497-518
3. Wiederhold B, Wiederhold M. From SIT to PTSD. Annual Review of CyberTherapy and Telemedicine, Interactive Media Institute, San Diego, 2006
4. GUIS. Pre-traumatic personality as a predictor of post traumatic stress disorder among undergraduate students exposed to a terrorist attack: a prospective study in Israel. Pers Individ Dif, 2005: 39
5. Lauterbach D, Vrana S. The relationship between personality variables, exposure to traumatic events and severity of post traumatic stress symptoms. J Trauma Stress, 2001; 14: 29-46
6. Zawadzki B, Kaczmarek M,Strelau J. Emotional reactivity and the severity of posttraumatic stress disorder (PTSD) in victims of floods: effect of pathoplasticity, spectrum, susceptibility or complications? [In] Strelau J, Zawadzki B, Kaczmarek M, eds. The consequences of psychological trauma: conditioning and therapy. Warszawa, Scholar, 2009: 77-109
7. Boden T, Bonn-Miller MO, Kashdan TB, et al. The interactive effects of emotional clarity and cognitive reappraisal in Posttraumatic Stress Disorder. J Anxiety Dis, 2012;26:233-238
8. Neria Y, Solomon Z, Ginzburg K, et al. Sensation seeking, wartime performance, and long-term adjustment among Israeli war veterans. Pers Individ Dif, 2000;29:921-932
9. Laarni J, Ravaja N, Saari T, et al. Personality related differences in subjective presence. Presence, 2004: 88-95
10. Wallach HS, Safir MP, Samana R. Personality variables and presence. Virtual Reality, 2010;14:3-13
11. Zawadzki B, Strelau J. Formal Characteristics of the Behavior - Temperament Inventory (FCZ-KT). Manual. Warsaw, Psychological Test Laboratory of the Polish Psychological Association, 1997
12. Strelau J, Jaworowska A, Wrześniewski K, et al. Coping Inventory for Stressful Situations (CISS), Manual. Warsaw, Psychological Test Laboratory of the Polish Psychological Association, 2005.
13. Siuta J. Personality Inventory NEO-PI-R, Manual. Warsaw, Psychological Test Laboratory of the Polish Psychological Association, 2009.
14. Sosnowski T, Wrześniewski K. StateTrait Anxiety Inventory (STAI). Manual. Warsaw, Psychological Test Laboratory of the Polish Psychological Association, 2011.
15. Weathers F, Litz B, Herman D, et al. The PTSD Checklist (PCL): Reliability, Validity, and Diagnostic Utility. Paper presented at the Annual Convention of the International Society for Traumatic Stress Studies, San Antonio, TX, October 1993.
16. Terelak J. Stres psychologiczny. Bydgoszcz, Brant Publishing House, 1995

Whether doctors live shorter? The study on the basis of Members one of the Regional Medical Chamber

Czy lekarze żyją krócej? Badanie na podstawie danych z jednej z Okręgowych Izb Lekarskich

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Abstract. The professions of doctor and dentist are particulary vulnerable to stress. Those who practice this profession are exposed to many physical and mental factors (excessive working hours, emergency work, lack of sleep, constant mental stress). On the basis of data obtained from the register of doctors and dentists who died in 2005-2012, who were members of the Beskyd Medical Chamber, it was revealed that women medical practitioners in particular have a shorter than average life expectancy in comparison to the national female population in general. The shortened life expectancy for women practitioners of dentistry is not statistically significant, while for men there was no significant difference compared with the average for the rest of society.
Keywords: average lifespan, Beskyd Medical Chamber, stress

Streszczenie. Zawód lekarza i lekarza dentysty jest zawodem szczególnie narażonym na stres. Osoby wykonujące ten zawód są narażone na działanie wielu czynników zarówno natury fizycznej, jak i psychicznej (nadmierna liczba godzin pracy, praca w systemie dyżurowym, brak snu, ciągłe napięcie psychiczne itp.). Na podstawie danych uzyskanych z rejestru lekarzy i dentystów, członków Beskidzkiej Izby Lekarskiej, zmarłych w latach 2005-2012, stwierdzono, że zwłaszcza kobiety wykonujące zawód lekarza żyją krócej niż wynosi średnia długość życia kobiet w naszym kraju. Skrócenie czasu życia dla kobiet wykonujących zawód dentysty jest nieznamienne statystycznie, natomiast dla mężczyzn nie zaobserwowano istotnych różnic w porównaniu ze średnią dla reszty społeczeństwa.
Słowa klucze: Beskidzka Izba Lekarska, stres, średni czas życia

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Introduction

The profession of a doctor and dentist is generally considered as very responsible and stressful, which is detrimental to health. Therefore, it is believed to belong to a group of professions at an increased risk of suicide [1]. The main health risks associated with the medical profession, based on the literature data, are presented in the table.

Taking into account a large number of harmful factors influencing a doctor at work, it can be assumed that this profession is associated with a particular health risk, resulting in, among others, shortening of lifespan.

Aim of the study

The aim of the study was to investigate whether in the Beskid region the medical profession is associated with a shortening of the average lifespan.

Material and methods

Evaluation of the average lifespan of physicians was based on data from the Central Register of Medical Practitioners and the Register of the Beskid Medical Chamber concerning the deaths of doctors and dentists during the period from 01 January 2005 to 31 December 2012 [2].

Table. Risk factors associated with the profession of a doctor
Tabela. Czynniki ryzyka związane z zawodem lekarza

psychological factors	physical factors
everyday contact with death, suffering and pain	excessive number of work hours per week
excessive pressure and expectations of the patient and his/her family	sleep deficit associated with night duty
constant threat of making a mistake, the consequences of which may be irreversible and harmful to others	the need for continuous and full focus and concentration
the need for continuous updating of knowledge and use its enormous resource in stressful situations	in the case of surgical specialties, long hours of surgery, sometimes in uncomfortable or standing position
the need for rapid, crucial decisions in life-threatening situations (often no time to think), taking decisive actions influencing human life	irregular and improper diet related to work (medical duty)
continuous competition and rivalry	the need to combine professional work with running a home and raising children, especially in the case of female doctors
frequent need to collaborate in a team consisting of people with different temperaments	
excessive expectations of superiors	
extensive documentation requiring the fulfillment of many documents	

The collection of data was approved by the Supreme and Regional Medical Councils [3]. The material was developed in accordance with the principles of protection of personal data, and analyzed on the basis of data calculated using descriptive statistics, regarding the division into gender as well as doctors and dentists. To calculate the average lifespan of doctors who died during this period, a life time (in years) was calculated for each of them, subtracting the year of birth from the year of death. The results were compared with the data for the Polish population. According to data from the Central Statistical Office in 2012, the average lifespan of men was 72.7 years and of women 81.0 years, regardless of the place of residence [4].

Results

The Beskid Medical Chamber covers the area of the former Province of Bielsko, i.e. the counties of of Bielsko, Cieszyn, Żywiec, Auschwitz, Sucha and Wadowice, and the city with the county rights - Bielsko-Biala, and has 3,377 members, representing 1.91% of the medical practitioners in Poland, including 2,609 physicians (1.87% of doctors in Poland) and 752 dentists (1.92% of dentists in Poland), as well as 16 doctors with both professional titles. Most members of the Beskid Medical Chamber are women, i.e. 2,065 (61.1%), while men constitute 1,315 (39.9%).

As shown in Figure 1, from 1 January 2005 to 31 December 2012, 181 doctors and dentists, members of the Beskid Medical Chamber died, including 139 doctors, 41 dentists and one physician with the title of both a doctor and a dentist, who performed the profession of a doctor. The group of deceased medical practitioners included 77 women and 104 men. The group of doctors included 53 women and 86 men, and the group of dentists - 24 women and 17 men.

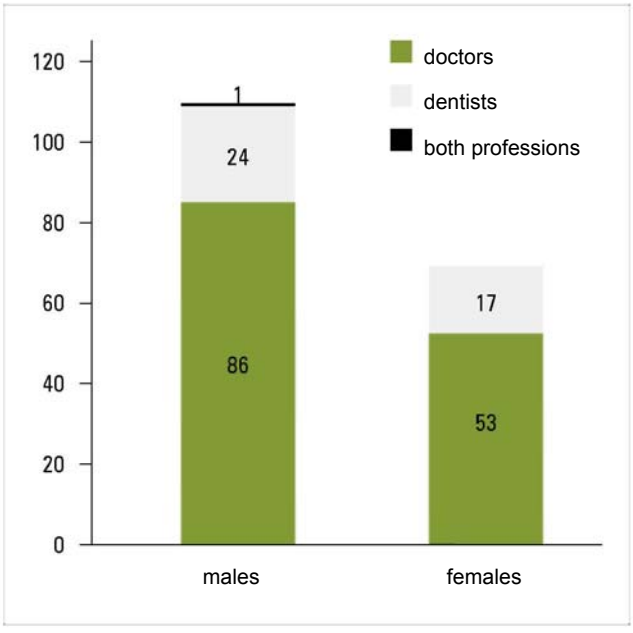

Figure 1. Doctors and dentists, Members of Beskyd Medical Chamber who died in the 2005-2012

Rycina 1. Lekarze i lekarze dentyści, członkowie Beskidzkiej Izby Lekarskiej zmarli w latach 2005-2012

As shown in Figure 2, the calculated average age of all doctors and dentists, members of the Beskid Medical Chamber who died in 2005-2012, was

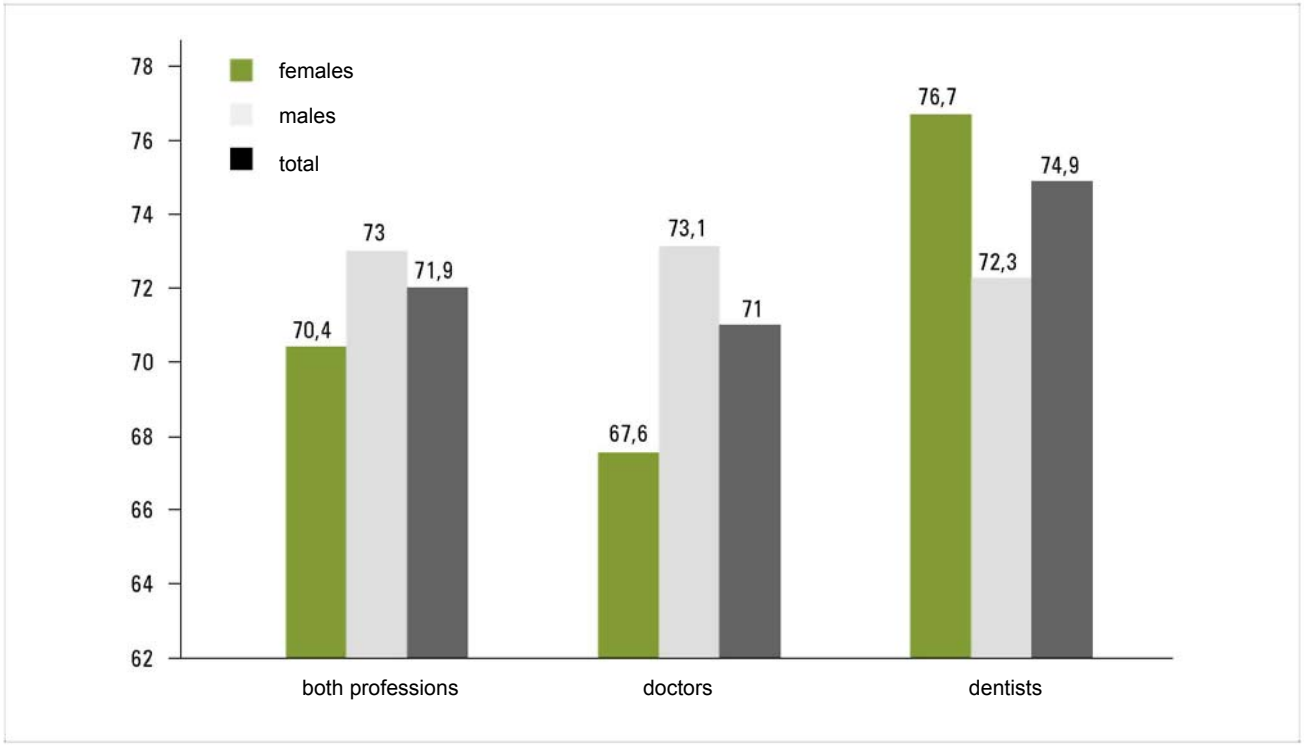

Figure 2. The average age at death doctors and dentists who died in the 2005-2012

Rycina 2. Średni wiek w momencie zgonu lekarzy i dentystów zmarłych w latach 2005-2012

71.9 ± 2.8 years at death. Men, who among the dead were the majority, i.e. 57.5%, at the time of death were 73.0 ± 13.3 years old, on average, and women (constituting 42.5%) were 70.4 ± 12.5 years old. Among doctors, the average age (regardless of gender) at the time of death was 71.1 ± 12.9 years. Male doctors died on average at the age 73.1 ± 12.6 years, while female doctors at the age of 67.6 ± 12.8 years. The average age of dentists at the time of death was 74.9 ± 12.0 years. Male dentists died on average at the age 72.3 ± 16.7 years, while female dentists at the age of 76.7 ± 9.5 years. Comparing the data for the general population, there was a significant shortening of lifespan of female doctors ($p < 0.05$). The shortening of life of female dentists was not statistically significant, and the lifespan of male doctors and dentists was similar to the rest of the population.

Discussion

The obtained results are consistent with the results of two previous studies analyzing the average lifespan of doctors in other medical chambers, which also demonstrated a significant shortening of lifespan of female doctors.

The first study was conducted in the Silesian Medical Chamber. The analysis included the lifespan of 600 members of this chamber who died in 2001-2006 [5]. It demonstrated that the average lifespan of male doctors was 2.4 years shorter (68.1 vs 70.5 years), and female physicians 11.6 years shorter (67.3 vs 78.9 years) than the corresponding average lifespan of other Poles. Our study has demonstrated a similar phenomenon of excess mortality of female doctors, expressed in a shorter lifespan.

In the second Polish study including a larger group of doctors and dentists who died in 2001-2008 and concerning the Silesian and Lower Silesian Medical Chamber, the average lifespan for the total population of Silesia was 67.45 years for men and 77.45 years for women [6]. A low average age of men in this area probably resulted from the adverse health effects of mining and metallurgical industry, in which most of the men are employed. The analysis of the Silesian Medical Chamber showed that the average age of deceased doctors and dentists, calculated for the years 2001-2008 amounted to 71.0 years for men, but only 69.9 years for women [6]. In the Lower Silesia, the lifespan for the general population is 70.4 years for men and 79.0 years for women. The analysis of the Lower Silesian Medical Chamber showed that the average age of deceased doctors and dentists, calculated for the years 2001-2009 amounted 68.5 years for men and 68.7 years for women, thus, a shortening of the average lifespan of female doctors was observed.

Shortening of the lifespan of female doctors is most

probably associated with the specific features of the feminine psyche and related reaction to stress, excessively long working hours and sleep deficit. In addition, the work of family doctors or specialists in outpatient care is different form the work of doctors employed in hospitals. Therefore, the intensity of particular factors presented in the table is different. It seems that excessively long working hours and constant mental strain related to responsibility for the life and health of another person are the most important factors. Control of the State Labour Inspectorate in 2011 showed that in one of the public health care institutions, a doctor of the surgical ward worked continuously for 103 hours and 35 minutes, without the required rest [7]. This inspection also revealed that almost every fourth employer did not provide employees (including doctors) with a required daily rest. The rule is that a doctor works more than full-time. The Control of Lodz Branch of NHF showed an extreme case of a doctor employed in 25 clinics [8]. This situation results from the employment on civil contracts, and first of all, from still low salary of doctors. Unfortunately, all sources indicate a high average salary of doctors, including overtime in the form of duty and income from additional employment, while the full-time salary is much lower. This argument seems to be confirmed by studies carried out in other countries, where results differed depending on the prosperity of the country.

In the world literature, not many analyses on the average lifespan of medical practitioners can be found. The American NOMS Registry (National Occupational Mortality Surveillance) 1984-1995 has demonstrated that male doctors - both Caucasian and black - lived longer (73.0 years for whites and 68.7 years for blacks) than the average for all male whites and blacks of other professions (70.3 and 63.6 years, respectively) [9]. This was explained by a healthier lifestyle of doctors, resulting from their knowledge of the principles of a healthy lifestyle. It is well known that the financial situation of doctors in this country is very good. The study of Indian Medical Association (IMA), based on an analysis of data from the social security system covering more than 16,500 doctors from all over India, showed that the average lifespan of physicians in 2005-2010 was 57.0 ± 2 years, while the average lifespan in this country was 69-72 years (70.5 ± 1.5 years) [10]. Most of the studies in developed (and rich) countries, mainly in Scandinavia, were focused on a comparison of the standardized mortality ratio (SMR, i.e. the number of deaths per 100,000 people in the particular population, assuming that the age structure of the observed population is consistent with the structure of the population recognized as standard). Studies on Norwegian physicians carried out in 1960-2000 demonstrated a lower all-cause mortality in doctors, with the exception of suicides [11]. Similar conclusions were drawn by authors who analysed the standardized mortality ratio among Danish physicians [12]. Both of these studies suggest that the medical profession - even in countries, where doctors are not forced to work excessive hours, is still associated with a very large psychological burden, resulting in an increased number of suicides.

Interesting findings were obtained in the studies carried out by Hawton et al. in the Warnerford Hospital in Oxford [13]. Based on the analysis of 223 doctors in England and Wales who committed suicide in the years 1979-1995, it was found that female doctors committed suicide more often than representatives of other professions (SMR 201.8, 95% CI: 99.7-303.9), while male doctors were less likely to commit suicide than men of other professions (SMR 66.8; 95% CI: 46.6-87.0) [13]. According to the authors, it was not certain whether this phenomenon was related to the psychological burden of the medical profession, but this hypothesis requires further investigation.

Similar results were obtained by the authors analysing the causes of death of female doctors in the United States in the years 1967-1972 [14]. In this study, the suicide rate among women was higher than among male doctors, and for the rest of white American females of similar age. There have been no similar analyses for the population of Polish doctors.

If we add to the presented findings the need to work long hours, and especially the lack of sleep and rest, we get a very likely cause of the shorter lifespan of Polish medical practitioners, especially female doctors. It is worth noting that the medical profession, once reserved exclusively for men (the first female doctor Anna Tomaszewicz-Drobska started working in Warsaw in 1880, and medical schools in Poland began to accept women in 1900), after 100 years became a profession dominated in Poland by women [15]. According to data from the Central Register of Physicians in Poland, female doctors and dentists constitute 62% of all medical practitioners [2]. This phenomenon is also observed in other countries [16,17].

An important risk factor is also stress related to this profession. It is well known that doctors are among the most vulnerable to stress occupational groups [18,19]. This applies particularly to surgical specialties and young doctors starting their professional careers [18]. According to a survey including 158 doctors from Silesia, in the five-point scale of stress, 29.1% of respondents rated it at 4, and 38.6% at 5 points [19]; 47% admitted that they could not cope with stress at work. The authors referred to similar foreign analyses demonstrating that women are especially vulnerable to stress [20,21]. Although the differences between the sexes may not be significant, it was easier for men to cope with stress (over 62% claimed that they did not need help) [19]. According to the authors of the survey, the main causes of stress among physicians are: low salary, limited access to diagnostic methods, uncomfortable working conditions, poor work organization, bad atmosphere at work and helplessness in the face of some diseases [19]; these causes largely coincide with those presented in the introduction.

When analyzing the obtained information, it should be noted that data published by the Central Statistical Office shows that in Poland, as in most countries, excess mortality in men is observed [4]. In Poland, it is not as visible as in some European countries; nonetheless,

according to the Central Statistical Office, in 2012 women in Poland lived for about 8.3 years longer than men. This trend was even more pronounced in the period between 2006 and 2008, when the difference was 8.7 years in favour of women. Since 2009, a slight downward trend for this difference has been observed. It results from a slightly faster increase in lifespan of men than women.

Conclusion

1. Among the medical practitioners in the area of the Beskid Medical Chamber, a shortened lifespan of female doctors was observed in relation to the average lifespan of women in the general population. The lifespan of female dentists was similar to that of women in the general population.

2. The average lifespan of male doctors in the area of the Beskid Medical Chamber (both physicians and dentists) was similar to the average lifespan of men in the general population.

References

1. Grzywa A, Kucmin A, Kucmin T. Suicide - epidemiology, factors, motives and prevention. Part 1. Pol Merkur Lek, 2009; 27: 432-436
2. Central Register of doctors kept by the Supreme Chamber of Physicians. Available at: http://www.nil.org.pl/rejestry/centralny-rejestr-lekarzy/informacje-statystyczne
3. The Act on Chambers of Physicians of 2 December 2009. Journal of Laws 2009, No. 219, item 1708 The wording since 20 July 2013
4. Lifespan in 2012. Central Statistical Office. Warsaw, Department of Statistical Publishing, 2013
5. Kijak R. Treatment at the cost of the doctor's life.. Służba Zdrowia, 2009; No. 43-46
6. Kozakiewicz J, Chodorski J. Job prospects for specialists in the area of Silesian and Lower Silesian Medical Chambers - demographic problems. http://www.izba-lekarska.org.pl/files/media_files/Referat-Perspektywy%20zawodowe%20lekarzy%20specjalist%C3%B3w%20na%20obszarze%20Izb%20Lekarskich%20%C5%9AI%C4%85skiej%20i%20Dolno%C5%9BI%C4%85skiej%20%E2%80%93%20problemy%20 demograficzne.pdf
7. Compliance with labour laws in health care institutions. Warsaw, National Labour Inspectorate, 2012
8. Czerwiński A. A doctor working at 25 full-time jobs at the same time. Available at: Gazeta.pl/lodz (access: June 17, 2009)
9. Frank E, Biola H, Burnett CA. Mortality rates and causes among U.S. physicians. Am J Prev Med, 2000; 19: 155-159
10. Sayyed N. Doctors have shorter lifespan than patients. Available at: www. dnaindia.com/lifestyle/1 341 722 (access: February 1, 2010)
11. Aasland 0G, Hem E, Haldorsen T, Ekeberg 0. Mortality among Norwegian doctors 1960-2000. BMC Public Health, 2011; 11: 173
12. Juel K, Mosbech J, Stottrup Hansen E. Mortality and causes of death among Danish medical doctors 1973-1992. Int J Epidemiol, 1999; 28: 456-460
13. Hawton K, Clements A, Sakarovitch C, et al. Suicide in doctors: a study of risk according to gender, seniority and specialty in medical practitioners in England and Wales, 1979-1995. J Epidemiol Community Health, 2001; 55: 296-300
14. Pitts FN, Schaller AB, Rich CL, Pitts AF. Suicide among US women physicians. Am J Psychiatry, 1979; 5: 694-696
15. Kulik H. Family or career in female doctor's life? Gazeta Lek, 2000; No. 10. Available at: http://www.oil.org.pl/xml/nil/gazeta/numery/n2000/n200 010/n20 001 017 (access: October 17, 2000)
16. Eisenberg C. Medicine is no longer a man's profession. N Engl J Med, 1989; 302:1542-1544
17. Relman AS. The changing demography of the medical profession. N Engl J Med, 1989;321:1540-1542
18. Konodyba-Szymański P, Irzyniec T, Konodyba-Szymański B. Stress - the hidden danger in the work of a doctor. Zdrowie Publ, 2006; 116: 554-558
19. Jośko J, Kasperczyk J, Gościniewicz P, et al. Stress - the only thing doctors do not lack. Prog Hig Epidemiol, 2006; 87: 198-200
20. Redinbaugh EM, Sullivan AM, Block SD, et al. Doctors' emotional reactions to recent death of a patient: cross sectional study of hospital doctors. Br Med J, 2003; 327: 185
21. Gautarn M. Women in medicine stresses and solutions. West J Med, 2001; 174:37-41

Laparoscopic colorectal operations - open method and laparoscopy (during learning curve)

Analiza wczesnych wyników zabiegów resekcyjnych jelita grubego - metoda otwarta i laparoskopia (w okresie krzywej uczenia)

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Abstract. In 2008-12 60 laparoscopic colon resection procedures were performed; 50 of them were performed using the laparoscopic technique (28 m, 22 f). Among the reasons for treatment there were both benign tumours (9) and cancers (41). A group of 60 patients has been randomly selected from the same period of time to have bowel resection procedures by open surgery method (0) - 39 m, 21 f. In both treatment groups the following items were evaluated: a decrease of hemoglobin level and an increase in the white blood cell count on the first postoperative day, the duration of surgery, the duration of hospital stay, need for blood transfusion in the postoperative period, early postoperative complications and costs of surgery. It was found that the average decrease of Hb in laparoscopic group (L) - 1.86, classic group (0)-2.0, average leukocyte increase L — 2.52, 0-2.58, average length of surgery L-3 h 42 min (1.45-6.40), 0-2 h 36 min (1.45-5.00), average postoperative hospital stay L —6.93, O- 11. 0.17 units per patient were transfused in group L and 0.66 units per patient in group 0. In group L there were 2 anastomotic leaks, 3 cases of wound infection. In group O there were 3 anastomotic leaks, 11 cases of wound infection and 2 cases of postoperative wound dehiscence. The average cost of the surgery was 4520 PLN in group L and 2800 PLN in group 0.
Keywords: colon, rectum, resection, laparoscopic procedure

Streszczenie. W latach 2008-2012 rozpoczęto przeprowadzanie laparoskopowych zabiegów resekcyjnych jelita grubego u 60 chorych, w technice laparoskopowej ukończono 50 z nich (28 u mężczyzn i 22 u kobiet). Wśród przyczyn zabiegów były zmiany łagodne (9) oraz raki (41). Losowo wyłoniono grupę 60 pacjentów, u których wykonano zabiegi resekcyjne jelita grubego sposobem otwartym (21 kobiet i 39 mężczyzn). W obydwu badanych grupach oceniano: zmniejszenie stężenia hemoglobiny oraz wartości leukocytozy w pierwszej dobie pooperacyjnej, czas trwania zabiegu operacyjnego, okres pobytu w szpitalu, potrzebę przetoczeń koncentratu krwinek czerwonych (KKCz) w okresie pooperacyjnym, wczesne powikłania pooperacyjne oraz koszty leczenia operacyjnego. Stwierdzono: średnie zmniejszenie Hb - grupa laparoskopowa (L) -1,86, grupa klasyczna (0) -2,0, średnie zwiększenie leukocytozy-L 2,52, O 2,58, średnią długość zabiegu operacyjnego L 3 h 42 min (1,45-6,40), O 2 h 36 min (1,45-5,00), średni pooperacyjny pobyt w szpitalu - L 6,93, O 11, w grupie L przetoczono średnio 0,17 j. KKCz na chorego, zaś w grupie O 0,66 j. W grupie L stwierdzono 2 przypadki nieszczelności zespolenia, 3 przypadki ropienia rany, w grupie O zaś 3 przypadki nieszczelności zespolenia, 11 przypadków ropienia rany oraz 2 przypadki rozejścia się rany pooperacyjnej. Średni koszt zabiegu w grupie L wynosił 4520 zł, w grupie O zaś 2800 zł.
Słowa kluczowe: jelito grube, odbytnica, resekcja, laparoskopia

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Introduction

When in 1990 Jacobs, then Fowler and Leahy, and in Poland in 1993 Leszczyszyn [1], initiated the era of laparoscopic colon resection procedures, it seemed that in a natural way it opened the door for advanced laparoscopic procedures; however, no revolution similar to that for cholecystectomy was observed. Opponents of this method presented concerns about the inadequate scope of the surgical procedures, and thus - oncologic asepsis. They raised the issue of implants at the injection site of trocars, etc. In their opinion, laparoscopy was associated with a compromise - reduction of surgical trauma to compensate for uncertain oncological radicality. Studies of large groups of patients have shown that this objection is not related to the method, but to the skills and experience of the surgeon performing colorectal operations [2]. It should be mentioned that surgeons performing laparoscopic colon resection procedures should have both experience in laparoscopic technique and in open surgery. Long-term results of laparoscopic procedures performed by experienced surgeons are comparable with the results obtained by the open technique [3]. Such operations can be performed using conventional laparoscopic sets, and the use of modern operating tables and power tools facilitates the procedures. No significant negative factors related to the performance of laparoscopic procedures have been identified [4]. In experimental studies determining the level of circulating endothelial progenitor cells (EPC), significantly lower EPC levels were observed after laparoscopic procedures than after open surgery. It is believed that EPCs facilitate the formation and dissemination of tumour cells in the body [5]

Aim of the study

Comparative analysis of the early outcome after elective colorectal resection procedures performed with laparoscopic and open methods.

Material and Methods

In 2008-2012, laparoscopic colon resection procedures were performed on 60 patients (24 women [F] and 36 men [M]; Fig. 1). The mean age of the patients was 69.5 years (F - 69, M - 69.8). Most procedures were carried out between 2011 and 2012. In 10 cases (17%), conversion to open surgery was required. A group of 60 patients (21 women, 39 men; mean age 67.8 years [F - 66.8, M - 68.2]; Fig. 1) was randomly selected from the same period of time to have bowel resection procedures by the open surgery method. In both groups, the following parameters were analyzed: haemoglobin prior to surgery and on the first postoperative day, WBC count, postoperative

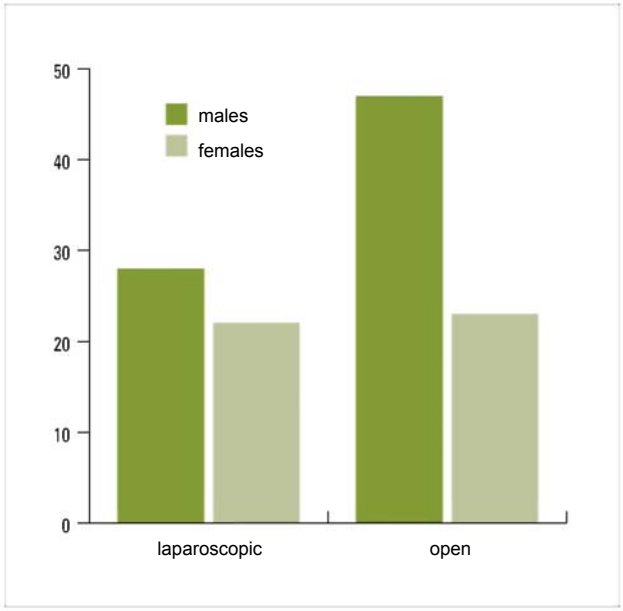

Figure 1. Female and male ratio in both groups

Rycina 1. Stosunek liczby kobiet do liczby mężczyzn w obydwu ocenianych grupach

complications,duration of hospitalization, number of RCC units transfused after surgery and treatment costs. The physical status of the patients was assessed using the ASA classification system; comorbidities, tumour location, its type and stage using the TNM staging system were also evaluated. Patients were eligible for surgery based on the endoscopic examination results, supported with radiological studies, allowing for assessment of the tumour stage in the case of cancer diagnosis. Patients with rectal cancer were consulted oncologically in order to qualify them for preoperative radiotherapy. Each surgical procedure was preceded by basic tests as well as consultation by an internist and/or cardiologist. The operations were performed under general anaesthesia, accompanied by continued epidural analgesia maintained for two days after surgery. All patients received antibiotic prophylaxis and, for the entire period of hospitalization, low molecular weight heparins.

After positioning and preparing the patient, the operation was initiated with vessel treatment, and after resection, the continuity of the gastrointestinal tract was restored in all cases. In patients after resection of the rectum and rectosigmoid junction, the anastomosis was performed using staplers; the other intestinal anastomoses were carried out manually. In 90% of cases, the end-to-end anastomosis was performed, with the side-to-side anastomosis in the remaining 10%. Postoperatively, the patients underwent intensive rehabilitation.

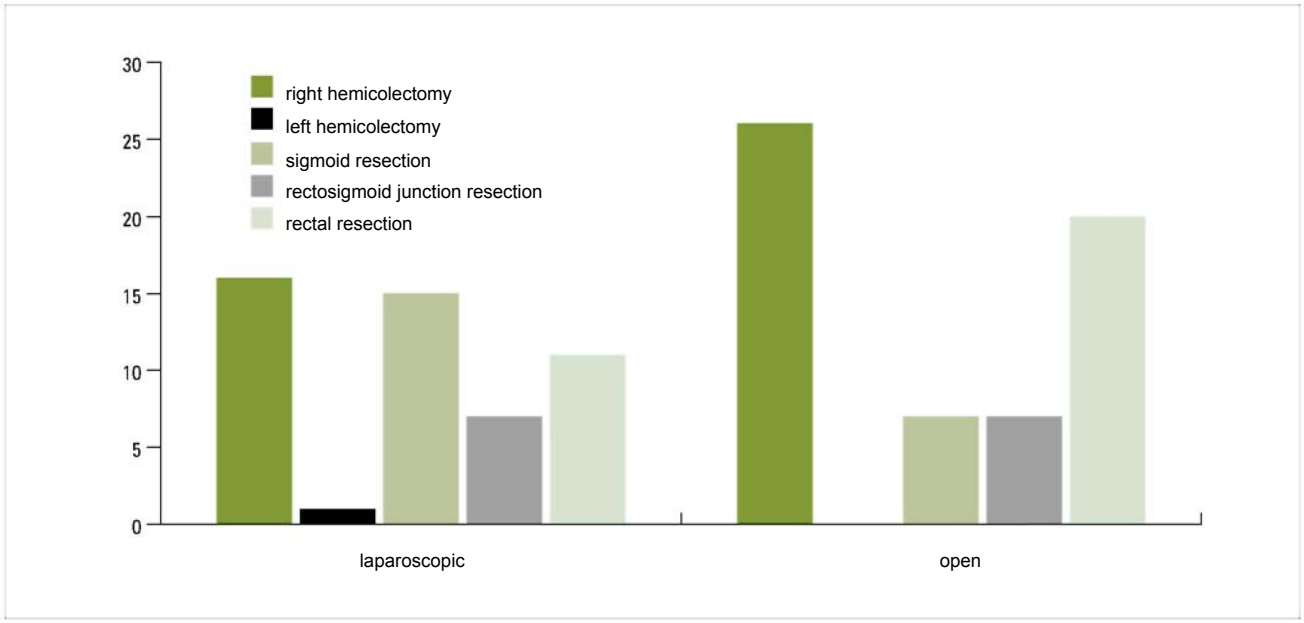

Figure 2. Surgical procedures in both groups

Rycina 2. Rodzaje wykonywanych zabiegów w obydwu ocenianych grupach

Results

The group of 50 patients in whom the laparoscopic procedure was completed included 28 men and 22 women. In this group the following procedures were performed: 15 (30%) right-sided hemicolectomies, 15 (30%) sigmoid resections, 11 (22%) rectal resections, 7 (14%) rectosigmoid junction resections, 1 (2%) left hemicolectomy, and 1 (2%) transverse colon resection (Fig. 2). The reasons for procedures were: hyperplastic polyps - 1 (2%), *adenoma tubulo-villosum* - 8 (16%), cancer - 41 (82%) (2 - T_1, 13 - T_2, 22 - T_3, 4 - T_4 [Fig. 3]). The average ASA patient status was 2.1 (Fig. 4). High blood pressure was diagnosed in 28, type 2 diabetes in 14, and ischaemic heart disease in 12 cases. In the group of 60 patients treated with open surgery, the following procedures were performed: 26 (43.3%) right hemicolectomies, 20 (33.3%) rectal resections, 7 (11.7%) rectosigmoid junction resections, and 7 (11.7%) sigmoid resections (Fig. 2). The diagnosis included: inflammatory polyp - 1 (1.7%), *adenoma tubulo-villosum* - 4 (6.6%), and cancer - 55 (91.7%) cases (3 - T_1, 10 - T_2, 33 - T_3, 9 - T_4 [Fig. 3]). The average ASA physical status was 2.23 (Fig. 4). Hypertension was diagnosed in 34, type 2 diabetes in 8, and ischaemic heart disease in 14 cases.

The analysis of haemoglobin concentration on admission and on the first postoperative day revealed a mean reduction by 1.86 in the group after laparoscopic surgery, and by 2.0 in the group undergoing open surgery. Similarly, the mean increase in WBC count was 2.52 in the 'laparoscopic' group and 2.58 in the 'open' group. The mean period of postoperative hospitalization was 6.93 days n the 'laparoscopic' group and 11 days in the 'open' group (Fig. 5). Patients operated on using the laparoscopic method were transfused 0.17 units of RCC per patient, and those undergoing open surgery - 0.66 units of RCC per patient. The cost of the surgery was 4520 PLN in the 'laparoscopic' group and 2800 PLN in the 'open' group (Fig. 6). The analysis of post-operative complications revealed: 2 cases of anastomotic leaks in the laparoscopic group and 3 cases in the open group; 3 cases of wound infection in the laparoscopic group and 11 cases in the open group. In two cases, postoperative wound dehiscence was observed in the group after open surgery.

Discussion

The end of the twentieth century was a period of dynamic development of laparoscopic techniques used in the surgical treatment of abdominal diseases. The world literature data indicating the benefits of using laparoscopy prompted us to use this method for colorectal surgery. The initiation of such procedures was preceded by training in centres with extensive experience in this field and the introduction of routine laparoscopic appendectomy. Patients with benign conditions and without significant internal diseases were qualified for the first operations. The encouraging results of these procedures, rapid return of peristalsis, low blood loss, small number of complications and shorter hospitalization made us use the laparoscopic method in colorectal resection procedures more commonly. Gaining new experience resulted in shortening the time of surgery and improvement of surgical technique, especially in the preparation of mesorectum. Therefore, most patients with colorectal tumours are currently qualified for the laparoscopic procedure [6].

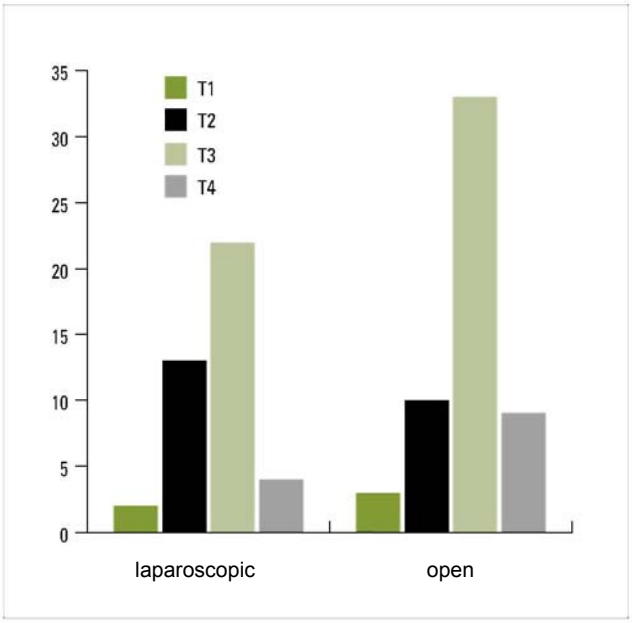

Figure 3. Stages of the cancer in both groups

Rycina 3. Zaawansowanie nowotworów w obydwu ocenianych grupach

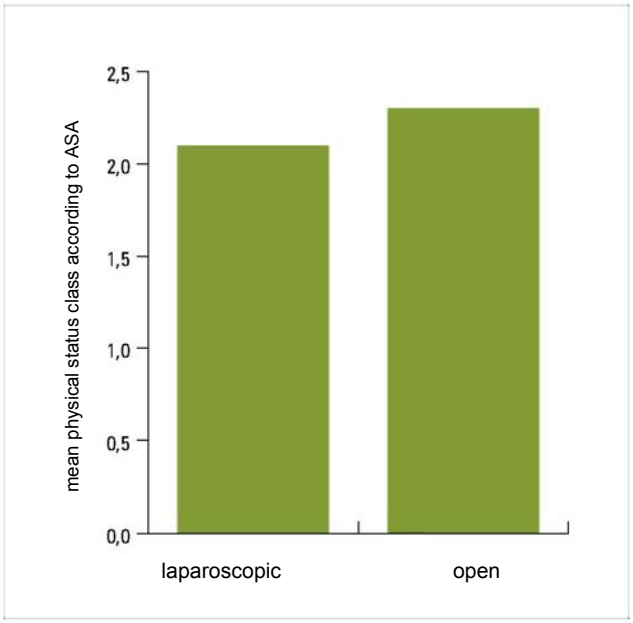

Figure 4. Mean physical status class according to ASA in both groups

Rycina 4. Średnia wydolność wg ASA w obydwu ocenianych grupach

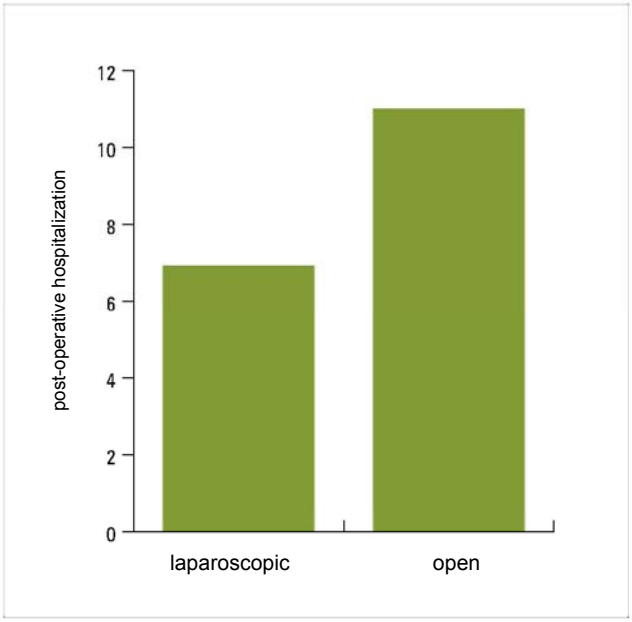

Figure 5. Hospital stay in both groups

Rycina 5. Czas pobytu pooperacyjnego w obydwu ocenianych grupach

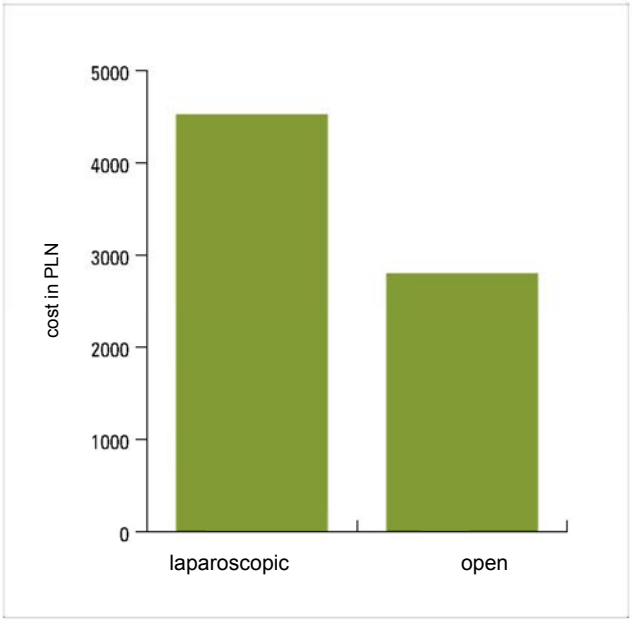

Figure 6. Costs of the procedure in both groups

Rycina 6. Koszty zabiegu operacyjnego w obydwu ocenianych grupach

Thorough pre-operative diagnostics and finding small pathologies enable a safe procedure. For the laparoscopic resection of the distal sigmoid colon cancers we qualified two patients who had undergone open surgery 28 and 30 days earlier due to symptomatic abdominal aortic aneurysms. The patients tolerated the treatment very well

and both were discharged home on the fifth postoperative day. The percentage of conversion in our study was 17%. In four cases, the reason was a technical problem leading to excessive prolongation of the procedure, and in four cases the tumour staging was 'underestimated' during the previous diagnostics. In the other two cases, the conversion resulted from excessive bleeding caused by damage to the left common iliac vein and to the middle colic vein, respectively. Such events are rather serious intraoperative complications, which we could not treat laparoscopically. Postoperative complications in the form of anastomotic leaks occurred in two cases in the laparoscopic group and in three patients in the open group. They were treated by means of laparotomy, and in the case of right hemicolectomy a new anastomosis supported with ileostomy was performed; in the case of anastomosis in the distal colon, the anastomoses were separated, the proximal stump was used to create abdominal stoma, while the distal stump was closed. Superficial wound infection was significantly less pronounced in the laparoscopic group (6%) compared to the open group (18%). A similar difference in favour of the laparoscopic group was observed for the required RCC transfusion. The only parameters to support the open surgery are the cost and duration of surgical procedure. A significantly higher cost of laparoscopic procedures results from the need to use disposable power tools and staplers (in most cases, more than one set was used). Compensation is a reduction of post-operative hospitalization in the laparoscopic group. The mean duration of operation is longer in the laparoscopic group because of the learning curve. Currently, the duration of a laparoscopic procedure performed by an experienced surgeon (30 operations) is comparable to the duration of open surgery.

Conclusion

1. We affirm that adequate preparation and acquiring the proper experience enable safe laparoscopic colorectal resections.

2. The benefits resulting from less frequent complications, less blood loss and shorter hospitalization support the laparoscopic method and remain in line with the observations of other authors [7-11].

3. A slightly longer duration and higher cost of treatment can be overcome by the continuous improvement of the surgical technique.

References

1. Leszczyszyn J, Ławiński M. Laparoscopic right-sided colon resection. Pol Przegl Chir, 1994; 66: 493
2. Jayne DG, Thorpe HC, Copeland J, et al. Five-year follow-up of the Medical Research Council CLASICC trial of laparoscopically assisted versus open surgery for colorectal cancer. J Vase Surg, 2010; 97: 1638-1645
3. Bonjer HJ, Hop WC, Nelson H, et al. Laparoscopically assisted *vs* open colectomy for colon cancer: a meta-analysis. Arch Surg, 2007; 142: 298-303
4. Fleshman J, Sargent DJ, Green E. The Clinical Outcomes of Surgical Therapy Study Group. Laparoscopic colectomy for cancer is not inferior to open surgery based on 5-year data from the COST Study Group trial. Arch Surg, 2007; 142: 298-303
5. Colon Cancer Laparoscopic or Open Resection Study Group, Buunen M, Veldkamp R, Hop WC, et al. Survival after laparoscopic surgery versus open surgery for colon cancer: long-term outcome of a randomised clinical trial. Lancet Oncol, 2009; 10:44-52
6. Condon ET, Barry BD, Wang JH, et al. Laparoscopic surgery protects against the oncologic adverse effects of open surgery by attenuating endothelial progenitor cell mobilization. Surg Endosc, 2007; 21: 87-90
7. Lezoche E, Guerrieri M, De Sanctis A, et al. Long-term results of laparoscopic versus open colorectal resections for cancer in 235 patients with a minimum follow-up of 5 years. Surg Endosc, 2006; 20: 546-553
8. Hacebroek EJ, Color Study Group: COLOR: A randomized clinical trial comparing laparoscopic and open resection for colon cancer. Surg Endosc, 2002; 16:949-953
9. Lujan J, Valero G, Biondo S, et al. Laparoscopic versus open surgery for rectal cancer: results of prospective multicentre analysis of 4970 patients. Surg Endosc, 2013;27:295-302
10. Feroci F, Baraghini M, Lenzi E, et al. Laparoscopic surgery improves postoperative outcomes in high-risk patients with colorectal cancer. Surg Endosc, 2013;27:1130-1137
11. Law WL, Poon JTC, Fan JKM, et al. Survival following laparoscopic versus open resection for colorectal cancer. Int J Colorectal Dis, 2012; 27: 1077-1085

Electrocardiographic and echocardiographic features of left ventricular hypertrophy in patients with hypertension

Elektrokardiograficzne i echokardiograficzne cechy przerostu mięśnia lewej komory u chorych z nadciśnieniem tętniczym

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Abstract. Introduction: The features of left ventricular hypertrophy (LVH) in patients with arterial hypertension (AH) are markers of organ damage. At the same time the sensitivity of electrocardiographic (ECG) criteria of LVH is low and poorly corresponds with the diagnosis of LVH in echocardiography (ECHO). Aim: The aim of this study was to determine the prevalence of selected electrocardiographic features of LVH and LVH diagnosed by means of the ECHO in patients with untreated AH, without significant comorbidities. Material and methods: 144 patients (99 men, mean age 45.2 years) were examined with: 1) ECHO, in which LVH was diagnosed on the basis of the assessment of left ventricular mass index (LVMI >95 g/m^2 for women and >115 g/m^{2}for men), and 2) ECG with evaluation of selected criteria for the diagnosis of LVH. Results: The ECHO LVH was found in 17 patients (11.8%), while the ECG LVH -in 11 patients (7.6%). Agreement of both methods was observed only in 3 cases. Conclusions: The prevalence of LVH in the study group was low and ECG criteria of LVH corresponded with increased LVMI to a small extent. Due to the low sensitivity ECG underestimated the frequency of LVH assessed by ECHO. However, the high specificity of ECG criteria suggested a low probability of false diagnosis of LVH.
Keywords: echocardiography, electrocardiography, hypertension, left ventricular hypertrophy

Streszczenie. Wstęp: Cechy przerostu mięśnia lewej komory (LVH) u chorych na nadciśnienie tętnicze (NT) są wykładnikami powikłań narządowych. Równocześnie czułość elektrokardiograficznych (EKG) kryteriów LVH jest mała i słabo koresponduje z echokardiograficznym (ECHO) rozpoznaniem LVH. Cel pracy: Celem pracy była analiza występowania wybranych cech elektrokardiograficznych LVH i przerostu LV rozpoznawanego za pomocą ECHO w grupie chorych z nieleczonym NT, bez istotnych chorób współistniejących. Materiał i metody: U 144 chorych (99 mężczyzn, średni wiek 45,2 roku) wykonano: (1) ECHO, w którym LVH rozpoznano na podstawie oceny indeksu masy lewej komory (LVMI >95 g/m^2 dla kobiet oraz >115 g/m^2 dla mężczyzn) oraz (2) EKG z oceną wybranych kryteriów rozpoznania LVH. Wyniki: W badaniu echokardiograficznym LVH stwierdzono u 17 osób (11,8%), podczas gdy w EKG u 11 osób (7,6%). Zgodność oceny obiema metodami odnotowano jedynie w 3 przypadkach. Wnioski: Cechy LVH w badanej grupie występowały rzadko, a kryteria EKG jego rozpoznania w niewielkim stopniu korespondowały ze zwiększonym LVMI. Z uwagi na małą czułość badanie EKG niedoszacowuje częstości występowania LVH w ECHO. Równocześnie duża swoistość kryteriów EKG wskazuje na małe prawdopodobieństwo uzyskania fałszywie dodatnich rozpoznań LVH na podstawie tego badania.
Słowa kluczowe: echokardiografia, elektrokardiografia, nadciśnienie tętnicze, przerost mięśnia lewej komory

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Introduction

The features of left ventricular hypertrophy (LVH) in patients with arterial hypertension (AT) are markers of organ damage, associated with an increased risk of cardiovascular events [1]. LVH is a physiological or pathological increase in the left ventricular mass (LVM) above the accepted normal values. On the basis of anatomopathological studies it has been established that the correct average mass of the left ventricle with the septum should be less than 190 g [2]; according to the current guidelines, LVH is diagnosed in echocardiography at the left ventricular mass index (LVMI) > 95 g/m^2 in women and > 115 g/m^2 in men [3]. In 1961, LVH was considered as one of four risk factors for cardiovascular disease (including AH, hypercholesterolemia and diabetes) [4]. Moreover, these factors are usually cumulative. LVH is diagnosed in 22-60% of patients with AH [5]. The risk of cardiovascular morbidity and mortality in patients with LVH is 2 - 4 times higher than in patients with normal LVM [6,7]. The presence of LVH increases the risk of developing congestive heart failure, arrhythmia, sudden cardiac death, coronary atherosclerosis and reduced coronary flow reserve, and consequently - favours myocardial ischemic attacks and strokes. In contrast, inhibition or reversal of LVH progression seems to improve the prognosis [8]

In view of the predictive value of LVH, an early diagnosis and appropriate choice of diagnostic tests are especially important. Electrocardiography (ECG) should be one of the first examinations, mainly due to its availability and cost [9]. The next examination, in order to verify ECG results, is echocardiography (ECHO), which is characterised by a greater accuracy of diagnosis, supported with an assessment of the structure, geometry, and systolic and diastolic function of the left ventricle (LV) [8]. Taking into account the limited availability of ECHO, especially in primary health care, it is important to determine whether the correct result of ECG can be a reason for abandoning echocardiographic verification. It is hard to resist the impression that the belief of high diagnostic value of ECG results is a reason for cessation of further diagnostics, particularly in the absence of other clinical indications for ECHO. However, the analysis of reports on this subject shows that limitation of diagnostics to ECG results in the fact that LVH is underdiagnosed, and consequently, the cardiovascular risk is underestimated.

Aim of the study

The aim of this study was to determine the prevalence of selected electrocardiographic features of LVH and LV hypertrophy recognized by ECHO in patients with untreated AH, with a particular emphasis on the diagnostic value of ECG in relation to the result of echocardiography.

Material and methods

Study group

The study included patients of both sexes, with untreated AH (elevated blood pressure ≥ 3 months). The eligibility criteria for the study were: (1) confirmed secondary AH, (2) confirmed chronic renal failure in the second and higher stage of the disease - GFR < 60 mL/ min/1.73 m^2 according to MDRD, (3) other severe comorbidities: systolic heart failure, cardiomyopathy, significant arrhythmias, significant valvular disease, chronic obstructive pulmonary disease (COPD), previously diagnosed diabetes, polyneuropathy, peripheral vascular disease, (4) age < 18 years and > 75 years, (5) body mass index (BMI) > 40 kg/m^2, (6) mental diseases that prevent full cooperation with the patient, (7) cardiac rhythm other than sinus rhythm (including permanent cardiac pacing).

The study protocol was approved by the Bioethics Committee at the Military Institute of Medicine (Agreement No. 3/WIM/2008), and all participants gave their written informed consent to participate in the study.

Clinical examination

The examination was performed with a particular focus on the medical history concerning cardiovascular risk factors (e.g. family history of cardiovascular disease, smoking) and the assessment of the body constitution (height, weight, BMI).

Echocardiography

ECHO was performed using the Vivid S6 apparatus (GE-Healthcare, USA). The following measurements were evaluated: the size of heart cavities, contractility and thickness of the left ventricular wall, ejection fraction as well as morphology and function of the heart valves. LVH was diagnosed in accordance with the current recommendations [3], based on the assessment of the left ventricular mass, indexed to the body surface area (LVMI > 95 g/m^2 for women and 115 g/m^2 for men). Calculations of LVM were made according to the following formula:

$0.8 \times (1.04 \times [LVEDD + PWTd + SWTd]^3 - [LVEDD]^3) + 0.6$ [g]

Parameters required for the calculations, i.e. left ventricular end-diastolic diameter [LVEDD] , diastolic posterior wall thickness [PWTd], and diastolic septal wall thickness [SWTd] were evaluated in the parasternal long axis, using the M-mode technique, under the control of two-dimensional imaging (2D). In this projection, the left ventricular enlargement (LVEDD index - dimension indexed to the body surface area) - over 3.2 cm/m^2 for men and over 3.1 cm/m^2 for women, was also estimated.

Resting electrocardiogram (ECG)

A 12-lead resting ECG was performed in the supine position, at a paper speed of 25 mm/s and voltage of 1 mV (= 10 mm). Detailed assessment included independently selected criteria for the diagnosis of LVH: (A) Sokolow-Lyon index > 3.5 mV, (B) Cornell product > 244 mV* ms, (C) R-wave amplitude in aVL > 1.1 mV, (D) Gubner index R in I + S in III > 2.5 mV, (E) R in V5 or V6 > 2.6 mV, (F) S in V2 + R in V5 or V6 > 4.5 mV, (G) Cornell index S in V3 + R in aVL > 2.8 mV (men) and > 2.0 mV (women), according to the recommendations regarding electrocardiographic diagnosis (Polish Cardiac Society guidelines 2010) [10]. In order to accurately assess ECG results, the analysis of records was performed using the Sentinel software (Reynolds Medical, 2012). The greatest distance from the isoelectric line to the top of the wave (measured in a perpendicular line to the isoelectric line) was assumed as wave amplitude; the duration of the broadest QRS complex was measured in one of twelve standard leads, in which the beginning and end of the complex were clearly visible (usually in II lead).

Statistical analysis

The statistical analysis of the results was performed using Microsoft Office Excel 2007 and Statistica 10.0 (StatSoft Inc.). The results are expressed as mean ± standard deviation (SD) for quantitative variables, and numbers and percentages for qualitative variables. Furthermore, ROC curve analysis was performed for selected variables to evaluate sensitivity and specificity for LVH diagnosis.

Results

The final analysis included test results from 144 patients with arterial hypertension (99 men, mean age 45.2 years), whose detailed clinical characteristics are shown in Table 1. The majority of subjects were patients with mild AH. There were no cases of irregular dimensions of the ventricles, whereas LA enlargement was observed in less than 17%.

ECHO revealed LVH in 17 patients (11.8%), while ECG - in 11 patients (7.6%). Among ECG criteria, increase in the amplitude of R-wave in aVL (> 1.1 mV) and Gubner index (R in I + S in III > 2.5 mV) was most frequently observed (in 6 subjects). For the other criteria, the frequency did not exceed three cases (Tab. 2). Agreement of both methods was observed in 3 cases only (Fig. 1 and 2). In the first case (male), LVMI in ECHO coexisted with R in aVL = 13.4 mm and Gubner index = 26.4 mm; in the second case (female) - it coexisted with R in aVL = 11.4 mm and S in V3 + R in aVL = 23.4 mm, whereas in the third case (male) -with Gubner index = 31.9 mm.

Table 1. Basic characteristics of the study group
Tabela 1. Charakterystyka podstawowa badanej grupy

	study group (n = 144)
age (years), mean ± SD	45.2 ±10.4
males, n (%)	99 (68.8)
mild AH	114 (79.2)
moderate AH	28 (19.4)
severe AH	2 (1.4)
SBP (mmHg), mean ±SD	141.3 ± 13.6
DBP (mmHg), mean ±SD	91.7 ± 15.7
HR (min^{-1}), mean ± SD	73.3 ± 10.4
BMI [kg/m^2], mean ±SD	30.0 ± 4.2
Family history of AH, n (%)	103 (71.5)
LV enlargement, n (%)	0 (0.0)

BMI - body mass index, DBP - diastolic blood pressure,
HR - heart rate, LA - left atrium,
LV - left ventricle, AH - arterial hypertension, RV - right ventricle,
SBP - systolic blood pressure

In relation to the echocardiographic diagnosis, ECG criteria demonstrated low sensitivity and high specificity. The ROC curves (receiver operating characteristic) for the tested parameters only slightly deviated from the curve x = y (AUC 0.500), which indicates that the diagnostic value of ECG for LVH is not much different from random sample (Tab. 2).

Discussion

The presented results indicate that compatibility of ECHO and ECG for LVH diagnosis is low, which is consistent with the observations in the Framingham study, in which LVH was detected by ECG in only 2% of the general population, while by ECHO - in 20% [11]. It is emphasized that the sensitivity of electrocardiographic criteria for LVH is low and poorly corresponds with the echocardiographic diagnosis of LVH, which can be the reason for diagnostic inaccuracy. Similar observations have been reported by Pewsner et al. [12] who, after analyzing a large set of data from the years 1966 to 2005, found that markers of LVH assessed in ECG were characterized by moderate specificity and low sensitivity: Sokolow-Lyon index 53-100% and 4-52%, Cornell index 89-100% and 2-41%, Cornell product 83-100% and 8-32%, Gubner index 80-100% and 0-39%, respectively.

Table 2.The diagnostic value of the electrocardiographic LVH classifiers
Tabela 2. Wartość diagnostyczna badanych cech elektrokardiograficznych jako klasyfikatorów LVH

ECG criterion	true		false		sensitivity	specificity	AUC
	positive	negative	positive	negative			
A	**0**	125	**2**	17	0.000	0.984	0.492
B	**0**	126	**1**	17	0.000	0.992	0.496
C	**2**	123	**4**	15	0.118	0.969	0.543
D	**2**	123	**4**	15	0.118	0.969	0.543
E	**0**	126	**1**	17	0.000	0.992	0.496
F	**0**	126	**1**	17	0.000	0.992	0.496
G	**1**	125	**2**	16	0.059	0.984	0.522

Abbreviations: AUC - area under the curve

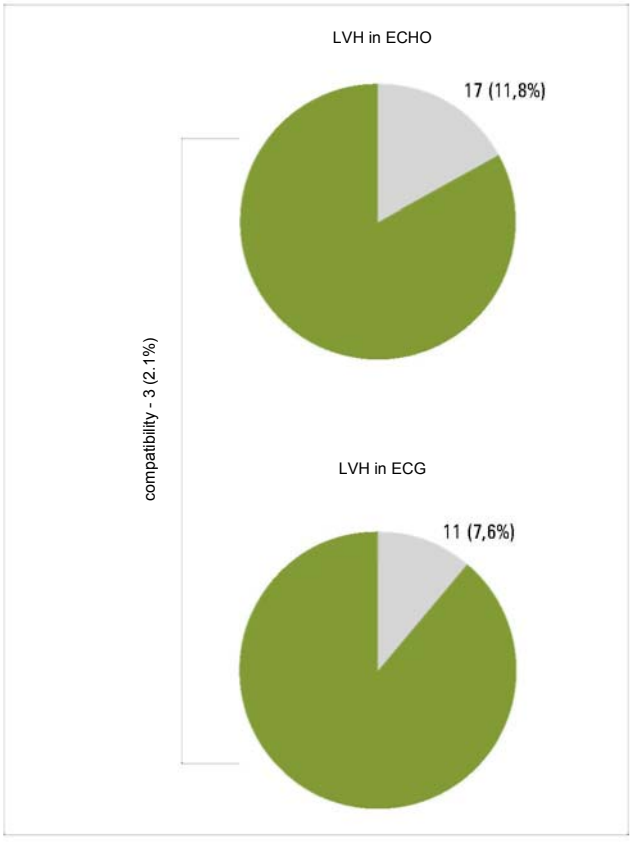
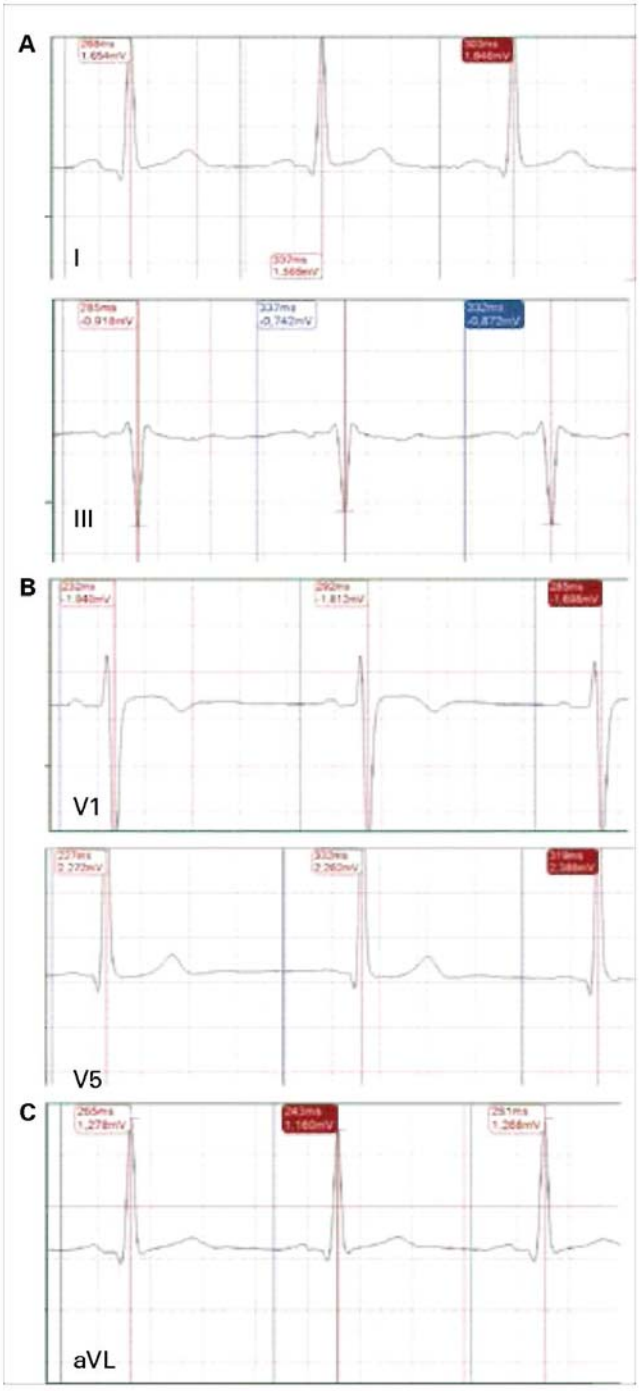


Figure 1. The prevalence of electrocardiographic and echocardiographic features of LVH and their relation

Rycina 1. Występowanie cech elektrokardiograficznych i echokardiograficznych LVH i ich wzajemne powiązanie

Therefore, attempts are made to define further markers of LVH in ECG. Klein et al. [13], based on the echocardiographic verification, suggested the sum of the amplitude of S-waves in V2 and R-waves in V6 greater than 45 mm as a diagnostic parameter for LVH, which achieved 86% sensitivity and 100% specificity. Other researchers, however, are trying to simplify these complex diagnostic algorithms. In recent years, for example, it has been demonstrated that the use of R-wave amplitude in aVL as a criterion for LVH is, in terms of sensitivity and specificity, comparable to more complex and time-consuming markers such as Cornell index and Sokolow-Lyon index [14-15].

It should be admitted that search for further composite markers does not change the status of ECG in the diagnosis of LVH, if the record of cardiac electrical activity is related to the assessment by means of ECHO. It is hard to expect that in the near future a new electrocardiographic parameter with a significantly higher predictive value for LVH will appear. This is probably due to the fact that the diagnosis of LVH by means of ECG is mainly based on the measurement of the amplitude of QRS waves, which is influenced by many factors (Tab. 3). In fact, ECG is a record of the electrical activity of the heart, and thus, it only indirectly reflects the mass of living myocytes, without taking into account interstitial tissue [16]. The reason for diagnostic discrepancies can be a pathological cardiac remodeling associated with the disease - in patients with hypertension, increased activity of the renin-angiotensin system promotes fibrosis, which leads to a reduction in the amplitude of the QRS complex, despite the presence of LVH. Similarly, false negative results may be found in patients with amyloidosis, hypothyroidism, obesity [17], pericarditis and chronic obstructive pulmonary disease. In contrast, the overestimation of QRS amplitude is observed in males, very thin individuals or in black patients. Another reason may be hypokalemia, also iatrogenic [10,16,18].



Rycina 2. Wybrane przykłady elektrokardiograficznych cech LVH: (A)-R I + S III >2,5 mV (2,56 mV), (B) - wskaźnik Sokołowa i Lyona (S VI + RV5) >3,5mV(4,32mV), (C)-RwaVL>1,1 mV(1,16mV)

Figure 2. The examples of the electrocardiographic LVH classifiers: (A) - R I + S III >2.5 mV (2.56 mV), (B) - Sokolow-Lyon index (S VI + RV5)>3.5mV(4.32mV), (C)-R waVL >1.1 **mV(1.16mV)**

Table 3. The factors influencing QRS amplitude
Tabela 3. Czynniki wpływające na relację amplitudy QRS

factors "underestimating" the QRS amplitude
obesity
lung diseases (e.g. chronic obstructive pulmonary disease)
presence of pathological amount of fluid in the pericardial sac (e.g. in the course of inflammation, cancer)
myocardial fibrosis (e.g. in prolonged activation of renin-angiotensin-aldosterone system)
storage diseases involving the heart (e.g. amyloidosis)
overhydration (e.g. pulmonary congestion, peripheral edema - in patients with heart failure, renal failure)
hypothyroidism
intense physical activity*
factors "overestimating" the QRS amplitude
young age
males
black race
slim build
tallness
ion disorders (e.g. hypokalemia)
rotation of the heart (e.g. associated with a significant enlargement of the right ventricle)
intense physical activity*

*depending on the type of effort

It should be noted, however, that the low compatibility of ECG and ECHO does not disqualify ECG from the stratification algorithm for cardiovascular risk. The prognostic value of ECG criteria was confirmed regardless of LVM assessed by means of ECHO. It is suspected that at least in some cases, electrocardiographic features of LVH reflect the actual pathophysiological disorders, imperceptible in ECHO [12]. Bacharova [19] indicates that the differences between various and independent information obtained in ECG and ECHO are important in the diagnosis of early changes in the structural and electrical remodeling of the myocardium. When analysing the results of healthy subjects and hypertensive patients (with comparable LVM), the author demonstrated a lower amplitude of QRS complex in patients with arterial hypertension. The voltage which is lower than expected due to the mass of the hypertrophic heart (false negative result) has been defined as "relative power deficit." It occurs in an early stage of LVH development and changes with the progression of LVH, being reduced in the phase of compensated LVH and increased again in the stage of heart failure development.

Therefore, attempts are made to identify selected groups of patients for whom ECG may be more useful in the diagnostic process. This examination is, for example, still recommended for hypertensive patients aged over 55 years, based on the premise that long-term hypertension

increases the weight of the electrically active myocytes [20]. It is not recommended to diagnose LVH based on ECG in patients under 40 years of age. However, observations made by Casiglia et al. [21] indicate that the ECG criteria may, to various extent, depend on age, sex, and blood pressure. This study showed that the Cornell index more often than other criteria was consistent with increased LVMI in women. The Sokolow-Lyon index correlated with the values of systolic blood pressure (SBP) regardless of age and gender, whereas the other criteria showed a correlation with SBP only in older men. Moreover, it was proven that true positive LVH results for the Sokolow-Lyon index indicated an increased risk of mortality to a greater extent than "isolated" diagnosis of LVH by means of ECHO.

A limitation of our study is the small number of subjects, including those with electrocardiographic and echocardiographic diagnosis of LVH. This prevents the extension of the analysis to search for own diagnostic criteria. The obtained results do not change the existing opinion, pointing out that even in a very homogeneous group, the sensitivity of ECG in predicting LVH in ECHO is low.

Conclusion

The features of LVH in the study group were rare, and electrocardiographic criteria for the diagnosis of LVH corresponded with increased LVMI to a small extent. Due to the low sensitivity ECG underestimated the frequency of LVH assessed by ECHO. However, the high specificity of ECG criteria suggested a low probability of false positive diagnosis of LVH based on this examination. Therefore, ECG cannot be used as a substitute for ECHO in the diagnosis of LVH in hypertensive patients, although the clinical and pathophysiological significance of electrocardiographic LVH classifiers should be the subject of further research.

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References

1. Levy D, Salomon M, D'Agostino RB, et al. Prognostic implications of baseline electrocardiographic features and their serial changes in subjects with left ventricular hypertrophy. Circulation, 1994; 90: 1786-1793
2. Lip GY, Felmeden DC, Li-Saw-Hee FL, et al. Hypertensive heart disease. A complex syndrome or a hypertensive 'cardiomyopathy'? Eur Heart J, 2000; 21: 1653-1665
3. Mancia G, Fagard R, Narkiewicz K, et al. 2013 ESH/ESC guidelines for the management of arterial hypertension: the Task Force for the Management of Arterial Hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC). Eur Heart J, 2013; 34:2159-2219
4. Kannel WB, Dawber TR, Kagan A, et al. Factors of risk in the development of coronary heart disease: six year follow-up experience: the Framingham study. Ann Intern Med, 1961; 55: 30-50
5. Arnett DK, de las Fuentes L, Broeckel U. Genes for left ventricular hypertrophy. Curr Hypertens Rep, 2004; 6: 36-41
6. Kannel WB. Prevalence and natural history of electrocardiographic left ventricular hypertrophy. Am J Med, 1983; 75: 4-11
7. Casale PN, Devereux RB, Milner M. Value of echocardiographic measurement of left ventricular mass in predicting cardiovascular morbid events in hypertensive men. Ann Intern Med, 1986; 105: 173-178
8. Kahan T. The importance of left ventricular hypertrophy in human hypertension. J Hypertens Suppl, 1998; 16: 23-29
9. Moser M. Initial workup of the hypertensive patient. Hypertensive Primer: The Essentials of High Blood Pressure. USA, Philadelphia, Williams & Wilkins, 1998:221-223
10. Hancock EW, Deal BJ, Mirvis DM, et al.; American Heart Association Electrocardiography and Arrhythmias Committee, Council on Clinical Cardiology; American College of Cardiology Foundation; Heart Rhythm Society AHA/ACCF/HRS recommendations for the standardization and interpretation of the electrocardiogram: part V: electrocardiogram changes associated with cardiac chamber hypertrophy: a scientific statement from the American Heart Association Electrocardiography and Arrhythmias Committee, Council on Clinical Cardiology; the American College of Cardiology Foundation; and the Heart Rhythm Society. Endorsed by the International Society for Computerized Electrocardiology. J Am Coll Cardiol, 2009; 53: 992-1002
11. Levy D, Anderson KM, Savage DD, et al. Echocardiographically detected left ventricular hypertrophy: prevalence and risk factors. The Framingham Heart Study. Ann Intern Med, 1988; 108: 7-13
12. Pewsner D, Jüni P, Egger M, et al. Accuracy of electrocardiography in diagnosis of left ventricular hypertrophy in arterial hypertension: systematic review. Br Med J, 2007;335:711-719
13. Klein RC, Vera Z, DeMaria AN, Mason DT. Electrocardiographic diagnosis of left ventricular hypertrophy in the presence of left bundle branch block. Am Heart J, 1984; 108 (3 Part 1): 502-506
14. RodriguesSL, Angelo LC, Baldo MP, et al. Detection of left ventricular hypertrophy by the R-wave voltage in lead aVL: population-based study. Clin Res Cardiol, 2013;102:653-659
15. Gosse P, Jan E, Coulon P, et al. ECG detection of left ventricular hypertrophy: the simpler, the better? S J Hypertens, 2012; 30: 990-996
16. Baranowski R, Wojciechowski D, Maciejewska M, et al.: Recommendations for the use of electrocardiographic diagnoses; Document prepared by the Working Group appointed by the Board of the Noninvasive Electrocardiology and Telemedicine Section at the Polish Cardiac Society, under the patronage of the Polish Cardiac Society. Kardiol Pol, 2010; 68 (suppl. IV): 22-24
17. Roberts WC, Filardo G, Ko JM, et al. Comparison of total 12-lead QRS voltage in a variety of cardiac conditions and its usefulness in predicting increased cardiac mass. Am J Cardiol, 2013; 112: 904-909
18. Dąbrowska B. Commentary: Relevance of electrocardiographic parameters indicators in the diagnosis of left ventricular hypertrophy in patients with hypertension - a systematic review. Med Prakt, 2008; 1: 113-115
19. Bacharova L. The structural and electrical remodeling in LVH and its impact on the QRS voltage. Anatol J Cardiol, 2007: 7 (Suppl. 1): 37-42
20. Fagard RH, Staessen JA, Thijs L, et al. Prognostic significance of electrocardiographic voltages and their serial changes in elderly with systolic hypertension. Hypertension, 2004; 44: 459-464
21. Casiglia E, Schiavon L, Tikhonoff V, et al. Electrocardiographic criteria of left ventricular hypertrophy in general population. Eur J Epidemiol, 2008; 23: 261-271

Profile mood cardiac surgery patients as a potential factor in the postoperative period - preliminary

Ocena profilu nastrojów u chorych operowanych kardiochirurgicznie jako potencjalny czynnik wpływający na przebieg okresu pooperacyjnego - doniesienie wstępne

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Abstract. The patient's mood prior to and following the cardiac surgery has an impact on the recovery process. The study aimed to measure the level of mood states in a group of cardiac surgery patients. Furthermore, the purpose of the study was to evaluate the variations in mood states that occurred after the surgical intervention. The examination involved 47 subjects awaiting coronary artery bypass grafting and heart valve surgery, aged 41-77 yrs, including 12 females and 35 males. The participants completed the Profile of Mood States (POMS) by McNair, Lorr, Dropplemann. Moods were measured one day before the surgery and on the fourth day thereafter. Test scores indicate a significant reduction of confusion, tension and vigour. The level of fatigue increased, while the levels of anger and depression showed a tendency to decrease in the whole group. No significant differences in mood states were detected between male and female patients' scores prior to and following the surgery, except for friendliness. The level of friendliness after the operation was considerably higher in female subjects.
Keywords: cardiac surgery patients, mood states, sex

Streszczenie. Nastrój pacjentów zarówno w okresie poprzedzającym operację, jak i następującym po niej stanowi jeden z czynników wpływających na przebieg procesu rekonwalescencji. Celem przeprowadzonych badań było określenie stanów nastrojów w grupie pacjentów poddawanych operacjom kardiochirurgicznym. Badania zmierzały ponadto do ustalenia zmian, jakie zachodzą w poziomie stanów nastrojów po operacji. Badaniami objęto 47 pacjentów w wieku 41-77 lat oczekujących na wszczepienie pomostów aortalno-wieńcowych, a także sztucznych zastawek serca - 12 kobiet i 35 mężczyzn. W badaniach zastosowano Profil Nastrojów (POMS) McNair, Lorr i Droppleman. Pomiaru nastrojów dokonywano w dniu poprzedzającym operację i w czwartej dobie po operacji. Po przeprowadzeniu operacji w porównaniu z okresem przedoperacyjnym w całej grupie nastąpiło istotne zmniejszenie zakłopotania, napięcia i wigoru oraz zwiększenie poziomu znużenia. Na poziomie tendencji odnotowano zmniejszenie poziomu gniewu i przygnębienia. Nie stwierdzono istotnych różnic między kobietami i mężczyznami w badanych stanach nastrojów zarówno przed operacją, jak i po niej, poza życzliwością. Była ona istotnie większa u kobiet po operacji.
Słowa kluczowe: pacjenci kardiochirurgiczni, stany nastrojów, płeć

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Introduction

Cardiovascular diseases belong to conditions whose development is considerably determined by both biological and psychosocial factors.

Myocardial infarction, cardiac surgery and hospitalization lead to serious psychological stress, which is accompanied by strong emotional reactions [1-3]. They not only indicate the level of patient adaptation during hospitalization, but also belong to factors affecting the physical health before and after surgery [1]. The clinical picture of many diseases includes emotional disorders. Due to their chronic or recurrent nature, they pose a serious social and economic problem. Stress reactions and anxiety of various degrees of severity and of different causes have a huge impact on the psychophysical health [4]. Emotional or behaviour disorders are most often observed in cardiac surgery patients of all ages in the postoperative period [2]. The condition determining the duration of hospitalization and the rate of return to psycho-physical fitness is a good co-operation after surgery and lack of mental disturbances. Patients undergoing surgery are elderly, with a long history of disease and increased operational risk. These people have multiple co-morbidities various psychological problems. Among patients aged 75 years there are often single persons without any psychological support and assistance of family in the rehabilitation process [2]. Cardiac surgical procedure related to the opening of the chest (median sternotomy) is a frightening and often traumatic experience [2,5], which may trigger the symptoms of post-traumatic disease during treatment in the ICU [6]. Its consequences may include sleep disorders, nightmares, depression, frequent mood swings and feeling of guilt [6]. Emotional response syndrome, which is a reaction to a difficult situation, can be observed after surgery. Prolonged (associated with cardiac arrest) or short-term cerebral ischemia occurring during cardiac surgery may result in neurological disorders and cause neuropsychological deficits [7]. Fear related to pain after cardiac surgery, dismay, lack of immediate improvement of the functioning, a need to follow recommendations related to the change of lifestyle, as well as a slight reduction of contact with family trigger certain emotional responses and behaviour. It is most often manifested in the form of mood swings (crying, grief), lack of psychomotor drive, aversion to activity and any co-operation with the medical staff [2,8]. Due to its prevalence, myocardial infarction is not only a medical, but also psychological and social problem. It is well known that emotions play an important role in the recovery process. Emotional stimuli (positive and negative) have a specific directional effect on the activity of the heart. People constantly experience emotions and feelings which influence their perception of the world, as they contribute to their behaviour and reactions. Negative emotions can have dangerous consequences for the patient's condition, especially early in the treatment of myocardial infarction [3]. Studies in patients treated due to cardiac diseases demonstrated that preoperative education allows patients to better understand their disease, treatment strategy and its effects. By reducing stress, it improves treatment results [3,9]. The studies point out the importance of psychological factors in the occurrence and course of myocardial infarction. The occurrence of anxiety and depression in patients with acute myocardial infarction seems a significant factor delaying the healing process both in the early and late period, also hindering patient adaptation to a normal life after leaving the hospital [3,10]. In the 17th century, William Harvey emphasized the importance of emotions for a serious cardiac risk, including death. In contrast, William Osler in 1897 observed a relationship between the psychological construction, behaviour and coronary heart disease. The INTER-HEART study has demonstrated that psychosocial factors are independent risk factors for cardiovascular diseases [11]. The main cause of death in industrialized societies is ischemic heart disease. Numerous studies have shown that emotional stress has an impact on morbidity and mortality related to this disease [12].

Mood can be defined as a short-term or long-term emotional state affecting the psyche. It is subject to fluctuations depending on external and internal factors [13]. As a trait of character, temperament makes a person prone to certain moods. Mood disorders can also be observed. Physiological mood swings show a wide range of possibilities (from joy to sadness). Quantitative intensification of mood, not always adequate to the actual situation, is observed in disease states [13].

Aim of the study

The aim of the study was to determine changes of the level of mood states in patients undergoing cardiac surgery. It also aims to establish their differentiation according to gender.

Material and methods

The study involved 47 subjects awaiting coronary artery bypass grafting and heart valve surgery, aged 41-77 years, including 12 females and 35 males. The average age was 66.58 years for women and 62.74 years for men. The participants completed the Profile of Mood States (POMS) by McNair, Lorr and Dropplemann, in the Polish adaptation by Dudek and Koniarek (1987). The scale contains 65 adjectives defining different states and moods, possibly experienced by respondents. It allows the assessment of the seven states of mood - 5 negative and 2 positive. It was used twice: on the day before the operation and on the fourth postoperative day.

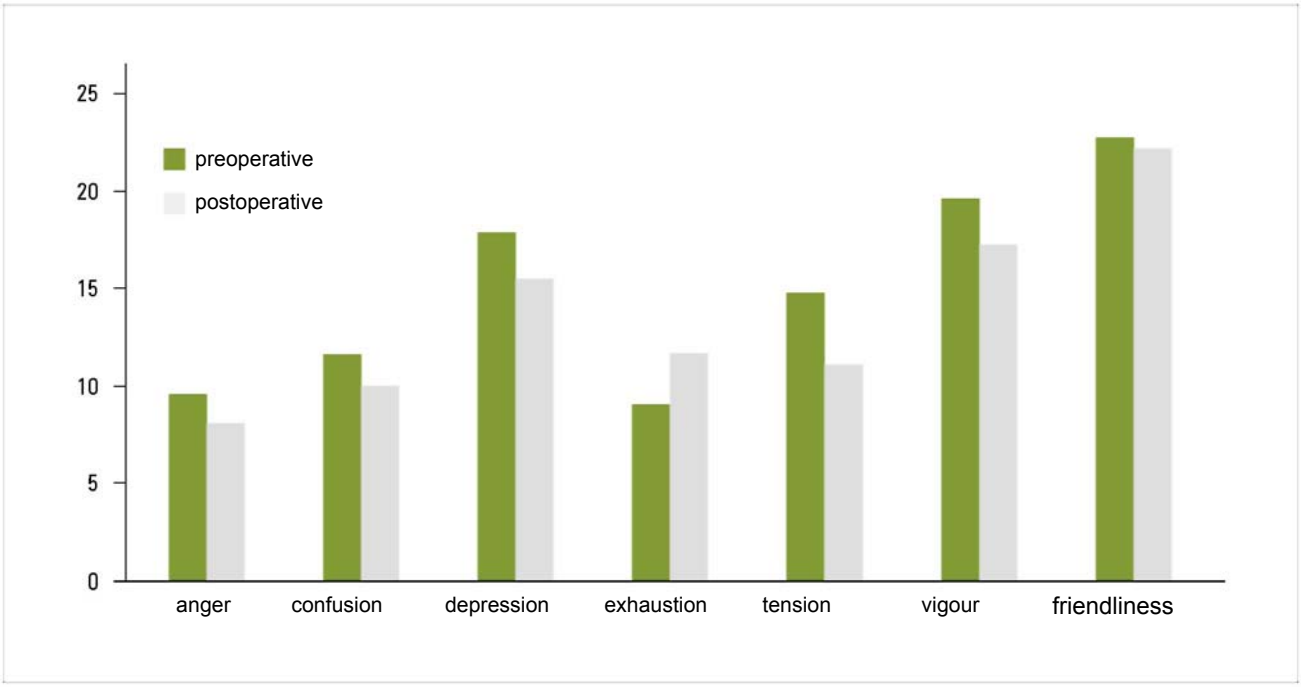

Figure 1. The change of mood states in the whole group

Rycina 1. Zmiany stanów nastrojów w całej grupie

Results

Changes of mood states in the whole group are shown in Figure 1. The significance of differences in the measurements was assessed using the Student's t-test for dependent samples. Compared to the preoperative period, there was a significant reduction of confusion (t = 2.354, p = 0.023), tension (t = 3.051, p = 0.004) and vigour (t = 2.792, p = 0.008) in the study group after surgery. There was a significant elevation of the level of fatigue (t = 2.344; p = 0.023). As regards trends, a reduction of anger (t = 1.959; p =0.056) and depression (t =1.910; p =0.062) was observed.

There were no significant differences between men and women in the states of mood studied both pre- and postoperatively, beyond friendliness in the postoperative period (t = 2.433; p = 0.019), the level of which was significantly higher in women.

In the group of men, there was a substantial reduction of tension in the postoperative period, whereas the reduction of depression and vigour and increase in fatigue was maintained at the level of trends (Tab. 1). Changes in the group of women were more pronounced. There was a significant decrease in anger, confusion and vigour, while reduction of tension reached the level of trend (Tab. 2).

Table 1. The change of man's mood states
Tabela 1. Zmiany stanów nastrojów u mężczyzn

measurement	before		after		Student's t-test	
mood state	M	SD	M	SD	t	P
anger	9.54	6.142	8.71	7.098	0.936	0.356
confusion	11.46	4.773	10.46	4.883	1.313	0.198
depression	17.14	10.373	14.60	10.118	5.266	0.066
exhaustion	8.86	5.72	10.86	5.72	0.368	0.090
tension	14.51	8.248	11.09	7.648	6.377	0.024
vigour	18.51	5.187	16.80	6.14	3.653	0.081
friendliness	22.20	3.17	21.34	3.531	2.079	0.163

Discussion

The results show significant changes of mood states in the postoperative period in patients undergoing coronary bypass grafting and artificial heart valve implantation. Most of the observed changes indicate improvement of the psychological well-being compared with the preoperative period. The observed decrease in the level of vigour and increased fatigue

Table 2. The change of woman's mood states
Tabela 2. Zmiany stanów nastrojów u kobiet

measurement	before		after		Student's t-test	
mood state	M	SD	M	SD	t	P
anger	9.67	7.487	6.25	6.326	2.449	0.032
confusion	11.92	4.144	8.67	7.114	2.450	0.032
depression	19.67	11.388	17.83	14.603	0.617	0.550
exhaustion	9.58	5.248	13.92	7.681	1.585	0.141
tension	15.33	6.243	11.00	10.322	2.035	0.067
vigour	22.50	4.275	18.25	6.510	2.423	0.034
friendliness	23.92	2.937	24.25	3.696	0.277	0.787

probably resulted from the physical burden due to a substantial interference with its functioning. It can be expected that over time the level of vitality will increase. Changes suggesting improvement of the emotional well-being will also be observed.

The results are consistent with the findings of previous studies. Saitoh et al. [14], using the POMS questionnaire, found a significant improvement of mood in patients who had undergone cardiac surgery (10 days after the operation), compared to the preoperative period. Favourable changes were less pronounced in elderly patients and those with postoperative complications. Hermele et al. [9] assessed the level of mood and coronary artery bypass grafting in a group of 56 patients. The showed a significant association between mood and disease (anger and depression) and insignificant relationship for tension.

The analysis of the studies carried out by Rankin [15] demonstrated that in the group of all patients after cardiac surgery, there were fewer mood disorders, with the exception of anger. There were differences in the studied states of mood between women and men. In the group of women, lower scores were observed for tension, anger and depression compared to men, in whom these values were higher.

Perkins and Jenkins [16] studied 90 adult, previously professionally active, patients undergoing cardiac surgery. The authors demonstrated a significant improvement of the mood, diagnosed using the POMS, within two weeks. In contrast, Crumlish [17] did not observe in his studies any significant changes of mood states following cardiac surgery. Similarly, Hedges and Redeker [18] in the studies of patients undergoing coronary artery bypass grafting both with and without the use of extracorporeal circulation, did not observe any significant differences in mood disorders between groups. Fukuoka et al. [19] obtained higher scores in POMS, with the exception of anger and confusion, among patients after myocardial infarction and CABG. Bennet et al. [20] demonstrated a correlation in the scale for fatigue (on day 4 after surgery or later) in cardiac surgery patients. Wrześniewski and Włodarczyk [21] conducted studies among men after the first myocardial infarction with pain, who were undergoing rehabilitation. There was a reduction in the level of anxiety associated with the disease, and improvement of mood and subjective assessment of health. Simultaneously, the increase in fatigue and some subjectively assessed symptoms (pain, lack of energy, locomotor limitation) was observed.

Wrześniewski et al. [3], when exploring a relationship between the ways of coping with stress and mood states, examined men after their first myocardial infarction. Results obtained by these authors suggest that patients from the group of subjects poorly focused on the task are more often depressed after myocardial infarction than patients strongly focused on the task. Patients strongly focused on their emotions more often experience anxiety, tension, despondency, depressed mood and fatigue. Avoiding any signals associated with stress can aggravate it, resulting in confusion and depression. These findings suggest that further studies of mood changes in cardiac patients should include, as mediating variables, their preferences for ways of coping with stress, as well as the permanent personality traits such as self-efficacy [16].

Conclusion

Changes in mood states during the postoperative period are not clear. Both deterioration and improvement of psychological well-being was observed. A great variability of mood states requires further research in diverse groups of subjects.

References

1. Łosiak W. Situations and individual conditioning of the changes in emotional response of surgical patients. Przegl Lek, 1994; 51: 329-332
2. Zielińska D, Garlicki M. Emotional and behaviour disorders in postoperative patients aged over 75 years operated on due to coronary heart disease. Probl Lek, 2004; May-August: 93-96
3. Wrześniewski K, Skuza B, Buczyńska R, Kolodziejek J. Styles of coping with stress and emotions of patients after myocardial infarction. Pol Tyg Lek, 1994; T. XLIX: 596-598
4. Skórzyńska H, Pacian A, Wojtowicz-Chomicz K, et al. The impact of the disease on the psychological well-being of patients. Zdr Publ, 2005; 115: 510-512
5. Rogowski J, Jarmoszewicz K, Siondalski P, Pawlaczyk R. Postoperative care after cardiac surgery. Folia Cardiol Exc, 2006; 1: 457-464
6. Kucewicz E, Czech B, Wojarski J, et al. Evaluation of the results of treatment in intensive care units based on the quality of life of patients in a few months after hospitalization - reflections on the basis of a review of the literature. Anestezjol Intens Ter, 2002/1: 27-30
7. Krzyżanowska E, Friedman A. Neuropsychological disorders in patients after cardiogenic cerebral hypoxia. Neuropsychiat Neuropsychol, 2012; 7: 26-34
8. Wożakowska-Kaplon B, Barylski M, Salwa P, et al. Guidelines for dyslipidemia - proposed algorithm for family doctors. Family Medicine Forum 2012; 6: 261-282
9. Hermele S, Olivo E, Namerow P, Oz M. Illness representations and

psychological distress in patients undergoing coronary artery bypass graft surgery. Psychology, Health & Medicine, October 2007; 12(5): 580-591
10. Sitnik K, Michalak A, Trzciniecka-Green A, et al. The role of psychological intervention in improving mental and physical health of patients early after acute myocardial infarction - a pilot study. Ann Acad Med Siles, 2006, 60,5:416-421
11. Sobczak M, Kasprzak J, Drygas W. Psychocardiology - the introduction of a new scientific field. Kardiol Pol, 2011; 69, 8: 838-843
12. Cristea I, Sucala M, Stefan S, et al. Positive and negative emotions in cardiac patients: the contributions of trait optimism, expectancies and hopes. Cognitie, Creier, Comportament/Cognition, Brain, behaviour, 2011; 3: 317-329
13. Bilikiewicz A. Psychiatry. Handbook for students. Warszawa, PZWL, 2003
14. Saitoh K, Kobayashi N, Ueshima K, et al. The effects of aerobic training on the emotional response in patients who underwent cardiac surgery. Kyobu Geka, 2000; 53 (9): 742-746
15. Rankin S. Differences in recovery from cardiac surgery: A profile of male and female patients. Heart & Lung, 1990; 19:481- 485
16. Perkins S, Jenkins LS. Self-efficacy expectation, behaviour performance, and mood status in early recovery from percutaneous transluminal coronary angioplasty. Heart Lung, 1998; 27 (1): 37-46
17. Crumlish CM. Coping and emotional response in cardiac surgery patients. West J Nurs Res, 1994; 16 (1): 57-68
18. Hedges C, Redeker N. Comparison of steep and mood in patients after on-pump and off-pump coronary artery bypass surgery. Am J Crit Care, 2008; 17: 133-140
19. Fukuoka Y, Lindgren T, Rankin S, et al. Cluster analysis: a useful technique to identify elderly cardiac patients at risk for poor quality of life. Qual Life Res, 2007;16:1655-1663
20. Bennet S, Puntenney P, Walker N, Ashley N. Development of an Instrument to Measure Threat Related to Cardiac Events. Nursing Research, 1996; 45 (5): 266-270
21. Wrześniewski K, Włodarczyk D. Coronary heart disease. Psychological aspects of treatment and prevention, psychosomatics. Gdansk, Gdansk Psychological Publisher, 2004
22. Dudek B, Koniarek J: Adaptation of test by D. M McNair, M. Lorr, L. F. Droppleman - Profile of Mood States (POMS). Przegląd Psychologiczny, 1987; t. XXX: 3]

Acute upper limb ischaemia in Maidan defenders caused by high velocity gunshot wounds

Ostre niedokrwienie kończyn górnych powstałe w wyniku ran postrzałowych zadanych z karabinu wyborowego u obrońców ukraińskiego „Majdanu”

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Abstract. In this article we present two patients, citizens of Ukraine, who were shot by snipers during the uprising at Independence Square in Kiev. Early clinical diagnosis of acute limb ischaemia was confirmed by diagnostic imaging. Emergency surgical procedures enabled complete revascularization with good outcome.
Key words: acute limb ischaemia, sniper rifle, Maidan

Streszczenie. Artykuł przedstawia przypadki dwóch pacjentów, obywateli Ukrainy, którzy w trakcie walk na Placu Niepodległości w Kijowie zostali trafieni przez snajperów, doznając ran postrzałowych kończyn górnych. Wczesne rozpoznanie kliniczne ostrego niedokrwienia, potwierdzone badaniami obrazowymi, pozwoliło na szybkie wdrożenie odpowiedniego leczenia. Wykonane w trybie nagłym zabiegi rewaskularyzacyjne spowodowały przywrócenie prawidłowej perfuzji tkankowej i odzyskanie funkcji kończyn.
Słowa kluczowe: ostre niedokrwienie kończyn, karabin wyborowy, Majdan

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Introduction

In Poland, gunshot wounds are rare injuries, hence the experience of physicians in managing such wounds is limited. In peace time, shotgun wounds such as sniper rifle, hardly ever occur. Understanding of the complex mechanism of this type of injury is necessary for effective diagnostic and therapeutic procedures. As part of the Polish Government's international aid for the Ukrainian people, in February and March 2014, 22 young men, citizens of Ukraine engaged in the struggle at the Kiev's Independence Square were admitted to the 4th Military Hospital in Wroclaw. During the segregation of patients in the hospital emergency department, acute upper limb ischaemia was observed in two men with provisionally dressed gunshot wounds. Both patients were shot by snipers. On admission, they were conscious, and cardiovascularly and respiratorily stable.

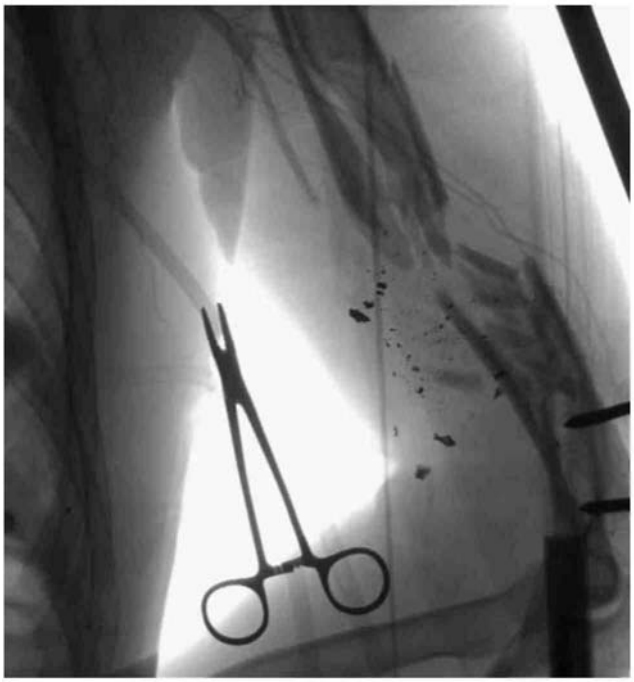

Figure 1. Arteriography (DSA) of left upper limb before surgery revealed occlusion of brachial artery and multiple fracture of humerus stabilized with external fixation

Rycina 1. Arteriografia (DSA) lewej kończyny górnej przed operacją. Widoczna niedrożność tętnicy ramiennej oraz wieloodtamowe złamanie kości ramiennej zaopatrzone stabilizatorem zewnętrznym

Figure 2. Arteriography (DSA) of left upper limb after reversed saphenous vein graft implantation

Rycina 2. Arteriografia (DSA) lewej kończyny górnej po wszczepieniu wstawki z odwróconej żyły odpiszczelowej

Case reports

The first patient, a 27-year-old man, while dressed in a bulletproof vest, suffered two penetrating gunshot wounds - in the torso and left arm. The injuries were managed in Kiev, in a field hospital provisionally organized in the hotel, where the patient underwent splenectomy and left-sided nephrectomy, suturing of the diaphragm and the right lung; two pleural drains were left. Because of comminuted fracture of the humerus, the left upper limb was supported using the external fixation. Physical examination revealed a significant swelling of the left upper limb, no palpable pulse in the arteries of the forearm, paresis and numbness of the hand, and loss of skin at the exit wound. Doppler confirmed arterial blood flow impairment. Selective arteriography using the femoral access (*digital subtraction angiography* - DSA) showed segmental occlusion of the left brachial artery at the level of 1/2 of the arm, at a length of about 10 cm (Fig. 1). In addition, comminuted fracture of the humerus and several small metallic foreign bodies, probably sherds, were revealed. A longitudinal incision was used to get access to the brachial artery; no disruption of the blood vessels was revealed. The brachial artery was bruised at a length of approximately 10 cm, entirely filled with a blood clot. Rupture of the fascia and muscles of the arm, and numerous bone fractions were found. The damaged section of the vessel was removed within the unchanged tissue, and the vascular lumen was revised using the Fogarty probe, obtaining a satisfactory blood inflow and outflow. The vessel continuity was restored using a reversed saphenous vein graft. The control arteriography confirmed the effectiveness of the procedure (Fig. 2). Fasciotomy was performed due to the significant swelling of the tissues of the left forearm. In the following days, improvement of the local condition of the limb was observed. Due to the continuing paresis, the patient was consulted neurologically and EMG was performed; axonal injury of the median and radial nerves was diagnosed. After a week of hospitalization, a massive necrectomy of the exit wound area was performed in the patient due to extensive soft tissue necrosis of the left arm. After obtaining a satisfactory general and local condition and control of infection foci, the patient was transferred to the orthopaedic department for further treatment.

The other patient, a 32-year-old man suffered a blank gunshot wound of the abdomen and a through gunshot wound of the left arm (Fig. 3). In a field hospital in Kiev, the injury of the bladder was managed leaving cystostomy, and the brachial artery torn by a missile was anastomosed end-to-end. At the time of admission to the department, the physical examination revealed moderate cooling and pallor of the limb and lack of a

Figure 3. Entry wound and postoperative wound after primary procedure

Rycina 3. Rana wlotowa oraz pooperacyjna - miejsce pierwotnego zaopatrzenia uszkodzonej tętnicy

Figure 4. Arteriography (DSA) of left upper limb before surgery revealed occlusion of brachial artery

Rycina 4. Arteriografia (DSA) lewej kończyny górnej przed operacją. Widoczna niedrożność tętnicy ramiennej

clearly perceptible pulse on the forearm arteries. The patient also reported dysesthesia increasing for a few hours and abnormalities of the active motion of the forearm and hand. Doppler confirmed arterial blood flow impairment. Selective arteriography using the femoral access (DSA) showed segmental occlusion of the left brachial artery at the level of distal 1/3 of the arm, at a length of about 6 cm (Fig. 4). After the initial surgical procedure the wound was revised, reaching the place of the brachial artery reconstruction using the end-to-end technique. It was found that the artery was bruised over a length of about 10 cm. The damaged and filled with a blood clot section of the vessel was removed, and the vascular lumen was revised using the Fogarty probe, obtaining a satisfactory blood inflow and outflow. The vessel continuity was restored using a reversed saphenous vein graft. The control arteriography confirmed the effectiveness of the procedure (Fig. 6). After waking, the patient reported almost complete relief of symptoms in the limb. Until discharge from the surgical department, the patient presented characteristics features of the ulnar nerve dysfunction, manifested as hypoesthesia of three fingers from the cubital side.

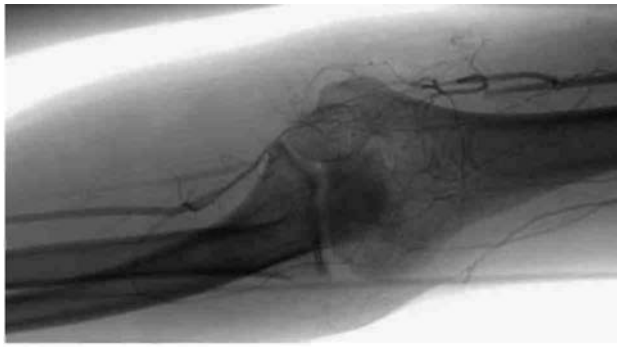

Figure 5. Reoperation - reversed saphenous vein graft is visible

Rycina 5. Operacja rewizyjna -widoczna wszczepiona wstawka z odwróconej żyły odpiszczelowej

Discussion

When considering the damage caused by the penetrating bullet, we should take into account several mechanisms [1]. The immediate effect is the formation of a gunshot channel and disruption of anatomical structures. The indirect effect is a cavity, resulting from rapid pressure changes and propagation of the high-pressure shock wave in the tissues. The surrounding tissues are crushed, and the extent of the damage can reach a multiple of the diameter of the gunshot channel made by the bullet [2]. Extensive damage of this type is particularly characteristic for shotgun, such as middle-caliber sniper rifles, hurling missiles with a kinetic energy of up to 6,000 J [3]. Such injuries are rare among the civilian population due to the very limited access to this type of weapon. Another mechanism of injury is the formation of bullet or bone shards resulting from bone fragmentation by a penetrating missile.

Figure 6. Arteriography (DSA) of left upper limb after reversed saphenous vein graft implantation

Rycina 6. Arteriografia (DSA) lewej kończyny górnej po wszczepieniu wstawki z odwróconej żyły odpiszczelowej

When managing a gunshot wound, we should take into account all the above factors and remember that the originally observed extent of the damage may over time significantly increase, involving the key anatomical structures, such as vessels and nerves.

In the case of gunshot injuries of the arteries, we can observe contusion by a shock wave or contusion and tearing the vessel by the bullet. Indirect damage to the arterial wall by a shock wave triggers the coagulation cascade and formation of a blood clot blocking the vessel lumen. During the reconstruction, we should ensure that the anastomosis involves the undamaged fragments of the artery. Otherwise, after anastomosis and transient improvement of limb blood flow, a clot will be formed at the site of anastomosis and acute limb ischaemia reappear. Grafts of the patient's own veins or vascular prostheses can be used to reconstruct arteries. Gunshot wounds are originally infected wounds [4], therefore, plastic materials should be used as a last resort, because they significantly increase the risk of a serious local infection or sepsis. If necessary, vascular prostheses impregnated with a germicide or silver coated are preferred. Note, however, that they are intended to prevent primary infection in the clean surgical field, and their potential usefulness in the originally infected field is questionable [5-7]. In the case of suspected compartment syndrome in the operated limb, it is necessary to perform fasciotomy as soon as possible, as it improves blood circulation in tissues and reduces the risk of infection [8].

The effectiveness of therapeutic procedures used in acute limb ischaemia caused by a gunshot wound depends on many factors. A long period of ischaemia, as well as comminuted fractures and extensive soft tissue and nerve damage significantly worsen both early and long-term effects of treatment.

References

1. Alexandropoulou CE, Panagiotopoulos EE. Wound ballistics: Analysis of blunt and penetrating trauma mechanisms. Health Science J, 2010; 4 (4): 225-236
2. Hollerman JJ, Fackler JL, Coldwell DM,Ben-Menachem Y. Gunshot wounds: 1. Bullets, ballistcs and mechanisms of injury. Am J Roentgenol, 1990; 155 (4): 685-690
3. Wolf YG, Rivkind A. Vascular trauma in high velocity gunshot wounds and shrapnel blast injuries in Israel. Surg Clin North Am, 2002; 82: 237-444
4. Petersen K, Riddle MS, Danko JR, et al. Trauma-related infections in battlefield casualties from Iraq. Ann Surg, 2007; 245 (5): 803-115
5. Hernśndez-Richter T, Schardey HM, Wittmann F, et al. Rifampin and Triclosan but not silver is effective in preventing bacterial infection of vascular dacron graft material. Eur J Vase Endovasc Surg, 2003; 26: 550-5576
6. Larena-Avellaneda A, Russmann S, Fein M, Debus ES. Prophylactic use of the silver-acetate-coated graft in arterial occlusive disease: a retrospective, comparative study. J Vase Surg, 2009; 50: 790-798
7. Ricco JB, Assadian 0. Antimicrobial silver grafts for prevention and treatment of vascular graft infection. Semin Vasc Surg, 2011; 24: 234-241
8. Farber A, Tan TW, Hamburg NM, et al. Early fasciotomy in patients with extremity vascular injury is associated with decreased risk of adverse limb outcomes: a review of the National Trauma Data Bank. Injury, 2012; 43 (9): 1486-1491

Casualty examination in tactical environment

Badanie poszkodowanego w środowisku taktycznym

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Abstract. Examination of casualty in tactical environment is performed on 3 levels according to danger zones. The first level-Care Under Fire (CUF) is the care of the injured under fire which consists of self-examination and self-diagnosis. The casualty locates injuries and tries to provide help himself. The role of a medic is to carry out examination at a distance, so-called *medicine cross barrier.* If it is possible to examine the patient it is done as TPA (tactical patient assessment). Second Phase-Tactical Field Care (TFC) is care of injured in a combat environment based on the extended posttrauma assessment taking into account the most common injuries in tactical environment. During the examination it is recommended to follow the scheme MARCHE (each letter represents steps and the criterion of conduct). Posttrauma assessment must take into account the spectrum of disciplines which limit realization (light, sound, equipment, time, etc.). TACEVAC -the third zone, which is tactical evacuation allows to perform a complete examination based on the standard PHTLS or ITLS during evacuation (MEDEVAC or CASEVAC) to the hospital, an outpatient facility or FST (Forward Surgical Team).

Key words: tactical examinations, casualty, selfaid, tactical environment, schema MARCHE, CUF, TFC.TACEVAC, medicine cross barrier

Streszczenie. Badanie poszkodowanego w środowisku taktycznym realizowane jest na trzech poziomach wynikających ze stref zagrożenia. Pierwszy poziom -*care under fire* (CUF), to opieka nad poszkodowanym pod ostrzałem, polegająca na samopomocy i autodiagnozie. Poszkodowany sam lokalizuje odniesione obrażenia i próbuje udzielić sobie pomocy. Rolą ratownika jest przeprowadzenie badania na odległość, tzw. medycyna zza zasłony. Jeśli możliwe jest zbadanie poszkodowanego, odbywa się ono na zasadzie TPA *[tacticalpatient assessment).* Druga faza - *tactical field care [IK),* to opieka nad poszkodowanym w warunkach bojowych, polegająca na rozszerzonym badaniu pourazowym, uwzględniającym obrażenia występujące w środowisku taktycznym najczęściej. Podczas badania zaleca się skorzystanie ze schematu MARCHE (każda litera oznacza odpowiednie czynności oraz kryterium postępowania). Badanie pourazowe musi uwzględniać spektrum dyscyplin ograniczających postępowanie (światło, dźwięk, sprzęt, czas i inne). TACEVAC -trzecia ze stref, czyli ewakuacja taktyczna-pozwala na wykonanie pełnego badania według standardu PHTLS lub ITLS w trakcie ewakuacji (MEDEVAC lub CASEVAC) do szpitala, ambulatorium urazowego bądź do FST (*forward surgical team).*

Słowa kluczowe: badanie taktyczne, medycyna zza zasłony, poszkodowany, samopomoc, schemat MARCHE, CUF, TFC, TACEVAC, środowisko taktyczne

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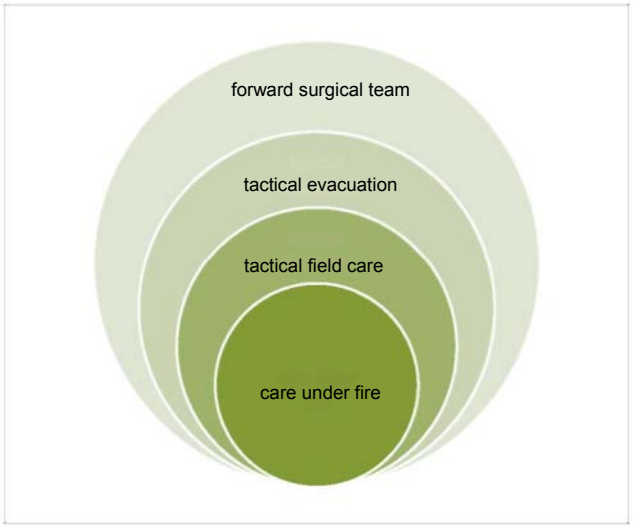

Figure 1. Threat of coming under fire in relation to aid zones. Source: Tomasz Sanak

Rycina 1. Gradacja zagrożenia kontaktem ogniowym w zależności od stref udzielanej pomocy. Źródło: Tomasz Sanak

Figure 2. Limitations on the example the light discipline with utilization of the blue color to visualize the bleeding. Source: Marek Dąbrowski

Rycina 2. Ograniczenia na przykładzie dyscypliny świetlnej z wykorzystaniem barwy niebieskiej w celu uwidocznienia krwotoku. Źródło: Marek Dąbrowski

Post-trauma examination

Main treatment areas and procedures which require particular focus in the assessment and treatment of a trauma casualty include, in order of importance: control of bleeding, ventilation, airway patency, oxygen saturation, perfusion and neurological function [1]. Regardless of whether the casualty suffered damage in civil conditions (vehicle accident) or as a result of an event in tactical environment (explosion of an improvised explosive device), the treatment will be based on similar procedures, which primarily protect the organism's ability to provide proper blood oxygenation, and prevent tissue hypoxia. Bleeding control, temporary in the field and permanent in the operating theatre, depends on the time in which the paramedics providing prehospital care will transport the casualty, as well as on the trauma team available immediately after arrival at the medical facility. Examination techniques for trauma patients in tactical environment must be strictly adjusted to the tactical situation (Figure 1) and should first and foremost consider the causes of the so-called avoidable deaths, which include massive limb haemorrhage (60% of cases), pneumothorax (30% of cases) and upper respiratory tract obstruction (10% of cases) [2].

The main purpose of treatment in different zones is to stop massive haemorrhaging according to the PHTLS (prehospital trauma life support) principle – every blood cell counts [1].

The unpredictable character of situations during rescue action may result in changing the order of individual procedures. This applies mostly to treatment in CUF, where time and environment often necessitate bleeding control (using tactical stasis) after quick localisation of wounds, even in limited visibility, with the use of appropriate light colours (comparison in Figure 2. and 3.), without careful assessment and proper procedures for the use of equipment [3].

Figure 3. Limitations on the example of the light discipline with the use of the color red to visualize the bleeding. Source: Marek Dąbrowski

Rycina 3. Ograniczenia na przykładzie dyscypliny świetlnej z wykorzystaniem barwy czerwonej w celu uwidocznienia krwotoku. Źródło: Marek Dąbrowski

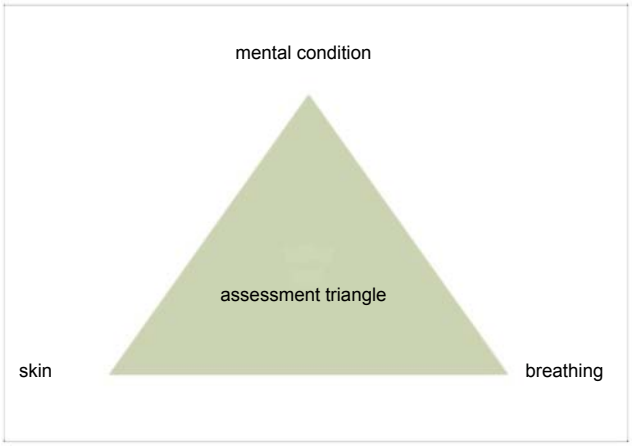

Figure 4. Assessment of casualty by observation of three parameters. Source: Tomasz Sanak

Rycina 4. Ocena poszkodowanego za pomocą obserwacji trzech parametrów. Źródło: Tomasz Sanak

Self-aid

A wounded operator should, thanks to many simulation trainings in tactical rescue, obtain self-aid skills in the CUF phase. As part of self-aid, a soldier should be able to self-diagnose massive haemorrhages and perform therapeutic procedures. TC3 guidelines state that 60% of avoidable deaths on the battlefield are due to massive limb haemorrhages. Therefore, in every situation when operator feels pain, numbness, loss of sensation or muscle tension in a limb, he or she should apply tactical stasis on the limb. The principle of using a tourniquet is to place it as high as possible, with the tourniquet on the inner part of the limb. After application of stasis, if the psychological and physical condition of the casualty allows it, the soldier should return to firing [4, 5].

Medicine cross barrier

In the CUF phase it is possible to examine casualties from a distance. This examination is dedicated to CQB (close quarters battle) situations, urban area and cases when approaching the casualty is impossible. The paramedic should first assess the tactical situation from a distance, and direct the casualty to a safe zone, providing vocal commands. The examination consists in observation considering three parameters of the injured patient (Figure 4) "Observation cross barrier" may be conducted through a sniper's scope to determine the largest possible number of details associated with the trauma. Using communication devices, the paramedic may also instruct the casualty and support his or her self-diagnosis and self-aid. It is also crucial to determine if the casualty shows vital functions. It is useful for the team which would evacuate the casualty from the battlefield [6].

Assessment triangle parameters

- **Mental condition** – the assessment should be focused on detection of movement and body position of the casualty, which help to determine the type of trauma. Evaluation of the course of the event (trauma mechanism) during which kinetic energy affected the organism allows one to anticipate injuries. In the case of explosion, the casualty's body is at risk of multiorgan injury. Penetration wounds in the case of small arms fire cause injuries of small surface, but high kinetic energy.
- **Breathing** – chest movement should be assessed on the basis of the movement of the tactical plates/vest of the casualty. If the tactical situation allows it, determination of the breath rate per minute will be useful. If the casualty breaths more than 30 times per minute, or less than 10 times, jugular veins are filled and there is a possibility of injuries due to small arms fire or explosion, chest wounds should be sought, and tension pneumothorax suspected.
- **Skin** – if the casualty is in close proximity to the source of fire or explosion, it should be assessed if blood stains are visible on the uniform. Each detection of blood traces may result in using tactical stasis by the casualty. The above procedures are suggested modifications of the assessment triangle, used also in the assessment of paediatric patients [7].

Tactical patient assessment

This type of examination should be performed in a safe zone of the tactical environment, so-called tactical field care. The aim of the tactical patient assessment (TPA) is to detect massive limb haemorrhages. The examination technique consists in so-called "limb raking" (Figure 5). With crooked fingers, paramedic verifies first the inner side of the lower limbs, starting with groins (large arterial vessels), then the anterior, lateral and posterior part. After examination of the lower limbs, the paramedic verifies the upper limbs, starting with the axillary fossa, the inner side of the limbs, then the anterior, lateral and posterior parts. Each time when an injury is detected (torn uniform parts, fingers "falling" into the tissue), even without visual contact, the paramedic should apply a tourniquet device on the limb. Confirmation of proper stasis is loss of pulse on the distal arteries of the limb. The next stage is chest control under the tactical vest, both in front and at the back. In relatively safe conditions, removing the vest is acceptable, but the casualty prepared for evacuation should still be wearing a vest for protection [8].

Figure 5. Palpation technique to detect massive bleeding in poor visibility. Source: Marek Dąbrowski

Rycina 5. Technika badania palpacyjnego w celu wykrycia masywnych krwotoków w warunkach ograniczonej widoczności. Źródło: Marek Dąbrowski

MARCHE

MARCHE examination is for casualties treated by qualified paramedics (Table). The name MARCHE derives from an acronym in which the letters refer to the elements of a test, starting with the highest priorities: M – massive bleeding, A – airway, R – respiratory distress, C – circulation, H – hypothermia management, E – everything else [9].

ITLS/PHTLS – post-trauma examination of the casualty

In the safe zone (or TFC/TACEVAC) the casualty is examined according to international procedures. The most frequently used are ITLS (International Trauma Life Support) and PHTLS (Prehospital Trauma Life Support).

The paramedic providing pre-hospital aid is bound by three priorities:

- assessment of the site of the event,
- assessment of the type of event – single or mass event (in the case of an event with a large number of casualties, implementation of TRIAGE, that is segregation and providing the best care possible to the largest number of patients),
- emergency procedure first applies to casualties whose health condition is considered the most serious; special attention should be paid to the casualties whose condition: a) may result in loss of life, b) may result in loss of limbs, and c) who are not at risk of death or loss of limbs.

Casualty assessment is usually divided into the preliminary (primary) and final (detailed) part. It takes into consideration earlier treatment elements, primarily associated with massive haemorrhage control, pneumothorax relief, or treatment of chest wounds and providing airway [10]. Discussed below are individual procedures and their order in casualty assessment:

- A - *airway management and cervical spine stabilization*,
- B - *breathing (ventilation*,
- C - *circulation and bleeding*,
- D - *disability*,
- E - *expose/environment* [11,12]

Steps

Airway patency with particular focus on stabilisation of the cervical spine. Always at the beginning of examination paramedics should manage the airway of the casualty or maintain and control patency provided previously. If necessary, using advanced methods of airway management should be considered (including intubation, if the paramedic's competence and skills allow it). While managing airway patency, the paramedics stabilise the head and cervical spine.

Step 2

Breathing and ventilation. The task of the paramedics is to assess the respiratory efficiency of the casualty. Respiratory efficiency assessment includes: determination of the breath rate measured in 10 seconds and multiplied by 6, which provides a result per minute, with simultaneous observation of chest movement (presence of paradoxical or asymmetrical movements). Moreover, if possible, saturation is measured (SpO_2) and chest auscultation/tapping is performed to exclude or confirm tension pneumothorax or hemothorax. In the case of tension pneumothorax and respiratory distress symptoms, needle decompression of the chest should be preformed immediately. In the case of prior pneumothorax relief, the condition of the casualty should be verified. If respiratory failure occurs, substitute ventilation is conducted and its quality is controlled. Open chest wounds should be secured with a tight dressing. In the case of saturation of <94%, oxygen therapy should be applied, depending on the condition of the casualty either using a passive or active technique.

Table. ***Casualty assessment*** **– MARCHE**

Tabela. ***Ocena poszkodowanego*** **– MARCHE**

massive bleeding	**bleeding control with tactical stasis**
airway	securing airway with the use of nasopharyngeal device, supraglottic systems, intubation or cricothyroidotomy/coniotomy
respiratory management	treatment of chest wounds with tight dressing or ventilated dressing dedicated in TCCC; performing thoracocentesis in respiratory failure
circulation **BIFT** **• bleeding control** **• IV/IO** **• fluid resuscitation** • *tourniquet removal*	another examination in order to detect sources of bleeding; placing at least one intravenous/intraosseous cannula, initiating fluid resuscitation, indicated in the case of loss of pulse in peripheral arteries; Hextend 500 ml is a recommended fluid, possible repetition of the 500 m dose after at least 20 minutes, change of tourniquets to haemostatic dressing ("packing the wound")
hypothermia	protecting the casualty against the loss of warmth, using systems of active body warming
head injury	diagnosis of cerebrocranial injuries; performing a neurological examination to diagnose traumatic brain injury (TBI)
eye injury	examination of the eyes
everything else ***(M*** – **PHAAT –** ***D)***	assessment of parameters with the use of available resources
• monitoring **• pain** **• head to toe** **• address all wounds** **• antibiotics** **• tactical evacuation preparation** • *documentation of care*	(pulse oximeter, cardiomonitor in medical evacuation vehicles, arterial blood pressure) analgesic treatment (morphine, fentanyl lollipop, ketamine) detailed examination head-to-toe, after undressing of the casualty administration of antibiotic in prehospital care. preparation for medical/tactical evacuation documentation of prehospital care

Step 3

Circulation and bleeding. First, it shold be verified if all the bleedings are controlled. If a fast examination is required, the pulse on the carotid artery and radial artery is measured. Absence of pulse on the radial artery signifies centralisation of the circulation, and the patient with this symptom should not wait for specialist care. To assess circulatory efficiency, arterial blood pressure should be measured, 3-lead ECG should be performed, filling of the jugular veins should be verified, as well as presence of cardiac tamponade by cardiac sound auscultation (measurement of arterial blood pressure and performing ECG usually is not possible in tactical conditions). If intravenous or intraosseous access is available, initiation of fluid resuscitation during preparation for transport and during the transport is considered.

Step 4

Assessment of consciousness and pupils. At this stage the patient's consciousness is assessed according to AVPU and/or GCS scale. Additionally, pupils reaction is assessed, PEARRL (pupils, equal and round reactive to light). If the cause of the loss of consciousness is unknown, the patient's glycaemia should be assessed.

Step 5

Examination of the entire body of the casualty. While undressing the casualty, it is important to maintain proper body temperature and cover the patient to protect the body against cooling. Post-traumatic head to toe examination is intended to find all the injuries. During this examination intravenous or intraosseous cannula is inserted, if possible. Limb instabilities (fractures) are also immobilised, and then the patient is prepared for transport. If any of these procedures could delay evacuation or transport, it is omitted [1, 10-14].

TACEVAC – tactical evacuation

During MEDEVAC evacuation of the casualty in a rescue helicopter or medical evacuation vehicle with emergency medical services, another post-traumatic examination should be performed. If the patient was passed by the rescue team to the aircraft, the craft personnel treats the casualty in the diagnostic process as a new patient, which requires collecting data about basic physiological parameters. MEDEVAC transport enables advanced monitoring of the casualty. While transporting intubated patients, the option of capnometry monitoring is crucial, as during transport respiratory sounds cannot be heard. Cardiac rhythm monitoring (especially in unconscious patients) is an important diagnostic and prognostic element in the assessment of hypovolemic shock. During ECG monitoring it is important to control the cardiac rhythm and haemodynamic response (measuring the pulse on the carotid arteries). It is the authors' belief that every casualty with cardiac arrest and pulseless electrical activity (PEA) or asystole should undergo resuscitation procedures. Although the above thesis is contrary to TC3 guidelines, in case the journey to hospital with surgical treatment is reduced to a few minutes, the prognosis of patients significantly improves, especially if the cardiac arrest is associated with PEA [15].

Conclusions

Proper preparation of a paramedic for providing aid in combat conditions is the key challenge for the educational system and the legal regulations associated with performing this profession in Polish Military Contingents. Appropriate examination of the casualty in tactical conditions is one of the most important procedures, focused on the treatment of a post-trauma patient on the battlefield. Paying attention to a catalogue of risks and causes of injuries different from civil ones is the key factor indicating proper procedures.

Awareness of the tactical field care procedures, and primarily the ability to properly examine the casualty depending on the zone in which aid is provided are most important elements in the treatment of trauma causing avoidable deaths in tactical environment.

The USA Army Medical Department (USA AMEDD) each year spends significant amounts on individual equipment for soldiers, including paramedics [16]. In the last 10 years, the process of preparation of Polish soldiers participating in Polish Military Contingents (IPMED project), as well as equipment for paramedics also changed radically. It contributed to a reduction in mortality and increased safety of soldiers and special unit police officers participating in tactical field actions [17].

References

1. National Association of Emergency Medical Technicians. Prehospital Trauma Life Support: Military Version. St. Louis, Mosby Elsevier, 2007: 501-519
2. Savage E, Forestier C, Withers N, et al. Tactical combat casualty care in Canadian forces: lessons learned from the Afghan War. Can J Surg, 2011; 54 (6 Suppl.): 118-123
3. Committee on Tactical Combat Casualty Care: Tactical Combat Casualty Care Guidelines. Government Printing Agency, Washington 30 August 2013
4. Butler FK, McSwain NE. Introduction to tactical combat casualty care. In: National Association of Emergency Medical Technicians. Prehospital Trauma Life Support: Military. St. Louis, Mosby Elsevier, 2010; 451-459
5. Butler FK, Hagmann J, Butler ER. Tactical combat casualty care in special operations. Mil Med, 1996; 161 (Suppl.): 3-16
6. Lakstein D, Blumenfeld A, Sokolov T, et al. Tourniquets for hemorrhage control on battlefield: a 4-year accumulated experience. J Trauma, 2003; 54 (5 Suppl.): 221-225
7. Sanak T, Dąbrowski M. Based on unpublished interview with Thomas G. LeClair, CD, BA, A-EMCA, ACP, DMS, EMT-T (Adv.) Special Operations Paramedic Ontario, Canada. TCCC -TPA- Tactical Patient Assessment - new recommendation from SOMA. Accessed: 19.12.2013
8. Hansen M, Spiro D. Teaching the pediatric assessment triangle using online video cases. Ann Emerg Med, 2013; 62 (5 Suppl.): 172
9. SanakT, Dąbrowski M, Kluj P, et al. Specyfika udzielania pierwszej pomocy medycznej w warunkach bojowych w środowisku taktycznym na bazie standardu TCCC. Część II. Zapewnienie hemostazy miejscowej podczas wykonywania zabiegów ratowniczych w fazie taktyczno-bojowej opieki nad poszkodowanym na bazie standardu TCCC. [Specificity of providing first aid in tactical field care, based on the TCCC standard. Part II. Providing haemostasis while performing emergency procedures in tactical field care over the casualty, based on the TCCC standard] Anestezjologia i Ratownictwo, 2013;3:356-363
10. Koszowski M. Badanie pacjenta urazowego. Na ratunek. [Trauma patient examination. For rescue] Elamed, 2007: 44-46
11. Sinz E, Navarro K, eds. ACLS for Experienced Providers. American Heart Association 2013: 13-23
12. Nolan JP, ed. Wytyczne resuscytacji 2010. [Resuscitation guidelines] Cracow, Wydawnictwo Europejska Rada Resuscytacji i Polska Rada Resuscytacji, [European Resuscitation Council and Polish Resuscitation Council]2010: 75-79, 108-131
13. Cambell JE,ed. International Trauma Life Support - Ratownictwo przedszpitalne w urazach. [International Trauma Life Support - Prehospital emergency services in trauma] Cracow, Medycyna Praktyczna, 2009: 15-32
14. http://www.operationalmedicine.org/TextbookFiles/FMST_2008/FMST_1420.htm United States Marine Corps, Perform Casualty Assessment, Available at: www.operationalmedicine.org, access: January 15, 2014
15. American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care.

Circulation, 2010; 122: 640-656
16. Parsons DL. Battlefield medicine: A new perspective. Infantry, 2004; 3:16-17
17. Dąbrowski M, Sanak T, Kluj P, et al. Specyfika udzielania pierwszej pomocy medycznej w warunkach bojowych w środowisku taktycznym na bazie standardu TCCC. Cz. 1. Przyczyny zgonów oraz odmienności w postępowaniu z poszkodowanym w warunkach bojowych w środowisku taktycznym na bazie standardu TCCC. [Specificity of providing first aid in tactical field care, based on the TCCC standard. Part I. Causes of death and different treatment of casualties in tactical field care, based on the TCCC standard] Anestezjologia i Ratownictwo, 2013; 2: 226-232

The possibility of endoscopic ultrasonography in the diagnosis and treatment of pancreatic pseudocysts

Możliwości diagnostyczno-terapeutyczne torbieli rzekomych trzustki w endoskopowej ultrasonografii

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Summary. Pancreatic pseudocysts are a common complication of both acute and chronic pancreatitis. Most pancreatic pseudocysts are located within the head and the body of the pancreas, but 20% of them are extrapancreatic - pleura, pelvis, spleen and liver. The indication for treatment of pseudocyst is the presence of clinical symptoms and complications. The treatment options for this entity are dictated by the severity of symptoms, the size of the pseudocyst, the ductal anatomy, and the surgical expertise available. Surgical drainage using open laparotomy or percutaneous drainage were the chosen treatment options. In most of the cases open surgical drainage should be reserved for patients in whom pancreatic necrosis, abscess, hemorrhage, or rupture of pseudocyst occurs. EUS plays a major role in evaluating cystic lesions of the pancreas. EUS-guided drainage of symptomatic pancreatic pseudocysts is currently considered a good choice of management in expert centers, with low rates of morbidity and mortality. The use of color-Doppler avoids the accidental puncture of intervening vessels. The correct positioning of the needle in the lesion is monitored in real time, intervening vessels are also visualized to avoid accidental puncture. Transmural drainage using approach endoscopic ultrasound guidance is a technically feasible, minimally invasive, and safe procedure for drainage of pancreatic pseudocyst.
Keywords: endosonography, pancreatic pseudocyst, endoscopic drainage, endoscopic ultrasound fine needle aspiration

Streszczenie. Torbiele rzekome trzustki są częstym powikłaniem ostrego zapalenia trzustki, ale mogą się również pojawiać w wyniku przewlekłego zapalenia trzustki. Większość torbieli rzekomych znajduje się w głowie i trzonie trzustki, ale 20% z nich ma lokalizację pozatrzustkową - w opłucnej, miednicy małej, w okolicy śledziony i wątroby. Wskazaniem do leczenia torbieli rzekomej jest występowanie objawów klinicznych i powikłań. Leczenie jest podyktowane stopniem nasilenia objawów, wielkością torbieli, rodzajem powikłań oraz doświadczeniem i preferencjami danego ośrodka. W leczeniu torbieli rzekomych trzustki nadal wykorzystuje się takie techniki chirurgiczne, takie jak laparotomia i drenaż przezskórny, ale w większości przypadków leczenie to powinno być zarezerwowane dla pacjentów z zakażoną martwicą trzustki, ropniami, krwotokiem czy pęknięciem torbieli. Ultrasonografia endoskopowa (EUS) odgrywa bardzo istotną rolę w diagnostyce zmian torbielowatych w trzustce. Drenaż pod kontrolą EUS jest obecnie uważany za najlepszą metodę terapeutyczną, zalecaną przez uznane ośrodki eksperckie w związku z małymi wskaźnikami śmiertelności. Użycie w EUS kolorowego dopiera pozwala uniknąć przypadkowego nakłucia naczyń krwionośnych. Prawidłowe pozycjonowanie igły w torbieli jest monitorowane w czasie rzeczywistym, co pozwala uniknąć nakłucia innych struktur. Przezścienny drenaż torbieli rzekomej trzustki pod kontrolą ultrasonografii endoskopowej jest zabiegiem technicznie wykonalnym, mało inwazyjnym i bezpiecznym dla pacjenta.
Słowa klucze: endosonografia, torbiel rzekoma trzustki, drenaż endoskopowy, biopsja pod kontrolą EUS

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Figure 1. Pseudocyst in the head of the pancreas in endosonography

Rycina 1. Obraz endosonograficzny torbieli rzekomej w głowie trzustki

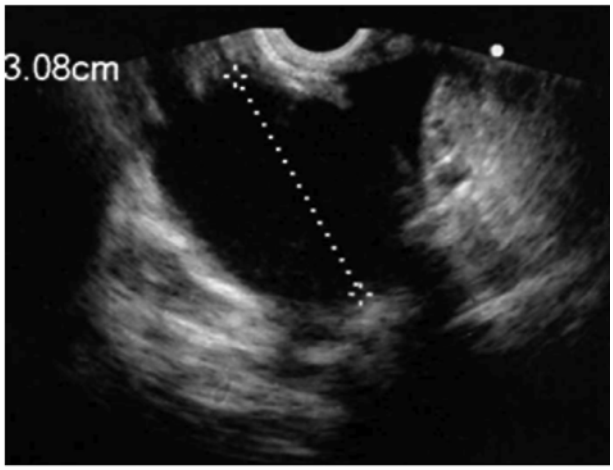

Figure 2. Pseudocyst in the body of the pancreas in endosonography

Rycina 2. Obraz endosonograficzny torbieli rzekomej w trzonie trzustki

A pancreatic cyst is a pathological collection of fluid, located in the pancreas or directly adjacent. Cysts are single or multiple, they have a baggy shape and different diameters, ranging from a few millimeters to several dozen centimeters [1]. In a classic division of pancreatic cysts, according to the internal layer, cysts and pseudocysts are distinguished. Cysts are lined with epithelium, in contrast to psudocysts, whose lining cannot be determined as epithelial.

Pseudocysts are not neoplasms, and they develop from acute peripancreatic fluid collections which survived at least 4 weeks after an episode of acute pancreatitis. Pancreatic pseudocysts are a common complication after acute pancreatitis, but they may also occur as a result of chronic pancreatitis. Most pseudocysts are located in the head (Figure 1) and body (Figure 2) of the pancreas, but 20% are extrapancreatic: in the pleura, pelvis, spleen and liver. A few cases of pancreatic cysts in the mediastinum have also been described in the literature [2].

Pseudocyst is a collection of fluid enclosed by a wall, filled with fluid content without necrotic masses. The pseudocyst wall resembles a bag made of fibrous connective tissue; from the inside it is built from granulation tissue. The fluid filling the cyst is usually sterile. Clinical symptoms of pseudocysts are usually associated with its size and pressure on the adjacent organs. The most frequently reported problems include: abdominal pain, nausea, vomiting, early feeling of fullness, chest pain, pseudoachalasia symptoms and reduced body weight [3].

Due to the progress in modern imaging techniques, pancreatic cystic lesions are increasingly often diagnosed in clinical practice. In approximately 20% of patients who undergo imaging examinations (ultrasound, computed tomography, magnetic resonance, endosonography) pancreatic cysts are detected by chance, and autopsy examinations confirm their presence in 24% of patients [4]. Most of pancreatic cystic lesions, approximately 75%, are pseudocysts; ca. 10% of the pancreatic cystic lesions may be neoplastic cysts. Therefore, it is necessary to differentiate pseudocysts from cystic tumours, which is possible after endoscopic ultrasound fine needle aspiration (EUS-FNA) with diagnostic examination of the fluid (Figure 3) [5].

Pancreatic pseudocysts are found in 7-15% of acute pancreatitis cases, and in 20-25% of chronic pancreatitis patients [6]. Considering the etiology of the inflammation, pseudocysts most often occur in patients with alcohol-induced pancreatitis (60-80% of patients). As a result of biliary pancreatitis, pseudocysts arise in 5-35% of patients, as a consequence of idiopathic pancreatitis in 6-20% of patients, and after pancreas injury in 3-8% of patients. Over 50% of pseudocysts are spontaneously absorbed, but in 5-40% of cases complications may occur (Table) [7].

Cysts of <4 cm in diameter in most cases are absorbed, whereas 75% of lesions of >10 cm in diameter require drainage treatment [8].

In diagnostics, cystic lesions of the pancreas should be considered in every patient reporting the clinical symptoms listed above, with a history of acute or chronic pancreatitis. In physical examination attention should be paid to pathological resistance in the upper or middle abdomen. In laboratory tests the following should be excluded: anaemia, cholestasis and presence of inflammatory markers. The most accessible ultrasound examination of the abdominal cavity and pleural cavities may direct further

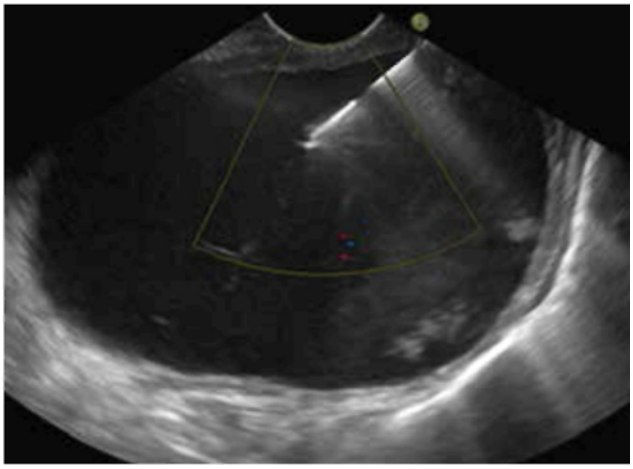

Figure 3. Endoscopic ultrasound fine needle aspiration of pseudocyst in the body of the pancreas

Rycina 3. Biopsja pod kontrolą EUS torbieli rzekomej w trzonie trzustki

Table. Complications of pancreatic cyst
Tabela. Powikłania torbieli trzustki

complications	mechanism and outcomes
cyst infection	deterioration of general condition, fever, increased acute phase parameters
mechanical jaundice	cyst pressing the common bile duct, extrahepatic cholestasis
gastrointestinal obstruction	cyst pressing the stomach, duodenum
ruptured cyst	peritoneal reaction and ascites or a fistula to the thorax with effusion in the pleural cavity
pseudoaneurysm	damage of peripancreatic arteries directly adjacent to the cyst wall, bleeding
splenic vein thrombosis	cyst pressing the splenic vein, portal hypertension

diagnostics (presence of peripancreatic collection, fluid in the abdominal cavity and pleural cavity). If a patient reports symptoms of dysphagia and psuedoachalasia, an X-ray examination of the upper gastrointestinal tract with water contrast may be required. However, this test does not determine the presence of a pancreatic pseudocyst, although it may demonstrate external impressions or detect another pathology. Imaging examinations, such as computed tomography (CT) and magnetic resonance cholangiopancreatography (MRCP), may correctly assess the cyst morphology [9]. MRCP in particular will present the biliary ducts, extensions of the main pancreatic duct and its lateral branches, as well as potential communication between pancreatic ducts and the cyst. Another advantage of MRCP is that the test does not expose the patient to high doses of X-radiation [10].

Spontaneous regression of a pancreatic cyst, especially with extrapancreatic location, is rare [11, 12]. Treatment options of pseudocysts with pancreatic and extrapancreatic location are conditioned by numerous factors. Asymptomatic pseudocysts should be observed with classic ultrasound or endosonography. If the pseudocyst diagnosis is not conclusive, the cyst is punctured under EUS guidance, and fluid is collected for further diagnostic tests. The diagnosis may be confirmed if the patient has a history of acute pancreatitis, and increased amylase activity is observed in the fluid [13]. Clinical symptoms and complication are indication for the treatment of pseudocyst. Treatment depends on severity of symptoms, size of the cyst, type of complications and experience and preferences of a given center. Pharmacological treatment is useful and comprises using somatostatin analogues, supplementation of water-electrolyte deficiencies, and introducing enteral or parenteral nutrition [14, 15]. However, this method is not recovery-oriented.

In surgical treatment of pancreatic pseudocysts, laparotomy and transepidermal drainage are still used [12], but in most cases these methods should be restricted to patients with infected pancreatic necrosis, abscesses, haemorrhage, ruptured cyst or in case endoscopic procedures fail [16].

EUS-FNA is a simple, economical diagnostic tool providing multiple options, and enabling precise diagnostics of pathologies in the gastrointestinal tract, as well as in adjacent organs [17]. There are numerous indications for EUS-FNA: diagnostics of lymph nodes in the abdominal cavity, mediastinum, solid pancreatic lesions, pancreatic cysts and submucosal gastrointestinal lesions. EUS-FNA performed after other, unsuccessful diagnostic attempts enables diagnosis in 85-95% of cases. It plays an important role not only in diagnostics, but also in therapy of pancreatic pseudocysts.

In the treatment of psudocysts the method of choice is endoscopic drainage. EUS-guided drainage is currently considered the best therapeutic method, recommended by reknown expert centers due to low mortality rates. Endoscopic treatment may be performed with a transpapillary or transmural access, or using both methods. Transmural drainage through a gastric or duodenal wall may be performed under EUS guidance or without endosonographic control. Procedures without EUS control are possible when an impression of the gastric or duodenal wall is visible, and imaging tests results (CT, MRCP) ensure the operator that the wall impression is caused by a cyst. Moreover, impossibility of assessment of the wall at the puncture site results in potential risk of vessel damage and complications, primarily bleeding. Therefore, EUS-guided pseudocyst drainage is a safer procedure, as it enables assessment of the gastrointestinal wall and

adjacent blood vessels. However, the most important advantage of EUS-guided drainage is the ability to use this procedure in the case of an absence of a gastric or duodenal wall impression [18].

Endoscopic drainage procedure consists in creating a fistula between the pseudocyst and the gastrointestinal lumen (cystogastrostomy or cystoduodenostomy). Then, one or more endoprostheses are introduced into the cyst lumen [19]. In the literature there are also a few cases of endoscopic treatment of pseudocysts located in the mediastinum, through transoesophageal access. Such procedures may be conducted only under EUS guidance [20]. The described transoesophageal drainage procedures were safe and no serious complications were reported, with the reservation that they should be performed in expert centres and by experienced surgeons. Transoesophageal drainage is an endoscopic procedure which may be used in all intervention procedures in the mediastinum, due to limited risk for the patient, and good assessment of the proximity of the aorta and heart in EUS. However, no randomised studies were conducted comparing transmural EUS-guided drainage and open surgical drainage in the treatment of pancreatic pseudocysts located in the mediastinum [21]. Therefore, further prospective studies are required to assess the effectiveness and safety of transoesophageal drainage.

In acute pancreatitis and during development of pseudocysts, changes occur in the pancreatic duct. Communication of the pseudocyst with Wirsung duct is a possible consequence [22]. Four stages of changes in pancreatic duct are distinguished:

- normal pancreatic duct,
- narrowing of the pancreatic duct,
- disruption of the pancreatic duct,
- chronic inflammation of the pancreatic duct.

This type of changes in the pancreatic duct are also included in standard endoscopic treatment, due to developing new techniques in procedures and additional accessories. In such cases transpapillary drainage is applied in endoscopic retrograde cholangiopancreatography (ERCP). It consists in transpapillary introduction of a prosthesis into the cyst lumen or the site of leak to enable drainage through the pancreatic duct. ERCP with transpapillary cyst drainage and stent implantation may be used only when the pseudocyst communicates with the Wirsung duct, or the Wirsung duct has been damaged [23].

EUS-guided endoscopic drainage of pancreatic pseudocysts procedures are very effective, up to 89-100% [24]. This effectiveness is associated with additional possibilities of EUS, such as colour Doppler which helps to avoid puncture of blood vessels. Correct positioning of the needle in the cyst is monitored in real time, which allows avoiding puncturing other structures. Success and complications associated with different methods of pseudocyst drainage were analysed in a study by Vosoghi et al. [6]: for surgical methods, transepidermal drainage, endoscopic methods without endosonographic guidance and with EUS. Effectiveness of these methods was evaluated at: 100%, 84%, 90% and 94%, respectively. The rate of complications in the case of surgical treatment was 28-34% with 1-8.5% mortality, in case of transepidermal drainage 18% with 2% mortality, for drainage without endosonographic guidance 15% with 0% mortality, and for EUS-guided procedures 1.5% with 0% mortality. Also Sahel et al. [19] and Cremer et al. [25] demonstrated safety and effectiveness of transmural drainage of pancreatic cysts.

On the basis of reports regarding safety and effectiveness of EUS-guided endoscopic drainage in may be concluded that this method is indicated in the treatment of symptomatic pancreatic pseudocyst.

References

1. Dąbrowski A. Gastroenterology. Warsaw, Medical Tribune, 2011: 373-385
2. Rose EA, Haider M, Yang SK. Mediastinal extension of pancreatic pseudocyst. Am J Gastroenterol, 2000; 95: 3638-3639
3. Komtong S, Chanatrirattanapan R, Kongkam P, et al. Mediastinal pseudocyst with pericardial effusion and dysphagia treated with endoscopic drainage. J Oncol Pract, 2006;7:405-410
4. Zhang XM, Mitchell DG, Dohke M, et al. Pancreatic cysts: depiction on single-shot fast spin-echo MR images. Radiology, 2002; 223 (2): 547-553
5. Penman ID, Lennon AM. EUS in the evaluation of pancreatic cysts. [In] Hawes RH, Fockens P, Varadarajulu S, eds. Endosonography. Philadelphia, Elsevier Saunders, 2011: 166-177
6. Vosoghi M, Sial S, Garrett B, et al. EUS-guided pancreatic pseudocyst drainage: review and experience at Harbor UCLA Medical Center. Medscape Gen Med, 2002; 4 (3): 2
7. Vitas GJ, Sarr MG. Selected management of pancreatic pseudocyst: operative versus expectant management. Surgery, 1992; 111: 123-130
8. Beebe DS, Bubrick M Onstad GR, et al. Management of pancreatic pseudocysts. Surg Gynecol Obstet, 1984; 159 (6): 562-564
9. Cremer M, Deviere J, Engelholm L. Endoscopic management of cysts and pseudocysts in chronic pancreatitis: long-term follow-up after 7 years of experience. Gastrointest Endosc, 1989; 35: 1-9
10. Sharma SS, Bhargawa N, Govil A. Endoscopic management of pancreatic pseudocyst: a long-term follow-up. Endoscopy, 2002; 34: 203-207
11. Frenzer A, Schubart P, Soucek M. Disappearance of a large mediastinal pseudocyst in a patient with chronic alcoholic pancreatitis after total parenteral nutrition. Eur J Gastroenterol Hepatol, 1995; 7: 369-371
12. Kotsis L, Agocs L, Kostic S. Transdiaphragmatic cyst-jejunostomy with Roux-en-Y loop for an exclusively mediastinal pancreatic pseudocyst. Scand J Thorac Cardiovasc Surg, 1996; 30: 181-183
13. Ingram M, Arregui ME. Endoscopic ultrasonography. Surg Clin North Am, 2004; 84: 1035-1059
14. Yasuda H, Yoshifumi I, Hisato H, et al. A case of pancreatic pleural effusion and mediastinal pancreatic pseudocyst: Management by a somatostatin analogue octreotide. Pancreas, 1999; 19: 410-412
15. Frenzer A, Schubart P, Soucek M. Disappearance of a large mediastinal pseudocyst in a patient with chronic alcoholic pancreatitis after total parenteral nutrition. Eur J Gastroenterol Hepatol, 1995; 7: 369-371
16. Bardia A, Stoikes N, Wilkinson NW. Mediastinal pancreatic pseudocyst with acute airway obstruction. J Gastrointest Surg, 2006; 10: 146-150
17. Erickson RA. EUS-guided FNA. Gastrointest Endosc, 2004; 60:

267-279
18. Giovannini M, Pesenti C, Rolland AL, et al. Endoscopic ultrasound-guided drainage of pancreatic pseudocysts or pancreatic abscesses using a therapeutic echo endoscope. Endoscopy, 2001; 33: 473-477
19. Sahel J, Bastid C, Pellat B, et al. Endoscopic cystoduodenostomy of cysts of chronic calcifying pancreatitis: a report of 20 cases. Pancreas, 1987; 2: 447-453
20. Mohl W, Moser C, Kra mann B, et al. Endoscopic transhiatal drainage of a mediastinal pancreatic pseudocyst. Endoscopy, 2004; 36: 467
21. Saftouia A, Cuirea T, Dumitrescu D, et al. Endoscopic ultrasound-guided transesophageal drainage of a mediastinal pancreatic pseudocyst. Endoscopy, 2006; 38: 538-539
22. Nealon WH, Bhutani M, Riall TS, et al. A unifying concept: pancreatic ductal anatomy both predicts and determines the major complications resulting from pancreatitis. J Am Coll Surg, 2009; 208 (5): 790-799
23. Mallavarapu R, Habib TH, Elton E, et al. Resolution of mediastinal pancreatic pseudocysts with transpapillary stent placement. Gastrointest Endosc, 2001;53:367-370
24. Varadarajulu S, Tamhane A, Blakely J. Graded dilation technique for EUS -guided drainage of peripancreatic fluid collections: an assessment of outcomes and complications and technical proficiency. Gastrointest Endosc, 2008; 68 (4): 656-666
25. Cremer M, Deviere J, Engelholm L. Endoscopic management of cysts and pseudocysts in chronic pancreatitis: long-term follow-up after 7 years of experience. Gastrointest Endosc, 1989; 35: 1-9

The use of ^{99m}Tc-MIBI in modern oncology

Zastosowanie 99mTc-MIBI w onkologii

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Abstract. There are still limited diagnostic techniques in oncology. Nuclear medicine imaging brings range of new opportunities in diagnosis and therapy for cancer patients. Sestamibi, which is a radiopharmaceutical agent used primarily in investigation of the myocardial perfusion, appears to be a promising tool for oncology patients. It allows for noninvasive diagnosis even in cases where cytology remains inconclusive. Nuclear imaging with Sestamibi allows for assessing the progression of the disease, it recurrence but also in helps to predict the effectiveness of the therapy. We aimed to review the characteristics of this radiopharmaceutical agent and its use in the contemporary oncology.
Key words: thyroid cancer, breast cancer, sestamibi, scintigraphy

Streszczenie. Ograniczone możliwości diagnostyki onkologicznej skłaniają do poszukiwania nowych metod obrazowania. Wydaje się, że medycyna nuklearna dysponuje takimi rozwiązaniami. Sestamibi - radiofarmaceutyk stworzony w celu oceny żywotności mięśnia sercowego, okazał się użyteczny w badaniach onkologicznych. Można dzięki niemu różnicować zmiany ogniskowe w sytuacjach, gdy inne badania nieinwazyjne bądź cytologiczne nie dają jednoznacznej odpowiedzi, a w klasycznym algorytmie postępowania pozostaje tylko weryfikacja histopatologiczna. Scyntygrafia z sestamibi umożliwia również ocenę stopnia zaawansowania choroby i wykrycie wznowy; pozwala także prognozować skuteczność leczenia. W artykule omówiono właściwości radiofarmaceutyku oraz jego wykorzystanie we współczesnej onkologii.
Słowa kluczowe: rak tarczycy, rak piersi, sestamibi, scyntygrafia

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Introduction

^{99m}Tc-MIBI (sestamibi) is a radiopharmaceutical agent composed of a centrally located technetium atom surrounded by six lipophilic groups of methoxybutyl isonitrile. Methoxyisobutylisonitrile (MIBI) is responsible for physicochemical properties of the compound, while metastable technetium isotope (^{99m}Tc) for imaging [1]. Sestamibi was synthesised in 1982 by Alana Davison and Alun Jones. In 1986, a comparative study conducted by McKusick et al. demonstrated the superiority of the compound over previously used isotopes (^{99m}Tc-TBI, ^{99m}Tc-CPI and ^{201}TT) in evaluation of the cardiac muscle. Better contrast was achieved, due to increased absorption in the myocardium, and decreased absorption in the liver and lungs [1]. In 1990, the radiopharmaceutical agent was approved by FDA and its production under the marketing name Cardiolite (DuPont Merck Pharmaceutical Company) was started [2].

Since 1997, sestamibi has been used in oncological diagnostics to differentiate breast nodules (Miraluma test) [2, 3]. Scintigraphic diagnostics of parathyroid adenomas dates back to 1989 [1]. Presently,this radiopharmaceutical agent is indicated in: imaging test of myocardial perfusion, location diagnostics of parathyroid adenomas and supportive examination in breast cancer diagnostics, if mammography is inconclusive (Table). Apart from the manufacturer's indications, sestamibi is used in thyreology to find non-radioiodine-avid thyroid carcinoma metastases, and as a supportive tool to differentiate follicular thyroid nodules before deciding to perform a surgery [4]. It is also helpful in differentiation of amiodarone-induced hyperthyroidism type 1 and 2 [1]. Oncological indications include also diagnostics of multiple myeloma, lymphoma, lung carcinoma and brain tumours [1].

Table. Oncological indications for diagnostic scintigraphy with ^{99m}Tc-MIBI
Tabela. Wskazania do diagnostyki scyntygraficznej z ^{99m}Tc-MIBI w onkologii

manufacturer's indications
breast carcinoma – mammoscintigraphy parathyroid adenoma – subtraction and double-phase scintigraphy
suggested oncological indications
thyroid carcinoma – locating non-iodine-avid metastases, differentiation of focal lesions in the thyroid lung carcinoma – differentiation of focal lesions in the lungs evaluation of drug resistance due to overexpression of MDR-1 gene in neoplasms

Presently, in Poland MIBI is obtained in the Polatom National Centre for Nuclear Research in Świerk. In the form of a dry substance provided in vials it is supplied to nuclear medicine departments in the country. The departments are equipped in molybdenum-technetium generators used to obtain metastable technetium isotope (^{99m}Tc). The function of generators consists in decay of long-lived parent nuclei to form short-lived daughter nuclei. After rinsing with saline, eluate is collected, whose products include sodium pertechnetate ($Na^{99m}TcO_4$) and negligible quantities of other isotopes. It is possible to obtain technetium with an alternative method, by bombarding molybdenum nuclei (^{98}Mo) with neutrons, or splitting of the nuclei of uranium isotope (^{235}U); however, products of these reactions are to a larger extent contaminated with intermediate isotopes. The next step in producing sestamibi is incubation of technetium of 10,000–11,000 MBq with MIBI in boiling water bath. The product is ^{99n}Tc-MIBI and by-products (up to 5% of total activity). Thus obtained pharmaceutical may be used for up to 6 hours since labelling [2, 5, 6].

As mentioned before, MIBI is responsible for distribution of sestamibi, whereas technetium allows tracing pharmacokinetics in the body, without changing the properties of the compound. Characteristics of ^{99m}Tc will be discussed separately.

Technetium

Technetium isotope has many advantages, due to which it is one of the most frequently used in nuclear medicine. It is used in approximately 70% of scintigraphic examinations [1, 2, 5]. It is the first artificially generated element, obtained by Carlo Perriera and Emilio Segré in 1937, although its existence was earlier anticipated by Dmitri Mendeleev, on the basis of a gap in his periodic table of elements. The name derives from Greek *(technetos* – artificial) [2].

Benefits of ^{99m}Tc include short half-life (6 h), absence of ß radiation and optimal radiation energy (140 keV); due to these characteristics it causes less damage in surrounding tissues. Pure γ radiation emission with optimal energy and possibility of intravenous administration allows quickly performing a test with very good contrast [2,5]. Important factors include low production costs and common availability in nuclear medicine departments. The product of metastable ^{99m}Tc decay is ^{99}Tc. In medicine technetium is used as an independent compound, e.g. in thyroid technetium scintigraphy, or it is used to label carrier substances, such as MIBI, somatostatin analogues etc.

Sestamibi (^{99m}Tc-MIBI)

^{99m}Tc-MIBI reveals specific pharmacodynamic properties. It is administered intravenously. In myocardial perfusion scintigraphy the product is administered at rest or during peak effort during effort test, and imaging is performed 30-60 minutes after the administration. In locating parathyroid adenomas, two test protocols are used: double-phase and subtraction scintigraphy. Double-phase scintigraphy consists in imaging after 5-15 minutes following administration, and then after 1-2- hours. The second phase demonstrates the sites with delayed tracer washout, such as neoplasms, including parathyroid adenomas [5]. Other sites with initially high uptake, such as the lungs, thyroid and its benign nodules, lose contrast (washout). In subtraction examination, initially scintigraphic image is obtained with the use of thyroid-specific tracer (iodine isotope, technetium), followed by a scan after administration of sestamibi accumulating in the thyroid and the parathyroid glands. A computer programme subtracts the obtained images and provides the picture of parathyroid adenoma.

The examination protocol in the diagnostics of malignant neoplasms is analogous to double-phase scintigraphy described above, or consists in a single test after 60-90 minutes following the administration [1].

Initially, accumulation is proportionate to vascularisation of a given area – arterial phase of the test. The flow conditions, such as vascular system, presence of terminal vessels, malformations or vascular wall abnormalities determine preliminary retention. The above factors are responsible for imaging in the vascular phase. The next distribution stage is cellular uptake – intracellular internalisation. Radiopharmaceutical agent passes passively, according to the concentration gradient, through the cellular membrane, attracted by the cytosol negative charge. Transmembrane transport facilitates peripheral location of lipophilic MIBI molecules.
Therefore, the factors affecting cellular uptake from the blood (extraction) include: blood flow associated with product density in a given area and its "longer" contact with a cell, lipophilic character of MIBI

molecule which facilitates penetration through the cellular membrane, and MIBI positive charge, attracted by negatively charged interior of the cell and mitochondria [1, 2, 5, 6]. Despite significant pharmacokinetic similarities between sestamibi and tetrofosmin, there are also differences. Following administration of ouabain (a specific Na^+/K^+-ATPase inhibitor) transition of sestamibi into the cytoplasm does not change, whereas tetrofosmin transition is reduced by 20-30%, which suggests that its transport is partially active, contrary to MIBI [7]. Another difference is associated with the accumulation site in a cell: MIBI is 90% accumulated in mitochondria, tetrofosmin mainly in cytoplasm [1, 7].

Another property used in imaging is the ability to accumulate sestamibi in certain cells. The aspects which affect retention of the compound inside include: cellular membrane potential, number of mitochondria and presence of factors associated with its elimination. The mechanism responsible for accumulation has not been entirely discovered. Probably the radiopharmaceutical agent passively penetrating the cellular membrane is kept inside by the negative charge of the cytoplasm; the higher transmembrane potential, the more difficult it is for MIBI to leave the cell (first barrier). From the cytoplasm, it passes to the mitochondria, where it is probably "trapped" by the same mechanism in the organella (second barrier). Membrane potential is maintained by ATP-dependent sodium/potassium pump; it is an energy-consuming process which requires sufficient ATP synthesis from the cell. These conditions are met by cardiomyocytes and parathyroid cells. Cells in which sestamibi is accumulated primarily due to the presence of mitochondria providing the energy for proliferation are neoplastic cells. MIBI is "trapped" in them mostly behind the second barrier.

The time of intracellular accumulation depends on only on maintaining the difference of charges by the cellular and mitochondrial membranes. Another important factor is active elimination of the compound from the cell due to MDR-1 (multidrug resistance gene) overexpression. The product of the gene is P-glycoprotein (Pgp) which acts as a pump excreting toxins and drugs from the cell, including sestamibi. MDR-1 overexpression is the main factor responsible for multidrug resistance of diseases, and reduced contrast in scintigraphic examinations of certain neoplasms. In physiological conditions, Pgp is found in hepatocytes situated along biliary ductules, and in the cells of proximal renal tubules, which facilitates elimination of toxins. It also plays an important role in preserving organ integrity, as it is the key factor responsible for the seal of organ barriers, such as blood-brain, blood–intestine or blood-placenta barriers. However, it is not found in cardiomyocytes. An important aspect of scintigraphy with MIBI in the case of neoplastic disease is the ability to assess overexpression of MDR-1 in the tumour. Sestamibi is an acknowledged substrate for Pgp protein; therefore, by assessing washout of the radiopharmaceutical, the activity of MDR gene may be indirectly evaluated. Detection of MDR-1 overexpression in the tumour helps to predict effectiveness of planned chemotherapy, as well as evaluate if the drug will not be to quickly excreted from the cell, which would significantly reduce its effect [1, 8].

During studies on MDR-1 it was discovered that certain pharmaceuticals reduce the effect of Pgp, resulting in retention of sestamibi and/or a chemotherapy agent in the cell with MDR-1 overexpression. The following drugs demonstrate such properties: verapamil, ciclosporin A and new drugs, such as tariquidar [1, 7]. Performing a test with MIBI and determination of tracer washout before conservative treatment, and in the case of Pgp hyperactivity, using, e.g. verapamil, could significantly improve tumour treatment [7]. In classic therapy effectiveness is evaluated only after a few months, on the basis of imaging examinations, and the treatment might be modified. Testing MDR-1 overexpression could in certain cases save valuable time and increase effectiveness of the treatment by complementing chemotherapy with Pgp inhibitor.

It has been found that mutations of p35 suppresoror p21-ras oncogene may additionally increase MDR-1 expression in the brest carcinoma cells [7]. Increased Pgp production in this neoplasm results in three times faster sestamibi washout compared to the carcinoma with normal MDR-1 expression [8].

Another important element of isotope diagnostics is evaluation of MIBI washout. Following intravenous administration of radiopharmaceutical agent, the maximum activity in blood is obtained after a minute since the injection. Cellular uptake reduces activity in circulation, and after 5 minutes it is only ca. 10% of the baseline activity, after 10 minutes it is 2.5%. Then blood clearance decreases due to accumulation and slow release from cells. In physiological conditions, after 60 minutes the highest uptake is observed in the cardiac muscle, lower in the liver and spleen. Effective half-life of the isotope over the heart is 3 hours, over the liver it is 30 minutes [1].

Description of the scintigraphic image consists in subjective evaluation of contrasting uptake areas. The evaluation consists in comparing the activity over the studied area, so-called region of interest (ROI), and over the surrounding tissue (background) or organs with homogenous uptake (e.g. lungs, liver). In most tests the early phase was determined at 5-15 minutes following the injection, and delayed phase at 60-90 minutes [1]. An important element of scintigraphic test description is assessment of the level of isotope washout. It can be objectified by calculating a washout rate according to the formula: $(T_{10}-T_{120}dc)/T_{10}$, where T_{10} means the number of measurements in ROI in 10. minute, T_{120}- in delayed phase in 120. minute, and dc is a correction factor for the exponential decay [4].

Scintigraphy with the use of sestamibi is applied

primarily in the myocardial perfusion diagnostics. In oclological diagnostics the product is registered in Poland as a supportive agent in breast carcinoma diagnostics, while in endocriology for localisation of parathyroid adenomas. Since MIBI was introduced to cardiac diagnostics, many papers demonstrated the effectiveness of this radiopharmaceutical in the diagnostics of other neoplasms, such as thyroid carcinoma, bronchial carcinoma, liver carcinoma or lymphoma. Non-neoplastic pathologies demonstrated in the test include: benign focal lesions in the thyroid and granulomas in tuberculosis and sarcoidosis.

Breast carcinoma

In 1997, MIBI under the name of Miraluma (DuPont Merck Pharmacutical Company) was approved by the FDA (Food and Drug Administration, USA) as a tool in breast carcinoma diagnostics.

The benefits of using scintimammography (sMM) in diagnostics of breast tumours include the possibility of assessment, despite the factors which complicate obtaining proper image in classic mammography (MM). In MM the quality of imaging is affected by breast size, fat tissue to glandular tissue, and previous treatment. In studies comparing MM and sMM, sensitivity and specificity of breast carcinoma detection in women before menopause were assessed, in the case of tumours of ≤2 cm. Scintigraphic examination demonstrated sensitivity of 80.6% and specificity of 93.3%, while mammography revealed 80.6% sensitivity and 60% specificity. Application of both methods resulted in 94.4% sensitivity and 93.3% specificity [9].

Dominance of glandular tissue in a breast (so-called dense breasts) is an obstacle for X-rays. In this case focal lesions are not in contrast with the surrounding tissue; however, in sMM it is not a problem. A similar effect is observed in fibrosis, calcifications in the case of mastopathy, in lesions due to trauma,surgery or radiotherapy. In patients with silicone implants scintimammography is clearly a test of higher diagnostic value.

Classic mammography is limited by difficulty with complete presentation of breast glands, especially the axillary process, also known as tail of Spence. Scintigraphic examination, apart from showing the entire studied area, additionally helps to assess regional lymph nodes.

In the case of inconclusive results of a mammography and cytology test, scintigraphy with sestamibi may prove to be a valuable diagnostic tool before histopathological verification.

Sestamibi uptake may also indicate the type of breast carcinoma, as a considerably higher uptake is observed in ductal carcinoma than in lobular carcinoma [1].

To sum up, classic mammographic examination is an excellent screening test for breasts with dominant fat tissue. However, in younger women, with a dominance of glandular tissue, sMM may be more beneficial. As mentioned before, examination with sestamibi has another important advantage: it allows to indirectly evaluate the effectiveness of potential chemotherapy in breast carcinoma. Detection of Pgp overexpression is a signal that to obtain better therapeutic effect, appropriate MDR gene inhibitors may be used.

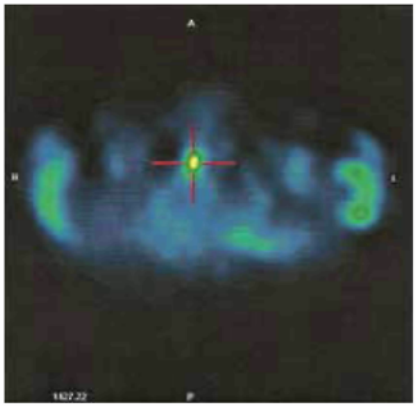
Thyroid carcinoma

In evaluation of thyroid focal lesions, double-phase scintigraphic test may be used, in which the uptake of $^{99m}TcO_4$ and ^{99m}Tc-MIBI are assessed separately. Due to different pharmacokinetics of these compounds, comparative analysis increases specificity of the test compared to a single test with MIBI. Technetium uptake depends primarily on the activity of the sodium-iodine symporter, whereas sestamibi uptake depends on the potential of the cellular membrane and the quantity of mitochondria. Hypofunctional lesions ("cold" in technetium scintigraphy) characterised by increased MIBI uptake (this scintigraphic discrepancy is referred to as mismatch) are associated with higher oncological risk. "Cold" nodules in both scintigraphic tests (match) are benign lesions with negative prediction close to 100% [1, 10].

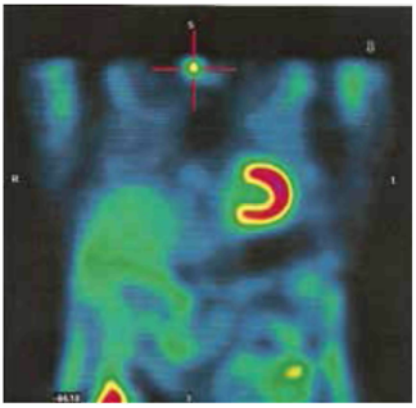
Considering that thyroid carcinoma cells demonstrate lower activity of sodium-iodine symporter than the surrounding thyroid tissue, and that during sestamibi synthesis contamination with sodium pertechnetate occurs, "hot" or "cold" lesions in both scintigraphies are much less suspicious than those revealing only MIBI uptake [1]. Hurta-do-Lopez et al., qualifying the lesions with above described characteristics as mismatch, obtained negative prediction of 100% for hypofunctional lesions for pertechnetium and sestamibi [10].

A significant percentage of non-diagnostic biopsy results of thyroid focal lesions urges searching for a test which would facilitate diagnosis. Biopsy is an inconclusive test in the case of follicular lesions described as "suspected follicular/oxyphilic neoplasm" (class IV in Bethesda classification). The risk of malignancy in the case of such diagnosis is 5-20%; in most cases histopathological verification is indicated. It occurs that in those cases scintigraphic examination with sestamibi might be a valuable complementary diagnostic tool. Another indications could involve absence of patient's consent for biopsy or technically limited accessibility of the lesion. In mulitnodular goiter, scintigraphy could help select the most suspicious lesions for cytology tests. Attempts to localise non-iodine-avid metastases of differentiated thyroid carcinoma, with negative "iodine scan" result and positive thyroglobulin concentration result ("thyroid tissue" marker) were made [4].

Positive malignancy prediction in case of a "hot" nodule in scintigraphy with sestamibi is 20-60% [1, 10], which signifies a risk comparable to cytological diagnosis of "suspected follicular neoplasm" or



NM Transaxials



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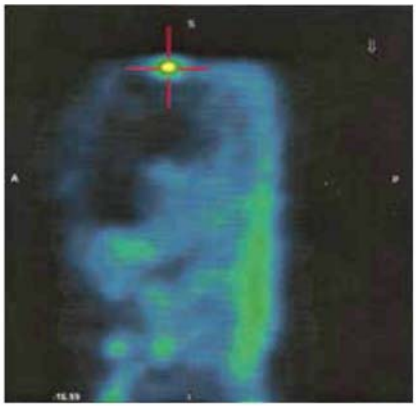
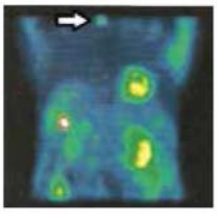


NM Saggitals



MIP Navigate

Figure. Perfusion scintigraphy of the heart with ^{99m}Tc-MIBI. Incidental nodule of the right thyroid lobe (arrow)

Figure. Scyntygrafia perfuzyjna serca z ^{99m}Tc-MIBI. Przypadkowo uwidoczniony guz prawego ptata tarczycy (strzałka)

higher. With such risk, in case of biopsy, the next diagnostic stage is often post-operative histopathological verification. The question might be asked if finding a focal lesion in the thyroid (ultrasound), characterised by increased MIBI uptake could be an indication for resection (Fig.). It seems that it could. However, an isotopic test is less accessible and it has certain limitations, such as contamination during synthesis of $^{99m}TcO_4$ (admissible up to 5% of total activity) and dependence on the size of the lesion and on MDR expression. Scintigraphy with MIBI is excellent as a supportive tool in detecting malignant thyroid lesions, but in this case it is used primarily to assess the risk, using very high negative prediction (no collection = no malignancy). This examination is a great complementary test in the case of inconclusive thin needle biopsy results with the diagnosis: "suspected follicular neoplasm" (class IV in Bethesda classification) and possibly "follicular lesion, undetermined" (class III in Bethesda classification). It allows minimising the risk of error in the case of a lesion without the radiotracer uptake. Scintigraphy with the use of Tc-sestamibi is a valuable test in oncological diagnostics. It helps to take decisions in many ambiguous clinical situations, becoming a permanent element of diagnostic algorithms. In certain situations it also allows predicting the effectiveness of planned treatment (evaluation of drug resistance).

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References

1. Bucerius J, Ahmadzadehfar H, Biersack H. ^{99m}Tc-Sestamibi. Clinical Applications. Berlin, Heidelberg, Springer-Verlag, 2012
2. Zoile I, ed. Technetium-99m pharmaceuticals. Preparation end quality control in nuclear medicine. Berlin, Heidelberg, Springer-Verlag, 2007: 173-181; 237-244
3. Coover LR. The role of technetium ^{99m}Tc sestamibi in the early detection of breast carcinoma. Hospital Physician February 1999: 16-21
4. Listewnik MH, Birkenfeld B, Piwowarska-Bilska H, et al. The application of SPECT/CT scintigraphy with MIBI-Tc99m in the

diagnosis of thyroid nodules - a preliminary report. Endokrynol Pol, 2010; 5 (61): 422-426
5. Królicki L. Medycyna nuklearna. [Nuclear Medicine] Warsaw, Ludwig Rydygier Foundation, 1996
6. Piciu D. Nuclear endocrinology. Berlin, Heidelberg, Springer-Verlag, 2012
7. Carpi A, Mechanick JI. Thyroid cancer from emergent biotechnologies to clinical practice guidelines. Taylor & Francis Group, LLC 2011
8. Crankshaw CL, Marmion M, Luker GD, et al. Novel technetium (III)-Q complexes for functional imaging of multidrug resistance (MDRI) P-glycoprotein. J Nucl Med, 1998;39:77-66
9. Lumachi F, Ferretti G, Povolato M, et al. Accuracy of technetium-99m sestamibi scintimammography and X-ray mammography in premenopausal women with suspected breast cancer. Eur J Nuclear Med, 2001; 28 (12): 1776-1780
10. Hurtado-López LM, Arellano-Montano S, Torres-Acosta EM, et al. Combined use of fine-needle aspiration biopsy, MIBI scans and frozen section biopsy offers the best diagnostic accuracy in the assessment of the hypofunctioning solitary thyroid nodule. Eur J Nuclear Med, 2004; 31 (9): 1776-1780

The organisation and functioning of emergency medical services as exemplified by the train crash which took place in the vicinity of Szczekociny

Organizacja i działanie ratownictwa medycznego na przykładzie katastrofy kolejowej pod Szczekocinami

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Abstract. We have experienced mass-casualty events and disasters since the beginning of time. However, the development of civilization results is increased number and frequency of their occurrence. Mass-casualty events constitute one of the greatest challenges to emergency services, including the State Emergency Service, which constitutes one of the elements safeguarding the citizens' health and safety. Proper planning and implementation of procedures at the scene impact the proper course of the rescue operation. This paper addresses the subject matter of organisation of emergency medical services taking into account the functioning of the State Emergency Service system in the case of mass-casualty events and disasters. The paper was developed based on an analysis of actions taken in the śląski voivodeship with regard to the train crash which took place in the vicinity of Szczekociny.
Key words: emergency medical services, medical emergency teams, action conducting medical rescue operations, disaster, the train crash

Streszczenie. Ze zdarzeniami masowymi i katastrofami mamy do czynienia od zarania dziejów. Rozwój cywilizacji powoduje natomiast zwiększenie ich liczby i częstości. Zdarzenia o dużym charakterze stanowią jedno z największych wyzwań dla służb ratowniczych, w tym dla systemu Państwowego Ratownictwa Medycznego, który jest jednym z elementów bezpieczeństwa zdrowotnego obywateli. Prawidłowe planowanie i realizowanie procedur na miejscu zdarzenia ma wpływ na prawidłowy przebieg akcji ratunkowej. Niniejsza praca jest przybliżeniem problematyki związanej z organizacją ratownictwa medycznego, uwzględniającą działania systemu Państwowe Ratownictwo Medyczne w przypadku zdarzeń masowych i katastrof. Praca powstała na podstawie analizy działań podjętych w województwie śląskim w związku z katastrofą kolejową pod Szczekocinami.
Słowa kluczowe: ratownictwo medyczne, zespoły ratownictwa medycznego, akcja prowadzenia medycznych czynności ratunkowych, katastrofa, wypadek kolejowy

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Rapid globalisation triggers serious problems of the contemporary world, for instance transportation accidents. These are one of the main causes of all injuries. According to WHO, about 75 million people are injured annually. Accidents at work cause 20% of injuries, whereas transportation accidents are dominant (40%), as well as accidents at home and other types of injuries (e.g.. falling from heights, violence, etc.) [1]. In Poland, the causes are distributed in a similar way. Most people are unaware of the fact that 23% of casualties die or suffer from permanent health impairment. Transportation injuries have the highest rate of fatality and post-injury disability. Injuries are also the third ultimate cause of deaths in the world [2].

One type of transportation accident is a train crash. Rail accidents are not as common as road accidents, yet they may be much more dangerous. Enormous kerb weight of the train and increasing speed generate big amounts of kinetic energy, which in the event of

rapid braking has a strong destructive power. In the case of passenger trains, significant number of casualties may be expected, especially if the crash conditions are complicated, for example by a difficult access to the crash site. An event on such a big scale may be called a disaster. Among numerous definitions of a "disaster", the one adopted in the USA by the Federal Emergency Management Agency and Red Cross defines the problem best: "disaster - event causing death, injury and property damage on such a scale when routine activities are insufficient to diminish its consequences. Its occurrence is usually sudden and requires immediate and joint action of a number of people and institutions" [3]. Train crashes are specific events, which are often complicated by infrastructure, bad weather, etc., which may make it difficult, or sometimes even impossible, to conduct rescue operations. Rail tracks are often located at large distances from populated areas and roads, which makes them difficult to be accessed by heavy equipment. Moreover, damage to train carriages hinders getting casualties out of the train. Such events bring about a large number of casualties. Dramatism of the situation and the atmosphere of extreme tension do not help make rational decisions. Such events require professional approach to medical rescue operations, which should be based on ethical principles, as well as on rational evidence and calm assessment of the situation. In the case of mass accidents, emergency medical services resemble military medicine. Disasters are one of the biggest challenges for the State Emergency Medical Service, as well as for other state emergency services, e.g. State Fire Service. One of the most important things during an event involving a large number of casualties is logistic protection of the event [4]. Logistics, according to a dictionary of the Polish language, means planning and managing a complicated undertaking [5].

In order to fulfil the state duty of providing help for each person facing sudden health threat, State Emergency Medical Service has been appointed, further called "the system". Pursuant to Art. 19 of the State Emergency Medical Service Act of 8 September 2006 (Journal of Laws of 2013, item 757, consolidated text) - further called the State Emergency Medical Services Act, the system in a given state is supervised by the minister in charge of health, whereas planning, management, coordination and supervision over the system in a given voivodeship is the responsibility of the voivodeship governor. The State Emergency Medical Services Act imposes also in Poland the state duty of planning coordination of such activities. These are not only the basis of everyday activities of emergency services, but also the starting point for planning a strategy for handling mass-casualty events and disasters [6].

The system in a given voivodeship is based on the provincial plan of action (further called the plan), developed by the voivodeship governor. The plan includes:

- description of potential life or health threats that are likely to occur in the voivodeship, including risk analysis for natural disasters and technical failures within the meaning of provisions relating to the state of natural disaster,
- number and distribution of the system units , i.e. medical emergency teams (further called METs) and hospital emergency departments in the voivodeship,
- scope of activities and operating areas,
- methods of coordinating activities of the system units and methods of cooperation with public administration bodies and system units from other voivodeships that would guarantee efficient life and health protection, irrespectively of voivodeship borders,
- methods of cooperation with units cooperating with the system specified in Art. 15 of the State Emergency Medical Services Act,
- information about location of voivodeship public-safety answering points and public-safety answering points within the meaning of the Fire Protection Act of 24 August 1991 (Journal of Laws No 178/2009, item 1380, No. 57/2010, item 353 and 2012, item 908) and the areas they cover,
- description of the structure of sudden health threat notification system that will enable telecommunication companies to provide essential connections enabling necessary call redirections from the public-safety answering point to specific units of the Police, State Fire Service or a MET dispatcher [6].

The śląskie voivodeship has a plan of action for the State Emergency Medical Services approved by the minister in charge of health for the śląskie voivodeship for 2011 and subsequent years. Pursuant to the State Emergency Medical Services Act, the plan may be modified according to need.

The above-mentioned plan of action of the State Emergency Medical Services for the śląskie voivodeship contains procedures of behaviour in the case of activating the system, e.g. for mass-casualty events or disasters. The plan contains procedures defining:

- methods of coordinating activities of the State Emergency Medical Service units - the aim of the procedure is to assure effective functioning of the system, which involves initiating and conducting medical rescue operations and coordinating and managing these operations; the procedure contains a description of behaviour on the scene of the event, activities undertaken by the MET dispatcher and by the Coordinating Physician of Emergency Medical Services,
- cooperation with public administration bodies and units of the State Emergency Medical Services from the neighbouring voivodeships - the aim of the procedure is to assure effective functioning of the system, which involves initiating and conducting medical rescue operations, as well as coordinating

and managing these operations during events crossing voivodeship borders; the procedure contains a description of behaviour, i.e. cooperation with public administration units, cooperation with units of the neighbouring voivodeships and with Coordinating Physicians of Emergency Medical Services from the neighbouring voivodeships,

- methods of cooperation of the State Emergency Medical Services units with other units working with the system - the aim of the procedure is to assure effective functioning of the system, which involves initiating and conducting medical rescue operations, as well as coordinating and managing these operations; this procedure is used when the system activities are undertaken, including the occurrence of mass-casualty events and disasters; the procedure concerns all subjects participating in activities of medical emergency services [7].

According to the State Emergency Medical Services Act, a medical emergency team is a unit of the system that performs medical rescue operations outside hospital in order to rescue subjects in the state of a sudden health threat. METs are divided into specialist teams of at least three people authorised to perform medical rescue operations, including a physician of the system and a nurse of the system or a medical rescue worker, and elementary teams of at least two people authorised to perform medical rescue operations, including a nurse of the system or a medical rescue worker. TEM is equipped with a specialist means of sanitary transport meeting technical and quality requirements of the Polish Standards, transferring harmonised European standards [6].

In 2012, there were 154 METs in 15 operation areas of the śląskie voivodeship, including 79 elementary teams and 75 specialist teams [7].

In the last several years, there have been some serious events in the śląskie voivodeship, e.g. collapses in mines, floods, hurricanes, tornadoes, a collapse of the roof of a hall where an international pigeon fair was taking place or an accident in the Wujek mine. One serious event with features of a disaster was a crash of two trains near Szczekociny (a town in the śląskie voivodeship, district of Zawiercie).

It took place on 3 March 2012 near Szczekociny. It involved a crash of two fast trains: TLK 31 100 „Brzechwa", travelling from Przemyśl Główny to Warszawa Wschodnia belonging to PKP Intercity and interREGIO 13126 „Jan Matejko" travelling from Warszawa Wschodnia to Kraków Główny, belonging to Przewozy Regionalne. The head-on collision of the trains took place in the village of Chałupki near Szczekociny at 20:57 on the 21.3 km of the railway line No 64 (Koniecpol-Kozłów).

The trains participating in the event had 11 carriages altogether with 350 passengers on board.

The first information about the disaster reached the Emergency Service Station in Szczekociny (branch of the Station in Sosnowiec) at 21:03, that is 6 minutes after the event took place [8].

Pursuant to the State Emergency Medical Services Act, one of the tasks of a medical dispatcher is to receive calls informing about events, establish priorities and immediately dispatch of METs to the scene of the event, according to the Regulation of the Ministry of Health of 7 May 2007 on framework procedures of receiving calls by a medical dispatcher and dispatch of medical emergency teams (Journal of Laws No. 90, item 605). Moreover, the task of medical dispatchers is also to collect up-to-date information about availability and readiness of METs in the operating areas, and to pass the information to the coordinating physician of emergency medical services. If the situation on the scene of the event requires it, the medical dispatcher informs about the event hospital emergency services, injury centres or hospital units specialising in providing emergency medical services and also units cooperating with the system. If it is necessary to use a MET from outside the operating area, the medical dispatcher will inform the coordinating physician of the emergency medical services about this fact. The physician, in turn, appoints medical dispatchers who would initiate, manage and control medical rescue operations and he coordinates the activities of dispatchers in the system units [6].

Since the accident happened on the border of three voivodeships - śląskie, świętokrzyskie and małopolskie - METs from these voivodeships were dispatched to perform medical rescue operations. In total, 20 elementary and 18 specialist METs were dispatched (Fig. 1.). The operation also involved two teams of Medical Air Rescue. METs acted jointly with 98 fire brigades, about 400 policemen, as well as SOK (Railroad Guards) officers and GOPR (Mountain Volunteer Search and Rescue) rescue workers [8].

The operation involved METs from 8 operating areas in total (5 from the śląskie voivodeship, 1 from świętokrzyskie and 2 from małopolskie voivodeship). According to a conducted analysis, none of the operating areas from which the METs were dispatched was left without protection, i.e. not all the teams were dispatched for the event.

The biggest number of METs were dispatched from the śląskie voivodeship (26 waiting areas for METs).

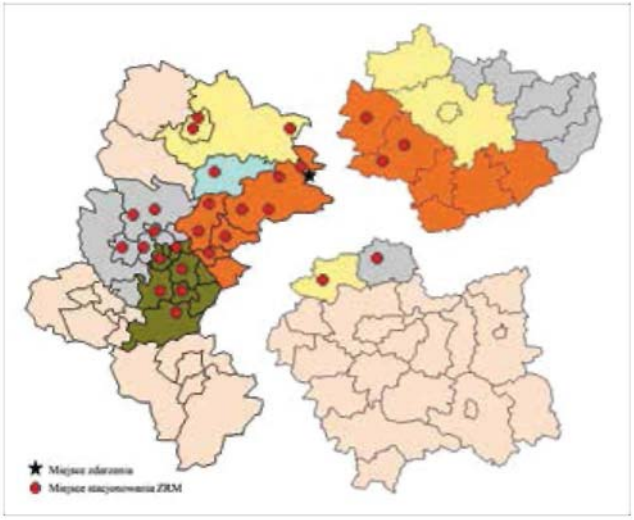

Figure 1. The scene of the crash, operating areas and waiting areas for medical rescue teams, from which teams were dispatched (author's own study)

Rycina 1. Miejsce zdarzenia, rejony operacyjne oraz miejsca wyczekiwania zespołów ratownictwa medycznego, z których zadysponowano zespoły (opracowanie własne)

In the świętokrzyskie voivodeship, teams were dispatched from 3 waiting areas, and in the małopolskie voivodeship from 2 areas.

Average time of MET dispatching for the event was 5 h 34 min (maximum 14 h 27 min and minimum 1 h 50 min).

Table 3 in Annex 3 to the Regulation of the Ministry of Health of 20 June 2008 on the scope of necessary information collected by healthcare providers, the detailed manner of registering that information and its disclosure to entities obliged to finance benefits from public funds (Journal of Laws of 2008 No. 123, item 801 with subsequent amendments) contains a list of codes to complete medical rescue operations by MET [9]. According to the conducted analysis:

- 17 subjects assisted by MET were admitted to hospital emergency departments (ED) emergency units (code 1 of completing medical rescue operations),
- 13 subjects were assisted on the spot and were not transported to ED or emergency unit (code 2 of completing medical rescue operations), 3 subjects were transported and admitted to a hospital unit specialising in providing emergency medical services (code 3 of completing medical rescue operations),10 subjects assisted by MET were transported directly and admitted to an injury centre (code 4 of completing medical rescue operations),
- in 29 cases, medical rescue operations were not performed (code 6 of completing medical rescue operations),

for 3 subjects, MET reported another than the above-mentioned code of completing medical rescue operations (code 7).

METs provided help for 82 casualties in total. Elementary METs provided help for 27 subjects, and specialist METs for 55 subjects. 16 people died in the disaster.

The operation conducted by METs was coordinated by the coordinating physician of the emergency medical services of the śląskie voivodeship. Thanks to a full list of hospitals, their departments, free beds, etc. and being in continuous contact with the physician coordinating the operation on the scene of the crash, he was able to decide which places the casualties should be transported to by METs.

As a result of the train crash, 21 medical facilities having signed agreements for hospital treatment services admitted 95 patients - 38patients in the małopolskie voivodeship, 39 in śląskie and 18 in the świętokrzyskie voivodeship. According to the conducted analysis, 6 patients that were admitted to medical facilities were transported to another medical facility within 12 hours from admission for further treatment. These were mainly patients with group S ICD-10 diagnosis - injuries, poisonings, e.g.:

- S12.0 - fracture of first cervical vertebra
- S28 - crushing injury of thorax and traumatic amputation of part of thorax,
- S71.1 - open wound of thigh.

Specific data with regard to particular voivodeships [8]

Management of medical rescue operations in the śląskie voivodeship

In the śląskie voivodeship, 30 METs (17 elementary and 13 specialist) were dispatched from 5 operating areas. One of the specialist METs was send by the coordinator for support of a medical facility.

METs provided help for 67 subjects: elementary METs provided help for 23 subjects and specialist METs for 44 subjects. The largest number of patients were attended by METs located in Szczekociny (17 subjects) and Miłków (14 subjects), i.e. located not far away from the scene of the crash. Please note that the Provincial Emergency Service Station in Katowice activated an additional team which was not part of the State Emergency Medical Services to transport casualties from the scene of the event.

39 casualties were admitted to 8 medical facilities providing hospital treatment services, including 29 subjects in mode 2 and 10 subjects in mode 3, in compliance with codes for admission modes defined in the Regulation of the Ministry of Health of 20 June 2008 on the scope of necessary information collected by healthcare providers, the detailed manner of registering that information and its disclosure to entities obliged to finance benefits from public funds (Tab. 1).

Table 1. Number of patients admitted to various medical facilities in the śląski voivodeship
Tabela 1. Liczba poszkodowanych przyjętych do poszczególnych podmiotów leczniczych w województwie śląskim

Facility name	Number of patients admitted
Wojewódzki Szpital Specjalistyczny nr 5 im. św. Barbary w Sosnowcu [St. Barbara Provincial Specialist Hospital No 5 in Sosnowiec]	10
Szpital Powiatowy w Zawierciu [Regional Hospital in Zawiercie]	9
SP Zespół Opieki Zdrowotnej w Myszkowie [Independent Public Healthcare Centre in Myszków]	6
Wojewódzki Szpital Specjalistyczny im. NMP w Częstochowie [Holy Mary Provincial Specialist Hospital in Częstochowa]	4
SP Wojewódzki Szpital Chirurgii Urazowej im. dra J. Daaba w Piekarach Śląskich [Dr Janusz Daab Independent Public Provincial Hospital of Traumatology in Piekary śląskie]	3
Miejski Szpital Zespolony w Częstochowie [Municipal Polyclinic Hospital in Częstochowa]	3
Szpital Specjalistyczny im. Sz. Starkiewicza w Dąbrowie Górniczej [Szymon Starkiewicz Specialist Hospital in Dąbrowa Górnicza]	3
Independent Public Clinical Hospital No 7 at the Medical University of Silesia in Katowice, Professor Leszek Giec Upper Silesian Medical Centre in Katowice	1

Only one patient with a diagnosis of ICD-10 S71.1 was transported from the Szymon Starkiewicz Specialist Hospital in Dąbrowa Górnicza within 12 hours from admission to the Military Clinical Hospital in Cracow.

Management of medical rescue operations in the małopolskie voivodeship

In the małopolskie voivodeship, 3 specialist teams from two operating areas were dispatched for the event. As explained by the MET dispatcher in New Hospital in Olkusz, one specialist MET that arrived at the scene of the event was dispatched by the person in charge of the operation to the medical aid point in the segregation tent.
Excluding this team, METs provided help for 3 subjects.

As a result of the event, 38 casualties were admitted to 7 medical facilities providing hospital treatment services, including 6 subjects in mode 2, 31 subjects in mode 3 and 1 subject in mode 6 (Ludwik Rydygier Specialist Hospital in Cracow - a patient was referred from another hospital (Tab. 2).

Within 12 hours from admission, two subjects were transported to another medical facility. One patient with a diagnosis of ICD-10 S12.0 was transported from a Healthcare Centre in Oświęcim to the Ludwik Rydygier Specialist Hospital in Cracow. There is no data concerning the other patient.

In the małopolskie voivodeship, a significant number of patients were admitted by medical facilities providing hospital treatment services as a result of the train crash near Szczekociny because - as explained by service providers - several subjects reported to these facilities on 4 March 2012 with pain problems resulting from the said event.

Management of medical rescue operations in the świętokrzyskie voivodeship

In the świętokrzyskie voivodeship, 5 METs (3 elementary and 2 specialist) were dispatched from one operating area. Moreover, one additional medical team was formed, which was not part of the State Emergency Medical Services, which provided help for 2 subjects.
METs provided help for 12 subjects: elementary METs for 4 subjects and specialist METs for 8 subjects.

18 casualties were admitted to 6 medical facilities providing hospital treatment services, including 12 in mode 2 and 6 in mode 3 (Tab. 3).

3 patients admitted to facilities in the świętokrzyskie voivodeship were transported within 12 hours from admission to other medical facilities in the same voivodeship. One patient with a diagnosis of ICD-10 S.28 was transported from the Healthcare Centre in Włoszczowa to the St. Rafał Provincial Specialist Hospital in Czerwona Góra, whereas two other patiens were transported from Non-Public Healthcare Centre, Hospital in Jędrzejów to:

- Healthcare Centre Hospital in Busko-Zdrój - musculoskeletal medicine,
- Provincial Polyclinic Hospital in Kielce - ophthalmology.

Summary

The above analysis shows that the action conducting medical rescue operations was performed efficiently and effectively.

Success of the action was to a large extent based on development of adequate procedures of behaviour in the case of mass-casualty events in the śląskie voivodeship.

To conduct efficient action of medical rescue operations in the case of mass-casualty events, the

Table 2. Number of patients admitted to various medical facilities in the małopolski voivodeship
Tabela 2. Liczba poszkodowanych przyjętych do poszczególnych podmiotów leczniczych w województwie małopolskim

Facility name	Number of patients admitted
5 Wojskowy Szpital Kliniczny z Poliklinika SP ZOZ w Krakowie [Military Clinical Hospital with a Polyclinic at the Independent Public Healthcare Centre in Cracow]	17
Szpital Miejski Specjalistyczny im. G. Narutowicza w Krakowie [Gabriel Narutowicz Municipal Specialist Hospital in Cracow]	8
Samodzielny Publiczny Zakład Opieki Zdrowotnej Szpital Uniwersytecki w Krakowie [Independent Public Healthcare Centre, University Hospital in Cracow]	6
Szpital św. Anny w Miechowie [St. Anna Hospital in Miechów]	3
Szpital Specjalistyczny im. Ludwika Rydygiera w Krakowie sp. z o.o. [Ludwik Rydygier Specialist Hospital in Cracow, Ltd.]	2
Szpital Specjalistyczny im. J. Dietla w Krakowie [Józef Dietl Specialist Hospital in Cracow]	1
Zespół Opieki Zdrowotnej w Oświęcimiu [Healthcare Centre in Oświęcim]	1

Table 3. Number of patients admitted to various medical facilities in the świętokrzyski voivodeship
Tabela 3. Liczba poszkodowanych przyjętych do poszczególnych podmiotów leczniczych w województwie świętokrzyskim

Facility name	Number of patients admitted
Zespół Opieki Zdrowotnej we Włoszczowie [Healthcare Centre in Włoszczowa]	8
NZOZ Szpital w Jędrzejowie [Non-Public Healthcare Centre, Hospital in Jędrzejów]	4
Wojewódzki Szpital Zespolony w Kielcach [Provincial Polyclinic Hospital in Kielce]	3
Wojewódzki Szpital Specjalistyczny Czerwona Góra im. Św. Rafata w Chęcinach [St. Rafał Provincial Specialist Hospital in Chęciny]	1
ZOZ Szpital Busko-Zdrój [Healthcare Centre Hospital in Busko-Zdrój]	1
ZOZ MSW w Kielcach [Healthcare Centre of the Ministry of Home Affairs in Kielce]	1

system of State Emergency Medical Services requires:

- organisation of large operating areas - formation of such operating areas with a bigger number of METs enables better management and dispatching of rescue resources,
- formation of a communication system enabling receiving calls and connection between METs and other units cooperating with the system and the dispatcher; recently, legislative work has been conducted concerning formation of a uniform notification system for fire services, police and medical services,
- clear and precise definition of methods for coordinating activities of units belonging to the system of State Emergency Medical Services, i.e. dispatching of forces and resources adequately to the scale of event and number of casualties,
- creating an updated and available for the person in charge of the medical rescue operations/coordinating physician of emergency medical services, data base of free places in particular hospitals,
- defining methods of cooperation of the voivodeship governor and dispatchers of the system units with public administration bodies and units from other voivodeships,
- continuous training of the system units in the case of mass-casualty events (exercise with units cooperating with the system and units from neighbouring voivodeships).

References

1. World Health Organization: Road traffic injuries. March 2013. http://www. who.int/mediacentre/factsheets/fs358/en/index.html
2. World Health Organization: The top 10 causes of death. July 2013. http://www.who.int/mediacentre/factsheets/fs310/en/index.html
3. Ciećkiewicz J. Ratownictwo medyczne w wypadkach masowych [Emergency medical services in mass-casualty events]. Wroclaw, Wydawnictwo Medyczne Górnicki, 2010
4. Pietkiewicz JA. Wypadki w transporcie lądowym [Land transport accidents]. In: Klukowski K, (eds) Medycyna wypadków w transporcie [Medicine of transport accidents]. Wydawnictwo Lekarskie PZWL, Warsaw, 2005
5. Uniwersalny słownik języka polskiego [Universal dictionary of the Polish language], PWN. Available at: http://sjp.pwn.pl/szukaj/logistyka
6. Ustawa z dnia 8 września 2006 r. o Państwowym Ratownictwie Medycznym [State Emergency Medical Services Act of 8 September 2006]. Consolidated text: Journal of Laws 2013, item 757.
7. Wojewódzki plan działania systemu Państwowe Ratownictwo Medyczne dla województwa śląskiego na rok 2011 i lata następne [Voivodeship plan of action for the system of State Emergency Medical Services for the śląskie voivodeship for 2011 and subsequent years]. http://bip.katowice. uw.gov.pl/strona. php?trs=ratownictwo2011
8. Data on the event were obtained from the report data submitted to the National Health Fund by dispatchers of medical emergency

teams (internal data of the National Health Fund)
9. Rozporządzenie Ministra Zdrowia z dnia 20 czerwca 2008 r. w sprawie zakresu niezbędnych informacji gromadzonych przez świadczeniodawców, szczegółowego sposobu rejestrowania tych informacji oraz ich przekazywania podmiotom zobowiązanym do finansowania świadczeń ze środków publicznych [Regulation of the Ministry of Health of 20 June 2008 on the scope of necessary information collected by healthcare providers, the detailed manner of registering that information and its disclosure to entities obliged to finance benefits from public funds]. Journal of Laws No. 123/2008, item 801, as amended.

Posterior capsule opacification - prevention and treatment

Zmętnienie torebki tylnej -zapobieganie i leczenie

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Abstract. Posterior capsule opacification (PCO) is the most common cause of secondary reduction in visual acuity after cataract surgery. PCO development is dependent on factors associated with the patient, the surgical technique and the type of implanted intraocular lens (I0L). Correctly handling all stages of cataract surgery and I0L appropriately selected are important factors in the prevention of PCO. Currently, the standard treatment for PCOS is to make cuts posterior capsule - capsulotomy, even during surgery or later postoperative period. The primary capsulotomy is usually performed in children and adolescents. Indications include the existence of posterior lens sity, leading to functional impaired vision, and / or the need for access to the posterior pole for examination and treatment of pathologies of the rear portion.
Keywords: PCO, prevention,treatment

Streszczenie. Zmętnienie torebki tylnej *[posterior capsule opacification* - PCO) jest najczęstszą przyczyną wtórnego pogorszenia ostrości wzroku po operacji zaćmy. Rozwój PCO jest uzależniony od czynników związanych z pacjentem, techniką operacyjną i rodzajem wszczepionej sztucznej soczewki wewnątrzgałkowej *[intraocularlens* - I0L). Poprawne przeprowadzenie wszystkich etapów operacji zaćmy oraz odpowiednio dobrana I0L są istotnymi czynnikami w profilaktyce PCO. Obecnie standardową metodą leczenia PCO jest wykonanie rozcięcia torebki tylnej - kapsulotomii tylnej, już podczas zabiegu operacyjnego lub w późniejszym okresie po operacji. Pierwotną kapsulotomię najczęściej wykonuje się u dzieci i młodzieży. Wskazania do kapsulotomii laserowej obejmują zagęszczenie torebki prowadzące do czynnościowego osłabienia widzenia i/lub potrzebę wglądu do tylnego bieguna w celu zbadania i leczenia patologii odcinka tylnego.
Słowa kluczowe: PCO, zapobieganie, leczenie

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Introduction

Secondary cataract is the most frequent cause of secondary reduction in visual acuity following cataract surgery. Posterior capsule opacification (PCO) affects approximately 25-50% of adult eyes within 2-5 years after the surgery, and 51-100% of cases in paediatric eye surgeries [1]. Presently, the standard method of PCO treatment is cutting of the posterior capsule (posterior capsulotomy), already during the surgical procedure or later after the surgery. Primary capsulotomy is most often performed in children and adolescents [1]. More frequent occurrence of PCO in young patients is probably due to increased quantity of lens epithelial cells (LEC), and their greater proliferative potential; therefore, it seems reasonable to perform during the cataract removal surgery a hole in the posterior capsule, and resection of the anterior part of the vitreous humour through the created aperture [1]. According to other authors, a similar procedure may be performed also in adults, e.g. in case of pseudoexfoliation syndrome (PEX) or significant myopia with peripheral retina diseases, as well as in the case of multifocal or toric lens implantation [2]. Usually the secondary posterior capsulotomy procedure is conducted with the use of Nd:YAG (neodymium: yttrium-aluminium-garnet) laser. Indications for laser capsulotomy include increased capsule density resulting in functional reduction in vision, and/or the need to see the posterior pole to examine and treat the pathologies in the posterior segment [3]. Functional qualification for posterior capsulotomy is determined by deterioration in best corrected visual acuity (BCVA) for distance below 0.4 according to Snellen [3]. According to certain authors, indication for posterior capsulotomy is BCVA ≤0.7 [4]. Both procedures are associated with possible complications, such as temporary increase in intraocular pressure, retinal detachment, intraocular inflammation, cystoid macular oedema or a hole in the macula [3]. Reducing the number of additional surgical or laser procedures, especially in patients with special lenses, decreases the probability of associated complications.

Methods related to the surgical procedure

In practice, many methods of PCO prevention are used. Patient-related factors include: age, history of uveitis in rheumatoid diseases, glaucoma, diabetes, arterial blood hypertension, metabolic diseases, type of cataract and injuries. This factors increase the risk of PCO shortly after the surgery [1]. To reduce the risk of PCO, preoperative stabilisation of the patient's general condition is indicated. Control of diabetes, arterial blood hypertension and rheumatoid diseases requires close interdisciplinary collaboration. In case of cataract surgery in children, simultaneous posterior capsulotomy with vitrectomy is preferred, or performing later posterior capsulotomy with 25-gauge sutureless posterior vitrectomy [5]. The methods of secondary cataract prevention are divided into two strategies: to minimise the amount of LEC and lens mass left, and prevention of LEC migration and proliferation. These strategies are directly associated with cataract surgery and IOL implantation. Correct performance of all the stages of cataract surgery is of much importance in PCO prophylaxis. Making a small main opening allows to minimise the occurrence of inflammatory factors which could stimulate PCO [1]. Ravalico et al. found that continuous curvilinear capsulorhexis (CCC) with a diameter slightly smaller than the optical part of IOL significantly reduces PCO [6]. Careful removal of cortical masses and LEC from the lens capsule may also be effective in PCO prevention. Hydrodissection with the use of standard tools for phacoemulsification facilitates removal of the nucleus, cortical masses and part of LEC while reducing the risk of the lens capsule or ciliary zonule damage. Removal of residual LEC may be obtained by careful polishing of the anterior and posterior lens capsule with irrigation nozzle, aspiration nozzle or other properly prepared cannulas [6].

Prevention methods associated with the type of implanted lens

The choice of IOL affects the development of PCO after a cataract surgery. Selecting IOL one should consider its biocompatibility, mechanical barrier effect for the epithelial cells, shape, size, angulation, haptic geometry, edge profile, maximum contact of the optical part of the IOL with the posterior capsule, and its correct and durable fixation [1]. The term "biocompatibility" is used to describe tolerance of the eye to intraocular lens. Amon et al. distinguish between uveal and capsular biocompatibility [7]. Uveal biocompatibility refers to the relation between the lens and iris, ciliary body and anterior part of the uvea. Breaking of the blood-chamber fluid barrier during a cataract surgery leads to reaction to a foreign body, which results in covering of the IOL by giant cells created by transformations of macrophages. On the other hand, direct contact between the IOL and the lens capsule and LEC is an important component of capsular biocompatibility. Proliferating LEC A and E may migrate to anterior and posterior capsule, as well as to the IOL surface. Abela-Formanek et al. demonstrated that a year after phacoemulsification with IOL implantation the highest incidence of cellular response to a foreign body is observed in case of hydrophobic acrylic lens, and the lowest in case of silicone lens [8]. Evaluating capsular biocompatibility, which plays the greatest part in PCO development, is was found that hydrophobic acrylic lenses are characterised by the lowest incidence of LEC proliferation. It was also demonstrated that most often laser capsulotomy was performed in the group of patients after PMMA (polymethyl methacrylate) IOL implantation (28.9%), less often after silicone lens implantation (14.4%), and least often in case of acrylic IOL (4.2%) [9]. Hydrophobic acrylic IOL of large optical part diameter and angulation are characterised by the highest bioadhesion to the lens capsule, creating a mechanical barrier effect for epithelial cells. The resulting hermetic space is an obstacel for LEC proliferation, and creates expulsion and pressure forces which lead to epithelial cells atrophy and PCO regression [10]. Experimental studies demonstrated that the adhesion force of acrylic surface shows the highest affinity to blood serum fibronectin and to the main ingredient of the capsule, collagen; it is also three times stronger than in IOL made of PMMA [11]. Geometry of the edge of the IOL optical part, as well as shape and angulation of haptic parts are also important. IOLs whose optical part has a sharp edge on the entire circumference are much less often associated with posterior capsule opacification. The sharp edge of lenses made of various materials while adhering to the lens capsule creates a break, visible in histopathological preparations, which acts as a barrier for the LEC migrating to the capsule surface, thus reducing the risk of secondary cataract (Figure 1).

According to Apple et al., IOLs with C-shaped haptens cause less posterior capsule opacification than those with J-shaped haptens. In the view of PCO prophylaxis, a shortcoming of single-piece lens may be the sites where haptens join with the optical part, without the sharp edge acting as a barrier for LEC [12]. An important stage of the surgery, from the point of view of PCO prevention, is placing the IOL in the lens capsule. A benefit of intracapsular fixation is separation of the IOL from the uvea, and creating a barrier for migrating LEC. The barrier effect is the most intense when the lens is placed entirely in the capsule in direct contact with posterior capsule. If one or two haptics are outside the capsule, a potential space is created between the IOL surface and the lens capsule, through which LEC may proliferate toward the visual axis [13].

Pharmacological and chemical prevention

Studies on animals revealed that 1% preservative-free lidocaine solution used during hydrodissection may reduce the quantity of live LEC by weakening cellular adherence to the basal membrane as a result of mechanical and toxic damage of desmosomal connections [14]. Other product used include:

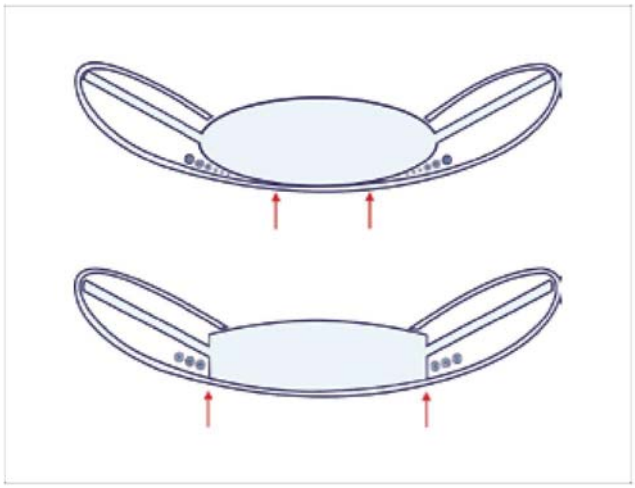

Figure. The barrier effect obtained with sharp edge of IOL. Arrows indicate the area IOL intimately adhere to the lens capsule

Rycina. Efekt barierowy uzyskany dzięki ostremu brzegowi IOL. Strzałki wskazują obszar ścisłego przylegania IOL do torebki soczewki

cyclooxygenase 2 inhibitors, trypan blue, diclophenac, dexamethasone, ricin A antibodies, somatostatin analogues, 90% ethanol, minoxidil, and recently also proteasome inhibitors, e.g. MG-132 [15-17]. It was observed that proteasome inhibitor reduces LEC proliferation in the presence or absence of growth factors which in normal conditions are secreted during the surgical procedure and after. The study results indicate that using proteasome inhibitors may be considered as PCO prevention [17]. It appears that a promising direction in PCO prevention may be using chemical compounds acting by damaging LEC through impedeing their proliferation (5-fluorouracil, C-mitomycin), or the compounds which chemically damage LEC through osmosis. This group includes 23.4% NaCl solution and distilled water [18, 19]. The type and scope of damage depends on the kind of pharmacological product and exposure time. The more cytotoxic agents, the faster and more extensive damage of LEC may be obtained. However, intraoperative pharmacological products should not only be effective, but first and foremost safe. Toxicity of preparations not only for LEC, but also for other eye structures and tissues, primarily the corneal endothelial cells, is the main limitation in their use.

Other prevention techniques

To inhibit LEC proliferation, radiation of the lens capsule with small doses of UVA was also used, as well as intraoperative ultrasounds and cleaning the capsule with a stream of warmed, balanced physiological NaCl solution [20]. For the same purpose, PMMA equator rings as a mechanical barrier for LEC [21]. In experimental studies on rabbits, intracapsular rings with the prolonged 5-fluorouracil release system were used. The presence of a ring as a barrier in the posterior capsule may reduce the risk of PCO, but prevention of LEC development with the use of 5-fluorouracil requires further research [22]. To damage LEC, Malecaze et al. developed a gene therapy method by inducing apoptosis as a result of excessive expression of proapoptotic genes [23].

Conclusion

Presently, there is not one effective method for the prevention of post-operative posterior capsule opacification. It is reasonable to use several methods of prevention simultaneously.

References

1. Pandey S, Apple D J, Werner L, et al. Posterior capsule opacification: a review of the aetiopathogenesis, experimental and clinical studies and factors for prevention. Indian J Ophthalmol, 2004; 52: 99-112
2. Menapace R. Routine posterior optic buttonholing for eradication of posterior capsule opacification in adults. Report of 500 consecutive cases. J Cataract Refract Surg, 2006; 32: 929-943
3. Hu CY, Woung LC, Wang MC. Change in the area of laser posterior capsulotomy: 3 months follow-up. J Cataract Refract Surg, 2001; 27: 537-542
4. Cheng CY, Yen MY, Chen SJ, et al. Visual acuity and contrast sensitivity in different types of posterior capsule opacification. J Cataract Refract Surg, 2001; 27: 1055-1060
5. Lam DSC, Fan DSP, Mohamed S, et al. 25-Gauge transconjunctival sutureless vitrectomy system in the surgical management of children with posterior capsular opacification. Clin Experimental Ophthalmol, 2005; 33: 495-498
6. Ravalico G, Tognetto D, Palomba M, et al. Capsulorhexis size and posterior capsule opacification. J Cataract Refract Surg, 1996; 22: 98-103
7. Amon M. Biocompatibility of intraocular lenses. J Cataract Refract Surg, 2001; 27: 178-179
8. Abela-Formanek C, Amon M, Schild G, et al. Uveal and capsular biocompatibility of hydrophilic acrylic, hydrophobic acrylic, and silicone intraocular lenses. J Cataract Refract Surg, 2002; 28: 50-61
9. Werner L. Biocompatibility of intraocular lens materials. Curr Opin Ophthalmol, 2008;19:41-49
10. Buehl W, Findl 0. Effect of intraocular lens design on posterior capsule opacification. J Cataract Refract Surg, 2008; 34: 1976-1985
11. Linnola RJ, Werner L, Pandey SK, et al. Adhesion of fibronectin, vitronectin, laminin and collagen type IV to intraocular lens materials in pseudophakic human autopsy eyes. J Cataract Refract Surg, 2000; 26: 1792-1806, 34: 1976-1985
12. Apple DJ, Nixon DR. Evaluation of lens epithelial cell migration in vivo at the haptic-optic junction of a one-piece hydrophobic acrylic intraocular lens. Am J Ophthalmol, 2006; 142: 557-562
13. Tognetto D, Sanguinetti G, Cernobori R, et al. Intraocular lens decentration and posterior capsule opacification: anatomo-pathologic findings after implantation of AM0SI40 I0LS. Eur J Ophthalmol, 2006; 16: 46-51
14. Vargas LG, Escobar-Gomez M, Apple DJ, et al. Pharmacologic prevention of posterior capsule opacification: in vitro effects of preservative-free lidocaine 1% on lens epithelial cells. J Cataract Refract Surg, 2003; 29: 1585-1592
15. Inan UU, Oztürk F, Kaynak S, et al. Prevention of posterior capsule opacification by intraoperative single-dose pharmacologic agents. J Cataract Refract Surg, 2001;27:1079-1087
16. Rabsilber TM, Limberger U, Auffarth GU. In-vivo of intracapsular lens epithelial cell growth using sealed capsule irrigation for

secondary cataract prevention - preliminary resalt: Letterto editor. Ophtalmology, 2007; 114: 397-398
17. Awasthi N, Wagner BJ. Suppression of human lens epithelial cell proliferation by proteasome inhibition, a potential defense against posterior capsular opacification. Invest Ophthalmol Vis Sci, 2006; 47: 4482-4489
18. Chung HS, Lim SJ, Kim HB. Efect of mitomycin-C on posterior capsule opacification in rabbit eyes. J Cataract Refract Surg, 2000; 26: 1537-1542
19. Crowston JG, Healey PR, Hopley C, et al. Water-mediated lysis of lens epithelial cells attached to lens capsule. J Cataract Refract Surg, 2004; 30: 1102-1106
20. Dewey S: Ultrasonic polishing of the posterior capsule with the dewey radius tip. Cataract surgery complications. Techniques in Ophthalmology, 2006; 4: 139-148
21. Hara T, Hara T, Hara T. Preventing posterior capsular opacification with an endocapsular equator ring in a young human eye 2-year follow-up. Arch Ophthalmol, 2007;125:483-486
22. Cochener B, Bougaran R, Pandey SK, et al. Non-biodegradable drug-sustained capsular ring for prevention of secondary cataract. Part I: In vitro evaluation. J Fr Ophtalmol, 2003; 26: 223-231
23. Malecaze F, Lubsen NH, Serre B, et al. Lens cell targeting for gene therapy of prevention of posterior capsule opacification. Gene Ther, 2006; 13: 1422-1429

70th anniversary of the 105th Military Hospital with an Outpatient Clinic - a short history of its coming into existence and development

70-lecie 105. Szpitala Wojskowego z Przychodnią w Żarach - zarys historii powstania i rozwoju

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Abstract. In October 2014 we celebrate 70. anniversary of creating the 105th Military Hospital with an Outpatient Clinic in Żary. It were formed in 1944 in Kock as the 8th Field Movable Surgeon's Hospital of the 2nd Polish Army. It passed the combat trail from Kock to Ruszów. In 1946 it arrived in the city Zary, where is stationed up till today. 13 commandants commanded the hospital, in it 9 veterans of the 2nd World War.
Keywords: military hospital. Żary, Sorau, Iłowa, Halbau

Streszczenie. W październiku 2014 roku obchodzimy 70. rocznicę powstania 105. Szpitala Wojskowego z Przychodnią w Żarach. Został on sformowany w 1944 roku w Kocku jako 8. Polowy Ruchomy Szpital Chirurgiczny w składzie II Armii Wojska Polskiego. Przeszedł cały szlak bojowy od Kocka do Ruszowa. W 1946 roku przybył do miasta Żary, gdzie stacjonuje do dziś. Szpitalem dowodziło 13 komendantów, w tym 9 weteranów II wojny światowej.
Słowa kluczowe: szpital wojskowy. Żary, Sorau, Iłowa, Halbau

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Introduction

In October 2014, we celebrate the 70th anniversary of creating the 105th Military Hospital with an Independent Public Health Care Clinic in Żary.

The local military clinic is one of the leading centres of this type in the entire Lubusz Land. It is famous for its experienced medical personnel and state-of-the-art equipment for diagnosis and treatment. Few people realise that this modern facility is a veteran of World War II - as the 8th Mobile Field Surgical Hospital, it blazed a combat trail with the troops of the 2nd Polish Army. Its character was put to the ultimate test during the unusually fierce battle while crossing the Lusatian Neisse in April 1945. A year after the war, it was permanently relocated to Żary, in which it has stationed ever since, for more than 68 years.

The 8th Mobile Field Surgical Hospital was established by the Order of the Commander-in-Chief of the Polish Armed Forces no. 8 of 20 August 1944, together with the other hospitals in the region of Czemierniki-Kock-Siedlce. The Field Evacuation Point (in Russian abbreviated as PEP) no. 3, commanded by Major Leon Gecow, MD, operated 13 different hospitals (8th Mobile Field Surgical Hospital - Kock, 9th Mobile Field Surgical Hospital - Krzesk, 10th Mobile Field Surgical Hospital - Dębica, 11th, 12th, 13th Mobile Field Surgical Hospital - Milanów, 20th Mobile Field Internal Medicine Hospital - Nowiny, 21st Mobile Field Internal Medicine Hospital - Kock, 24th Mobile Field Hospital of Infectious Diseases - Wrzosów, 25th Mobile Field Hospital of Infectious Diseases - Stok Lacki, 28th

Hospital for the Slightly Injured - Siedlce, 29th, 30th Hospital for the Slightly Injured - Czemierniki), including two of them in Kock. In the middle of October 1944, Lieutenant Karol Rumeld, MD, together with four medical doctors (Czesław Sadliński, Wiesław Hołobut, Wendelin Stanek, Tłuka?), four sisters and about ten paramedics departed for the new location, thus establishing the 8th Mobile Field Surgical Hospital.

The place where it all started is highly symbolic – Jabłonowski Palace in Kock, the backdrop against which Brigadier General Franciszek Kleeberg signed the surrender of the Independent Operational Group "Polesie," the last of the Polish Army troops that had been fighting Germans and Russians until 5 October 1939. It is right here that, after five years, one of the best field hospitals of the entire 2nd Polish Army was created. It is, then, safe to assume that the spirit of the virtuous general aided the Polish doctors. One half of the premises was occupied by the 8th Mobile Field Surgical Hospital, the other – by the 21st Mobile Field Internal Medicine Hospital, commanded by Lieutenant Witold Świątnicki, MD.

By design, the field surgical hospital is a centre with a hundred beds, two departments, and the following at its disposal: pharmacy, X-ray apparatus, specialist equipment and accommodation facilities. The first order of the day for the 8th Mobile Field Surgical Hospital (field post office no. 56881) was issued on 31 October 1944. It was signed on commander's behalf, by the agency of Officer Czesław Sadliński MD, PhD, an alumnus of Lviv University who came from the Eastern Borderlands, before the war – an employee of the 6th civil and military District Hospital in Lviv, (later – a distinguished professor and one of the fathers of Silesian surgery, for many years – head of the Department of Surgery at the Medical University of Silesia). Thus began the process of creating the structures of the unit, enlisting new soldiers and coaching the whole team.

It should be borne in mind that this is the period after the fall of the Warsaw Uprising, the outbreak of which - supposedly - had caused Stalin to withhold the Red Army's military manoeuvres on the Eastern Front. On this account, there was no influx of new wounded soldiers; hence, the hospital, for some time to come, would mainly tend to patients suffering from appendicitis and hernia. Staff shortages compelled the two neighbouring hospitals to cooperate, as a result of which the common duty operations services were alternately provided by the teams of the 8th Mobile Field Surgical Hospital and 21st Mobile Field Internal Medicine Hospital [1,6].

In the second half of December 1944, regardless of many difficulties, logistic in nature, the hospital began to resemble more and more of a fully equipped military medical unit. In recognition of MD Lieutenant Karol Rumeld's organisational efficiency, MD who was commander of the 8th Mobile Field Surgical Hospital, his superiors promoted him to the rank of Major by the Order of the Commander-in-Chief of the Polish Armed Forces no. 98 of 22 December 1944. Simultaneous promotions: to the rank of captain – Lieutenant Wiesław Hołobut, MD (later – a distinguished professor and rector of the Medical University of Lublin), to the rank of lieutenant – Sublieutenant Józef Tumułka, MD and Subieutenant Marian Litwin, MSc, to the rank of warrant officer - Senior Sister Irena Zielińska.

On 17 January 1945, the hospital moved out of the cosy Jabłonowski Palace, Kock, and by three vehicles (with all the staff, stock and equipment) arrived at the estate Leszczyny (Garwolin County), where for three days, since it put up its tents, it had been standing by to take action whenever necessary. Subsequently, by the Order of the Day no. 15 of 18 January 1945, it transferred all the remaining patients to the 12th Mobile Field Surgical Hospital, while preparing for the departure for the new location – the town of Koło upon the Warta River.

The unit positioned itself in the neighbourhood of multi-family residential buildings, sharing the premises with the partner 21st Mobile Field Internal Medicine Hospital, similarly as in Kock. During its month's stay in Koło, the hospital was still being held in a state of constant readiness, concurrently filling staff shortages and encouraging the cooperative spirit among the entire personnel. In that period, there was no influx of the wounded – only six ill Germans were tended to, which proves the physicians on duty to have had strong morals. After all, some of the staff had lost their relatives at the hands of the German army, in mass murder (including the Holocaust), and – thus – could not possibly have had any fondness for this people, who – in democratic elections – had voted for Adolf Hitler as their Führer and Reichskanzler.

On 15 February 1945, Lieutenant Colonel Andrzej Szkwara, MD, assumed command after being delegated from the Red Army to the Polish Army. By his order, three days later, the 8th Mobile Field Surgical Hospital departed, by five vehicles, for the town of Złotów (in German: Flatow), near Bydgoszcz. This manoeuvre was connected to the preparation of the 2nd Polish Army within the framework of the 1st Ukrainian Front and 1st Polish Army within the framework of the 1st Belarusian Front, for the Battle of Berlin. At that point, Złotów was one big hospital, where all public utility buildings (schools, offices, inns) were occupied by the medical personnel of the 1st Polish Army and Red Army. The 8th Mobile Field Surgical Hospital was then allocated as support for the field hospital of the 1st Polish Army, commanded by Colonel Dokuczaev. In that period, the organisational structure was altered to better serve the current intended purpose of the hospital, which had two fully-fledged departments, pharmacy, X-ray apparatus and canteen.

During its stay in Złotów, the unit did not start functioning on its own, as it provided medical assistance to the benefit of the soldiers of the 1st Polish Army. On 28 March 1945, it moved to Oleśnica (in German: Oels), only to arrive at Skarszyn (in German: Sauerbrunn) two days later, for the deployment of the 2nd Polish Army as back-up units in the siege of Breslau (in German: Schlacht um Breslau), within the

second wave of the Soviet troops. In Skarszyn, the hospital positioned itself partly in the local palace, partly under the tents in the palace gardens. All the time, dynamic changes on the staff roster were being made, necessitated by the constant shortage of physicians. It should be recalled that just in the Katyń Forest massacre a few hundred medical doctors had been murdered, many of them exiled to Siberia, and a significant number annihilated during the German AB-Aktion. Operational Order no. 8 of the 2nd Polish Army of 9 April 1945 prepared the subordinate units for the Battle of Berlin. In keeping with the directive issued by Commander of the 1st Ukrainian Front, Marshal Ivan Konev, of 11 April 1945, the 2nd Polish Army was to cross the Lusatian Neisse and breach the German defence on the frontline Rothenburg-Nieder-Neudorf, towards Niesky and Dresden. According to treatment and evacuation plan developed by the medical army unit, the whole operation would last seven days. It was estimated that the losses would reach 12,000 of the wounded (including 30% of the slightly injured) of the total 80,000 soldiers. The hospitals were divided into three groups: first-order hospitals, hospital base (collector) and reserve hospitals. On the eve of the operation, the medical facilities of the 2nd Polish Army, unfortunately, had only 1,530 beds, that is 40% of what they should have had by organisational structure design (4,100 beds). Medical transport turned out to be highly problematic as well, since instead of 245 vehicles, only 47 lorries and 10 special cars were available. On 16 April 1945, at 6 am (the beginning of the operation aimed at crossing the Lusatian Neisse), only the following were fully developed: the 10th Mobile Field Surgical Hospital in Gozdnica (in German: Freiwaldau) and 20th Mobile Field Internal Medicine Hospital, 24th Mobile Field Hospital of Infectious Diseases and CzPE no. 4 in Ruszów (in German: Rauscha). The 8th Mobile Field Surgical Hospital arrived on 14 April 1945 at the hospital base in Ruszów, where it positioned itself under tents and in the ordinary barracks where forced labourers exiled to Germany had previously dwelled.

The conditions of accommodation were just terrible, the huge barracks were divided into small dark, stuffy rooms. In one of the barracks with larger rooms, a segregation checkpoint and waiting area for the wounded were orchestrated. Generally, the hospital served as a centre for treating the wounded in the thighs and large joints, it had at its disposal a surgical dressing room with six tables; for the purpose of cast application, a makeshift orthopaedic table was constructed. The number of wounded soldiers catered for, which at the peak exceeded 1,000 persons (100 beds by organisational structure design), convincingly demonstrates the significant share of work the hospital staff put in.

The provision of medical service while crossing the Lusatian Neisse is deemed to have been the most spectacular success of the 8th Mobile Field Surgical Hospital. All the more it should be emphasised that no

Figure 1. Officer's corps of the Garrison Hospital in Żary, Żary, 1947

Rycina 1. Kadra oficerska Szpitala Garnizonowego w Żarach, Żary, 1947 r.

sooner had the operation begun than the hospital started accommodating to the new location and, virtually on the fly, leapt into action on a scale ten times greater than the capacity by its organisational structure design. The enormous number of severely injured soldiers whose lives were saved or suffering relieved in the last moments of their lives is the most notable success the hospital had ever had under its belt.

On 6 May 1945, a few days before the surrender of the 3rd Reich, Lieutenant Colonel Andrzej Szkwara, MD, who was at the helm of the hospital during the most intense combat operations, put Lieutenant Mieczysławow Melow, MD, in charge. The end of the 6-year World War II brought the entire staff overwhelming joy, even though some of them had come from the Eastern Borderlands and could not return to their home turf, illegally occupied by the USSR. Additionally, what raised their fears was the genocide of the Polish people in Volhynia at the hands of the nationalists from the criminal Ukrainian Insurgent Army, to whom relatives of the field hospital staff had fallen victim. For the next weeks, in the aftermath of the war, hundreds of severely injured,

mutilated soldiers were admitted to hospital; needless to say, they still required full commitment and devotion of the personnel [1,5,6].

In the middle of August 1945, the 8th Mobile Field Surgical Hospital, once more, changed its location and moved to Iłwia (in German: Halbau, formerly: Ilwa, at present: Iłowa), where it took over the rooms and part of equipment from the 29th Hospital for the Slightly Injured, which had previously stationed there. It occupied the local palace (at the moment, a private boarding house) and school, cinema and residential building near the glass works. Conditions in this new location were markedly better than in the barracks and tents in Ruszów. The spacious bright well-ventilated rooms, running water and beautiful park, soothing the minds of the wounded during their rehabilitation – all these factors converged to the benefit of the personnel and patients. The hospital itself made a step towards becoming a stationary facility. Similarly, the hospital saw Captain Maksymilian Mościsker, MD, alumnus of the Jagiellonian University, take the position of commander. He was the last to become commander of the 8th Mobile Field Surgical Hospital.

Changes of the organisational structure design in peacetime

On 22 August 1945, the 2nd Polish Army ceased to exist, while the 8th Mobile Field Surgical Hospital, included in the unit, by the order of the day no. 131 of 22 September 1945 (by the Organisational Order of the Commander-in-Chief of the Polish Armed Forces no. 0233 of 6 September 1945) was turned into the Garrison Hospital with the organisational structure design no. 24/24. It had 100 beds and was subordinate to the Military District Headquarters in Poznań. Back then, it was still stationed in Iłwia (in German: Halbau, at present: Iłowa) and comprised four departments of:

- surgery, commanded by Captain Arnold Sinkower, MD,
- general medicine, commanded by Captain Salomon Riegelhaupt, MD,
- infectious diseases, commanded by Lieutenant Stanisław Klimkiewicz, MD (from 26 November 1946),
- venereal diseases, commanded by Senior Brigadier Bernard Kohane, MD (soon promoted to the rank of officer).

The hospital also had a physiotherapy office and X-ray apparatus. On 26 October 1946, the Garrison Hospital became subordinate to the Military District Headquarters of Silesia.

The last – tenth – removal of the already stationery centre was scheduled to take place on 15 May 1946, destination: the town of Żarów (in German: Sorau, at present: Żary). The hospital occupied the buildings of the former German mental hospital (Brandenburg Psychiatric Institution), where – during World War II – within the framework of the Action T4, German psychiatrists had practised non-voluntary euthanasia on the mentally ill. The premises on which the former Brandenburg Psychiatric Institution had operated comprised the area of ca. 26 ha, 30 buildings, fruit orchard and two cemeteries, where officers and soldiers of the Red Army were buried. The majority of the available rooms had been adopted for the psychiatric ward; they had neither door nor window handles, their dimensions were huge, windows – behind bars.

Rubbish and debris everywhere, waves of rats, pungent odour – this is the picture that would spring to the minds of former soldiers from the Garrison Hospital in Żary. Bringing the building back to the normal state, typical of a decent hospital, required a gigantic amount of work, performed by the centre staff, the charge of which was taken by Captain Bronisław Seyda, MD, from 22 May 1946. Thanks to the titanic struggle against the odds, the physicians and remainder of the personnel were, in a few years' time, able to establish the 100-bed Garrison Hospital, as of 1949 – with three departments (of surgery, general medicine, skin and venereal diseases), admission room, X-ray room, physiotherapy office, laboratory, dentist office, laundry, canteen and administrative team.

More radical structural changes were introduced by the order of the Minister of National Defence no. 0055/organisational order of 18 June 1951, based on which the hospital was awarded the name of the 105th Garrison Hospital in Żary, while the number of available beds reached 200. New departments appeared. In total, there were already seven departments of: internal medicine, surgery, skin and venereal diseases, infectious diseases, ophthalmology, otolaryngology, gynaecology and obstetrics with the classification of infants (due to space limitations, the department of gynaecology would not develop and, basically, only the department of obstetrics with the classification of infants functioned) and admission room, X-ray room, dentist office, physiotherapy office, pharmacy and clinical laboratory. In addition, an anatomical pathology laboratory was created, allowing the staff to conduct the post-mortem examination onsite, and from June 1953, in building no. 23, a polyclinic. Besides the typically medical departments, the hospital developed on the logistic-bureaucratic side; the following units were established: headquarters, chancellery, quartermaster, administrative team, automotive team, call centre, financial section, organisational-maintenance group and military casino. As for the more important changes, what deserves to be mentioned is the creation of the post of chairman of the Military Medical Commission at the 105th Garrison Military Hospital.

The Special Order of the Commander of the 105th Garrison Military Hospital no. 01 of 1 February 1957 introduced the new organisational structure design no. 21/258, as a result of which the three existing departments were closed down, of: ophthalmology, otolaryngology, infectious diseases and anatomical pathology laboratory. In place of the previous structures, the following appeared: subdepartment of

Figure 2.105th Military Hospital with an Outpatient Clinic in Żary, Żary, 2014

Rycina 2.105. Szpital Wojskowy z Przychodnią w Żarach, Żary, 2014 roku

ophthalmology and subdepartment of laryngology, commanded by the senior assistants: ophthalmologist and laryngologist, without any definite number of beds arising from the organisational structure design, administratively subordinate to the department of surgery. Instead of the department of infectious diseases, there was a subdepartment of observation and isolation, within the department of internal medicine. The well-equipped and ready for work anatomical pathology laboratory, installed in a different building, was then closed down.

In June 1957, the existing department of obstetrics with the infant subdepartment developed into the department of gynaecology and obstetrics with the infant subdepartment. As far as the essential changes are concerned, speaking of the other departments, what deserves to be mentioned is the creation of the political section (three posts, including one for an officer) and transport-administrative team (four non-commissioned officers, five privates). Simultaneously, the Military Medical Commission witnessed the creation of an additional officer post for the commission member. At that time, the 105th Garrison Military Hospital, which could boast of 200 beds, employed 40 officers, 6 re-enlisted non-commissioned officers, 2 non-commissioned officers within the compulsory military service, 8 privates within the compulsory military service and 182 civilian workers. The scope of the hospital's activity then comprised the area confined by the Oder and Lusatian Neisse, with such locales as: Zielona Góra, Krosno Odrzańskie, Głogów, Zgorzelec, Żagań, Żary and others (two years later Głogów was allocated to the region of the 111th Military District Court in Poznań). There was a garden, with the total surface of 2 ha, fully self-sufficient, beneficial and providing fresh food products to the hospital canteen, near which it was located. Domestic pigs were reared (e.g. in 1957, 6 sows, 3 finisher pigs, 32 piglets) on kitchen scraps. There were also some pack animals: 4 horses and the great frontline heroine donkey "Baśka" (in official documentation by the name of "Iwa"), who would forever be remembered fondly by all the hospital employees as very friendly and helpful. At present, she is the official mascot of the military clinic in Żary.

The accelerated development of the medical thought helped improve treatment and working conditions, achieve greater efficiency in the struggle against many diseases, create new structures and introduce new specialities in the hospital. Especially important in the history of our centre were the 1960s and 1970s, which is when Major Józef Błaszczyk, MD, took control and implemented his vision for the development of the 105th Garrison Military Hospital, elevating it to a whole new level, letting it catch up with the best in Poland, with gusto, brazenly. On 9 November 1967, a blood donation point was officially launched, separated from the clinical laboratory, in which it had functioned beyond the organisational structure design since 1964. Four years later, by the order of the day no. 25/72 of 31 January 1972, the department of laryngology and ophthalmology was established, through the introduction of the posts of senior otolaryngologist assistant and senior ophthalmologist assistant from the department of surgery; in fact, the new structure had been in operation since 1971. In May 1971, by the personnel order no. 0105 of 29 May, the department of psychiatry

was emerged. Its head and originator was Lieutenant Colonel Wiktor Jędrzejkiewicz, MD.

All these changes resulted from the activity and initiative of the hospital staff, who – gaining new medical knowledge – could treat more and more serious cases, which necessitated the expansion of the entire centre through the acquisition of state-of-the-art equipment and adaptation of the rooms for given purposes. In 1969, upon commander's request, the number of beds by organisational structure design increased to 260, which was a positive sign for the dynamic and creative medical staff, indicating that there were real chances to build one's career in the 105th Garrison Military Hospital. Doubtless, Captain Henryk Śmiłowski, MD, and Lieutenant Colonel Stanisław Szmelter, MD, took advantage of the favourable conditions. In May 1978, the former created the isotope laboratory, the latter – distinguished the anaesthesiologists, previously operating within the department of surgery, as a separate anaesthesiology and intensive care team. On 1 June 1981, by the Ordinance no. 039/Organisational Order of the Silesian Military District Chief of Staff of 11 March 1981, the 105th Garrison Military Hospital was transformed into the 105th Military Hospital with an Outpatient Clinic, by the organisational structure design no. 56/108, with 370 beds, 63 soldiers in wartime and 64+22 soldiers in peacetime. At the same time, the hospital became responsible for the professional-specialist supervision of outpatient clinics, first-aid rooms, infirmaries of the Medical Area 9, including such garrisons as: Zielona Góra, Czerwieńsk, Szczawno, Radnica, Krosno Odrzańskie, Gubin, Przewóz-Potok, Nowogród Bobrzański, Kożuchów, Żary, Żagań, Głogów and Zgorzelec.

Changes in the medical nomenclature as regards the names of the particular departments are evident, as well as the creation of the new or transformation of the existing structures. As to the latter, it should be mentioned that the department of gynaecology and obstetrics with the infant subdepartment turned into the department of gynaecology and obstetrics, while the paediatrician's office replaced the former subdepartment. The department of laryngology and ophthalmology went back to its roots and was divided into two self-contained departments: of otolaryngology and ophthalmology (due to staff shortages and space limitations, in actuality, they did not start functioning on their own until 1986). The department of infectious diseases also went back to its roots, separated from the department of internal medicine, within which it had functioned as a subdepartment. Speaking of important structural changes, what deserves to be mentioned is the creation, from the ground up, of the department of traumatology and orthopaedics (due to staff shortages and space limitations, it began to function as a separate structure in January 1987). As a result of the transformation of the physiotherapy office, the therapeutic rehabilitation centre was established, whereas the anaesthesiology and intensive care team developed into the department of anaesthesiology and intensive care. It is also noteworthy that the blood donation point grew into a professional blood donation centre, a source of pride for commander and the entire hospital [1,2,4].

The development of modern medicine and new specialities had an impact on the structures of the 105th Military Hospital with an Outpatient Clinic. By the Order of the Day no. PF/90 of 1 February 1990, the department of urology was separated from the department of surgery; a few months later, the isotope laboratory turned into the nuclear medicine institute with an isotope department. The department of internal medicine also began to divide into smaller structures, related to given medical specialities. Hence, in 1986, a rheumatology clinic emerged, while two years later – a gastroenterology clinic and USG office. In 1990, a cardiology clinic was established. It was the germ of the department of cardiology, which was created in 1998.

The turn of the 21st century is one of the most difficult periods in the history of the military hospital in Żary. By the Ordinance of the Minister of National Defence of 7 October 1998, the 105th Military Hospital with an Outpatient Clinic was transformed into an Independent Public Health Care Institution, on 1 January 1999. As a result of the so-called restructuring in December 1998, the following departments were dissolved: ophthalmology as well as gynaecology and obstetrics. The further stages of this peculiarly interpreted reform took its toll on 26 March 2002, which is when the department of urology was closed down. The final nail in the hospital coffin during that "time of troubles" was the dissolution of the department of infectious diseases in 2004 and, two years later, the department of gynaecology (reactivated in April 2000). By the Order of the Day of Commander no. Z-248/2002 of 27 December 2002, the 105th Military Hospital with an Independent Public Health Care Clinic was stripped of some military posts; 43 officers left for the reserve force, a few individuals joined the reserve staff, the rest served in other military units. Under such circumstances, Lieutenant Colonel Sławomir Gaik, MD, stepped down as commander of our centre. On 27 February 2003, he became director of the already civil hospital.

The "time of troubles" in the history of our hospital came to an end in the second half of the first decade of the 21st century. At that time, the previously closed down structures began to reappear, which convincingly demonstrates that the decision on their dissolution was hasty. At the beginning of 2008, from scratch, within the department of otolaryngology, the subdepartment of ophthalmology was created, at the same time – the laboratory of fluorescein and indocyanine green angiography, laser and ultrasound laboratory, further – optical coherence tomography (OCT) laboratory, which positions our ophthalmology as one of the best in the entire Lubusz Land. The subdepartment of urology returned in grand style as well; it was reopened in 2009, within the department of surgery. On 29 January 2010, we held the official ceremony for the opening of

the intensive cardiac monitoring department compliant with all the criteria of the emergency medical service act SOR, the first such in this voivodeship, and state-of-the-art imaging centre. One year later, a central sterile services department was commissioned, which – as one of the few in this voivodeship – can also sterilise emergency vehicles.

An important date in the history of our centre is 27 April 2010, when between Żary hospital and eldership in Żagań, an agreement was signed for the provision of health services in the Żagań County (on 12 April 2013 re-signed for another five years). It bore the fruit of the branch of the 105th Military Hospital with an Independent Public Health Care Clinic based on the civil hospital in Żagań.

At present, the centre is supervised by the Minister of National Defence, through the agency of head of the military health care inspectorate. By its organisational structure design, the hospital is equipped with 470 beds, it employs, in different forms, ca. 700 workers, including 152 medical doctors, 2 dentists, 17 masters (pharmacists, analysts, physiotherapists, psychologists) and 348 nurses and rescue workers, including 18 midwives. A special mention should be made of the two new units: department of stroke medicine, with the subdepartment of neurological rehabilitation, subdepartment of neurotic disorders and combat stress (within the department of psychiatry), subdepartment of locomotor system rehabilitation (within the department of traumatology-orthopaedics surgery) and the following subdepartments of: gastroenterology, rheumatology and metabolic diseases (all of them within the department of internal medicine).

The branch in Żagań is equipped with 150 beds in five departments of: neonatology, gynaecology-obstetrics, internal medicine, with the subdepartment of gastroenterology, and general surgery, with the subdepartment of oncological surgery and urology, as well as state-of-the-art emergency medical service teams. It is plain to see that it perfectly complements its parent hospital, notably with the structures closed down in Żary towards the end of the 1990s. The comprehensive Primary Health Care system fares very well with clinics in the 105th Military Hospital with an Outpatient Clinic in Żary, in Świętoszów and Osiecznica. For many years, the specialist clinic has functioned successfully, which clinic includes 18 specialist offices in Żary and 15 in Żagań. Doubtless, what has symbolically strengthened the dominant position of our hospital among the health care centres of Lubusz Voivodeship is the rescue helicopter landing pad, which was put into service on 14 June 2013, located on the premises of the 105th Military Hospital with an Independent Public Health Care Clinic, in cooperation with the local government. Thanks to the helipad, our centre is one of the best equipped emergency medical service centres in the entire Lubusz Land, with the full capacity for diagnosis and treatment, and – possibly – the fastest medical transport facilities [1,2].

Table. Hospital commanders between 1944 and 2003
Tabela. Komendanci szpitala w latach 1944–2003

Rank, full name	Term of office
Lieutenant/Major Karol Rumeld, MD	10.1944-15.02.1945
Lieutenant Colonel Andrzej Szkwara, MD	15.02.1945-6.05.1945
Lieutenant Mieczysław Mel, MD	6.05.1945-29.08.1945
Captain Maksymilian Mościsker, MD	29.08.1945-23.10.1945
Captain Adam Browar Paszkowski	23.10.1945-22.05.1946
Captain/Major Bronisław Seyda, MD	22.05.1946-26.05.1948
Major/Lieutenant Colonel Dzieszuk-Ciszewski, MD	26.05.1948-02.1952
Major/Lieutenant Colonel Teofil Tadeusz Ziemski, MD	02.1952-6.04.1957
Major/Lieutenant Colonel Jan Buszke, MD	24.04.1957-12.04.1961
Major/Lieutenant Colonel Edmund Chronowski, MD	12.04.1961-13.03.1965
Major/Colonel Józef Błaszczyk, MD	13.03.1965-2.02.1993
Colonel Stanisław Wróblewski, MD	2.02.1993-18.03.2002
Major/Lieutenant Colonel Sławomir Gaik, MD	18.03.2002-27.02.2003

Commanders

In its entire history, the hospital, under different names (8th Mobile Field Surgical Hospital, Garrison Hospital, 105th Garrison Hospital, 105th Garrison Military Hospital, 105th, Military Hospital with an Outpatient Clinic, 105th Military Hospital with an Independent Public Health Care Clinic), has been commanded by 13 officers (see the tab.). It should be observed that nine of them are frontline soldiers; only four, in military jargon, have not fought "in the trenches." Among the commanders, we have had one soldier who fought the Bolsheviks in the Polish-Soviet War, 1920, veterans of the defensive war, 1939, soldiers of the resistance (Home Army, People's Guard, People's Army), 1st and 2nd Polish Armies and Red Army. One of the commanders – Lieutenant Colonel Teofil Tadeusz Ziemski, MD – for his bravery and courage, was awarded the Cross of Valour, one of the most important military decoration. These commanders were the longest in office: Colonel Józef Błaszczyk MD (28 years), Lieutenant Colonel Sławomir Gaik MD (1 years as commander + 11 years as director), Colonel Stanisław Wróblewski MD (9 years), and Lieutenant Colonel Teofil Ziemski MD (5 years). One of the most influential figures among the all of our commanders was, with all certainty, Colonel J. Błaszczyk, MD, not only because he obtained a

mandate for the 10th term of the lower house of the Polish parliament (Sejm), but also, and above all else, because of his contribution to the extension of the hospital and because of the improvement of its status as regards purchase of state-of-the-art equipment, introduction of efficient methods for treatment and diagnosis, as well as selection of highly qualified medical personnel. From among the 13 commanders, four of them are Polish Jews who were lucky to survive the Holocaust; they did not emerge psychologically unscathed (most of them had lost their relatives during the war); yet thanks to their high morale and passion for their work, they fully committed themselves to building and developing the hospital. A word or two should be put in for the education institutions where the commanders took their first steps as doctors. These are medical faculties highly-regarded throughout Europe. We have had two alumni of the Jagiellonian University, one of Lviv University, one of Vilnius University and one of Poznań University. The Medical University of Łódź, within the framework of the Military Medicine Major, included in the Military Medical Training Centre, taught another two commanders, similarly – the Military Medical University in Łódź. Among the European education institutions at which our commanders gained their knowledge are universities in: Prague, Turin, Modena, Naples and Montpelier. It should be emphasised that Colonel Teofil Tadeusz Ziemski, MD, PhD, during the interwar period, was an alumnus of the Reserve Battalion of the famous Medical Officer Cadet School in Warsaw, while Lieutenant Colonel K. Rumeld, MD, took his first steps as officer during reserve force manoeuvres organised by the Reserve Staff of the 5th District Hospital in Cracow. Considering the military ranks held while taking charge of the post of commander, we have had a variety of officers, from lieutenant to colonel; leaving the hospital, the majority of them had already been promoted to the ranks of lieutenant colonel and colonel (although there were also captains and one major). So far, the youngest commander has been 29-year-old Captain Adam Browar Paszkowski, the oldest – 47-year-old Colonel Stanisław Wróblewski, MD; the largest group consisted of the thirty-some-year-olds. The most of our commanders come from central Poland, two of them were born in Russia (one near Moscow, the other – Rostov), four in the Eastern Borderlands: Lviv Voivodeship, Tarnopol Voivodeship, Nowogród Land [1-3]. It should be emphasised that among the three most prominent commanders, two are from beyond the Bug, which confirms Marshal Józef Piłsudski's famous tongue-in-cheek theory of the alleged superiority of the Eastern Borderlands over the rest of Poland. On 9 May 2014, on the initiative of this publication's authors, a commemorative plaque was unveiled on the wall of the Polyclinic at the 105th Military Hospital with an Independent Public Health Care Clinic, to honour all the commanders.

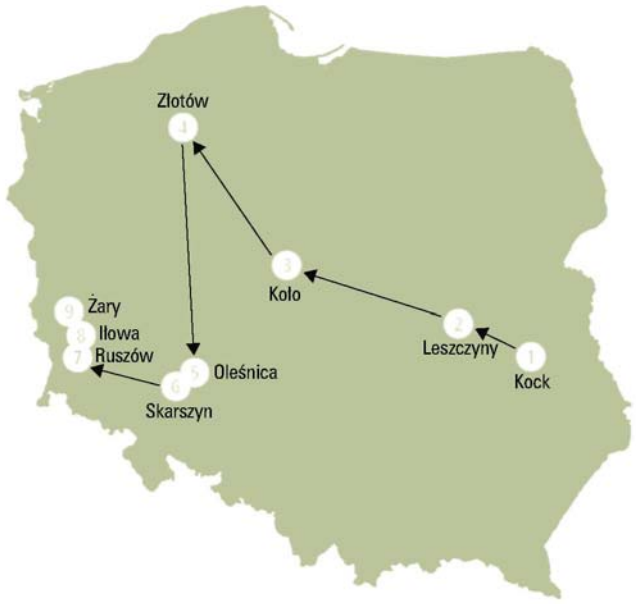

Figure 3. The combat trail of the 8th Field Movable Surgeon's Hospital

Rycina 3. Szlak bojowy 8. PRSzCh

Conclusions

The 8th Mobile Field Surgical Hospital, that is to say the forerunner of the 105th Military Hospital with an Independent Public Health Care Clinic in Żary, earned its place in the history books of Polish military health care, as a medical unit of the 2nd Polish Army. Within only a year, a modern and functional medical centre had been established from the ground up, which demonstrated its skill during actual combat operations. Its greatest asset was the highly trained and experienced medical staff, which allowed the hospital to perform tasks more complex than the capacity by its organisational structure design. It is not coincidental that among the originators, we have two graduates of Lviv University, who – soon enough – became icons of Polish medicine and gained fame around the world: Prof. Czesław Sadliński, MD, PhD, and Prof. Wiesław Hołobut, MD, PhD.

What also played a substantial role, apart from the quality education, was the involvement and commitment of the personnel, further – some kind of positive improvisation, necessitated by the field conditions, e.g. the creation of the makeshift orthopaedic table. During its frontline service, the unit changed the location and moved with the whole team and property nine times, which is noteworthy and appreciated by all those who have ever developed, even in peacetime, at least one field hospital (Fig. 3). The biggest and the most priceless success of the 8th Mobile Field Surgical Hospital is saving lives and

health of many Polish soldiers who, wounded in the battle against the Germans, had their pain relieved with the help of the personnel.

Summing up the changes of the organisational structure design of the Military Hospital in Żary in the 1970s, a special mention should be made of the constant development and extension of the centre (with a few years of standstill at the turn of the centuries), through the acquisition of state-of-the-art equipment and reaping benefits of science and technology. It has come a long way from the 100-bed, two-department military field hospital, in which 47 soldiers were on duty, to the 105th Military Hospital with an Independent Public Health Care Clinic with the branch in Żagań, having at its disposal 470 beds, 17 departments, employing ca. 700 civilian workers.

At the moment, not only is it a huge medical centre, providing care and treatment for many thousands of patients, but also one of the biggest employers in the region, which should not be understated in this time of crisis and sky-high unemployment. Today, no-one in the right mind could imagine Żary without the military hospital, thanks to which patients from our region have specialist medical care available within striking distance. In few, very dramatic cases, beyond our capabilities, the patient can be, in a split second, transported by helicopter to a centre characterised by a higher level of medical services. Equally important is the permanent care of the soldiers of the 11th Lubusz Armoured Cavalry Division, whose patron is Jan III Sobieski, currently one of the most combative units of the Polish Armed Forces.

It seems like decision-makers should think how to medically secure the draftees, so as to avoid the current state of affairs in future, when an ill officer is forced to wait in a long queue for a couple of months. In view of the lack of authoritative voices these days, we should give the credit a few generations of military doctors who, in extremely difficult conditions, were able to create a very good hospital out of thin air within a few dozen of years.

References

1. Archive of the 105th Military Hospital with an Independent Public Health Care Clinic: KRD PF15/98, PF11/98, Z-29/2002, Z-17/2002; KSG: 11-69
2. Military Archive in Oleśnica: Fonds 214, Żary Garrison Hospital, reference no. 1417/5/51, 0810/21/56,12322/65/8
3. Central Military Archive in Warsaw: TAP 1573/75/276; TAP 1256/67/160; TAP 990/64/199
4. Jeśman Cz. Profesorowie i Docenci Wojskowej Akademii Medycznej w Łodzi im. gen. dyw. prof. Bolesława Szareckiego [Professors and Decision-makers of the Military Medical University of Łódź]. Łódź, Wydawnictwo UM Łódź, 2008: 30-31
5. Killar M, Zabłotniak R. Niektóre uwagi o zabezpieczeniu medycznym forsowania Nysy w 1945 r. [Certain remarks on medical protection while crossing the Lusatian Neisse in 1945] Mil. Phys., 1966; 3: 239-245
6. Płoński K. W szeregach Służby Zdrowia 2 AWP [In the ranks of the Health Care of the 2nd Polish Army]. Warsaw 1969: 51-52

Lieutenant-colonel, professor of medicine Antoni Tomasz Aleksander Jurasz (1882-1961) - surgeon, scientist, community worker and patriot

Podpułkownik, profesor medycyny Antoni Tomasz Aleksander Jurasz (1882-1961) - chirurg, naukowiec, społecznik i patriota

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Abstract. Lieutenant-colonel, professor of medicine Antoni Tomasz Aleksander Jurasz (1882-1961) was an outstanding surgeon, a scientist and a community worker. Born as a German, all his skills he gave to Poland, once it regained its independence in 1918 and he continued his work for Poland despite the outbreak of the II World War. The purpose of the series of this articles is to present the cause-effect analysis of his development, work and achievements of his life.
Key words: Antoni Tomasz Aleksander Jurasz

Streszczenie. Ppłk prof. med. Antoni Tomasz Aleksander Jurasz (1882-1961) byt nietuzinkowym człowiekiem: chirurgiem, naukowcem i społecznikiem. Urodził się jako obywatel niemiecki, ale wszystkie swoje umiejętności ofiarował Polsce, ojczyźnie swojego ojca. Antoniego Stanisława Jurasza, po odzyskaniu przez nią niepodległości w 1918 roku. Realizacji tego celu nie przerwał nawet wybuch II wojny światowej. Celem niniejszego - pięcioczęściowego - opracowania jest zaprezentowanie przyczynowo-skutkowej analizy rozwoju bohatera, jego twórczości i dorobku całego życia.
Słowa kluczowe: Antoni Tomasz Aleksander Jurasz

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Introduction

The aim of the series of articles dedicated to Lieutenant Colonel Pofessor Antoni Tomasz Aleksander Jurasz, MD (1882-1961) is not only to present his contribution to Polish and international surgery, Polish society and Poland after it regained independence in 1918, but also to analyse the mechanisms through which his parents and teachers formed his character, as well as the circumstances which allowed him to generate such impressive and multi-faceted achievements during a long and rich life.

Professor A.T.A. Jurasz is the creator of Poznań school of surgery (also known as "Jurasz's school of surgery"), the Polish Medical Faculty at the University of Edinburgh, Chirurgia Clinica Polonica [1], a buoyant Academic Sports Association in Poznań, and active branch of the Polish Red Cross in Wielkopolska region. The Second World War was still not over, and Jurasz was already organising the necessary equipment for Polish hospitals, with restoration of the Polish health care in view. Unfortunately, it was not appreciated by the later Polish communist government, and, forced to emigrate, he died in New York.

The first part of the article presents the family and school environment of the character, the second part demonstrates his professional life until the outbreak of the Second World War, the third part focuses of his life in 1939 and the creation of the Polish Medical Faculty at the University of Edinburgh, the fourth – post-war vicissitudes, and the fifth part summarises his life achievements and contribution to science.

Part I

Family environment

The protagonist was born in Heidelberg [2], in the house of Antoni Stanisław Jurasz (1847-1923) and Caroline Jurasz née Gaspey (1858-1940) at 26 Bergheimerstrasse. On February 11th 1882, he was born as the second child of his parents, and was christened Antoni Tomasz Aleksander. The choice of names probably was not accidental; it might have been dictated by the parents' wish that the achievements of the Juraszes and Gaspeys were continued by their descendant.

The name Antoni was given after the father who at the time his son was born was already a popular laryngologist and academic researcher at the University of Heidelberg. Antoni Stanisław Jurasz is considered the father of European laryngology. Born in the Wielkopolska region, he graduated from a recognised medical faculty at the University in Gryfia (German Greifswald) [3].

Second name, Tomasz, was probably after the maternal grandfather, a Briton, Thomas Gaspey (1788-1871). Thomas Gaspey was an academic researcher at the University of Heidelberg, he ran English College in Heidelberg, published language textbooks for learning English, French, German and Italian [4]. He also wrote a few textbooks about Rhine and Heidelberg. Thomas Gaspey's linguistic interests probably originated in the fact that his father was a journalist with *The Morning Post* and author of numerous historical and political monographs [5].

Description of the family of Antoni Tomasz Aleksander would not be complete without his mother, an exceptionally intelligent person [7], fluent in English, French and German [8]. Her linguistic skills were used by her husband, Antoni Stanisław Jurasz, as she prepared his academic works for publishing. She also received extensive musical education [8]; therefore, she provided musical education to her children [3]. Caroline also took care of their physical development. Being British, she often took her children to rugby matches at her father's English College [9]. This sport fascinated her eldest son, Antoni Tomasz Aleksander, who became a rugby player at 13 years old, and two years later joined the rugby club of Heidelberg [9]. The ambiance of the household of Caroline and Antoni Stanisław Jurasz significantly influenced the development of Antoni Tomasz Aleksander. It was an open and "very Polish" house [10]. It was visited by Polish aristocrats who lived in Heidelberg or stayed there while travelling or studying. It is interesting that after Caroline Gaspey married Antoni Stanisław Jurasz, her teacher "in the household of professor and Mrs. Jurasz was Mrs Karłowicz, the composer's mother" [7]. Professor Antoni Stanisław Jurasz, an academic researcher at the University of Heidelberg, invited Polish students to his house for meals [7]. "Any Polish person staying at Heidelberg or studying at the university was a welcomed guest, and since they both (…) [Caroline and Antoni Stanisław Jurasz – author's note] were very social, not an evening passed without an event, guests visiting or dining, then engaged into parlour games or discussions, always interesting and educating" [7]. The family house of the Juraszes in Heidelberg was visited by: Adam Krasiński, Aleksander and Władysław Skrzyński, Wilhelm Feldman and Kazimierz Tetmajer [7]. The household was a centre of Polish life in Heidelberg [7]. Antoni Tomasz Aleksander's father, professor Antoni Stanisław Jurasz, repeated: "Polish people must get their act together to be ready to serve their reborn homeland" [7]. It may then be assumed that meetings and social conversations oscillated around the issue of regaining independence by the Polish state. Moreover, patriotism in the Juraszes family house is described by the eldest son, Antoni Tomasz Aleksander: "My father wished that his children be brought up as Poles; in German environment and with German education, the house and its ambiance, as well as constantly using the Polish language there were the only way to attain that goal. (...) we always spoke only Polish with father" [3]. Antoni Tomasz Aleksander's nephew, Aleksander Jałta-Połczyński, described the atmosphere of Jurasz's house: "He learnt the sense of national belonging and language in his family house, an oasis of Polishness, affecting both the environment and the family which was brought up in a native German city of great tradition, great wealth, high culture" [11]. The courage of the Juraszes in promoting Polishness in Heidelberg was remarkable, as it was not welcome by local authorities and institutions, which were gradually Prussianised by Germans brought from the North, and anti-Polish propaganda was widespread. The specific nature of the Polish house of Juraszes "was not missed by German police forces. In personal files n Karlsruhe there were reports demonstrating German distrust toward the scientist; it was frowned upon that he brought up the children as Poles, that he hosted subversive elements in his house, that is Polish students. Therefore, he had no chance to receive a tenure, despite apparently excellent professional standing, great respect at the university and having friends among the leading Germans in the government, at courts, in great industry and among high aristocracy" [7]. Moreover, fierce, systematic and planned germanisation of the Poznańskie region (conducted under the supervision of Ostmarkverein) very deeply affected negative attitude of Antoni Tomasz's father to German nation, especially to its prussianism policy. Possibly one of the reasons he settled in Heidelberg after graduation was the fact that it was a city of intellectuals, who did not succumb easily to Prussian influences, dictated by the creator of German Reich, Otto von Bismarck [7].

The family home of Antoni Tomasz Jurasz was open, which probably contributed to his extraordinary communication and social skills. Apart from great carnival balls, possible due to the large size of the house, his father, as the creator of developing laryngology, "was in close contact with laryngologists from around the world, and they used the opportunity to meet in person the famous pioneer in this special branch, who was deemed a person of great charm and outstanding host, with a beautiful wife" [7]. Thus, banquets at the house of Antoni Stanisław and Caroline Jurasz were part of the first international laryngology conferences in the Heidelberg scientific milieu. It is possible that during those meetings close relationships were initiated, which could be used by Antoni Tomasz Aleksander Jurasz in his adult life for worthy causes, which will be presented in further parts of this article.

Antoni Tomasz Aleksander's parents provided extensive education for their eight children, part of which was music. The sons played the violin, and the daughters played the piano. The parents were also musically talented; the protagonist's father played the cello, and his mother the piano. Musical skills of the family members were used during weekly musical meetings organised for friends and guests in the Juraszes house [7].

School environment

Pre-school and primary education of the eight children in the Antoni and Caroline Jurasz household was provided by their mother. Antoni Tomasz Aleksander started institutionalised education at the age of 9, when he joined secondary school in his native Heidelberg, and in 1900 he graduated it, having received a certificate of secondary education [14]. Brought up in the spirit of Polishness, he sensed anti-Polish sentiments in the Heidelberg secondary school, which he described in his memoirs [8].

Meanwhile, according to Laskownicki [13], he attended a secondary school in England, which is theoretically and practically possible, as his mother was English. Laskownicki could know about it from A.T. Jurasz himself, whom he met in Poland in 1939. After a year of obligatory military service in the German Army in 1901, he started medical studies at the University of Heidelberg. However, he did not continue, but chose forestry studies at the University of Tharandt (Saxony) instead [15]. The reason behind this change was an offer from count Krasiński, a friend of his father's, who envisaged entrepreneurial Antoni Tomasz as a manager of his forests in Russia. The offer was economically sound: employment with a good salary after graduation, and imminent relief for the house budget. However, after a year Antoni Tomasz Jurasz again took up medical studies in Heidelberg, as forestry did not meet his expectations.

During his medical studies he met excellent teachers, who, possibly due to the fact that his father was a professor of laryngology at the University of Heidelberg, invited him to assist in their practice when he was still a student. Young Antoni Tomasz Aleksander was delighted by excellent surgical technique of professor Jordan, as well as the warmth which he showed his patients. Professor Jordan's attitude and skills encouraged Jurasz to choose surgery as his specialisation. Professor Erb, internist and neurologist, showed Jurasz the effect of the patient's psyche on the treatment process. Professor Arnold, a pathologist who appreciated only solid knowledge, evoked in him a responsible attitude to medical studies. He completed his medical studies in 1906, passing an exam in pharmacology, and was soon employed as a ship's doctor on a transoceanic passenger line, and travelled around the world for a year [15].

References

1. Magowska A, ed. Listy prof. Antoniego T. Jurasza i jego dotyczące z lat 1944-1961. [Letters of prof. Antoni T. Jurasz and letters about him from 1944-1961] Acta Medicorum Polonorum, 2012; 2: 141-165
2. Kallmorgen W. Siebenhundert Jahre Heilkunde in Frankfurt am Main.[in German] Frankfurt am Main 1936: 4
3. Łączkowski A. Antoni Stanisław Jurasz 1847-1923. [Antoni Stanisław Jurasz 1847-1923] Warsaw-Poznań, Państwowe Wydawnictwo Naukowe, 1987: 64
4. Jurasz AS. Osobiste notatki. [Jurasz A.S. Personal notes.] Archiwum rodzinne. [Family archives]
5. http://en.wikipedia.org/wiki/Thomas_Gaspey [access: 1.02.2014]
6. Rostafiński W. Rodzina Karoliny z Gaspeyów Juraszowej, matki mojej mamy. [The family of Caroline Jurasz, née Gaspey, my mother's mother] Archiwum rodzinne [Family Archives], 1991: 1
7. Janta-Polczyński A. Kronika trzech pokoleń. [A chronicle of three generations] Archiwum rodzinne [Family Archives], 1991: 8
8. Jurasz AT. Wspomnienia pisane w języku angielskim w latach 1950-1960 (ich oryginał znajduje się w aktach przyjaciela rodziny Mrs. Helen Schelling-Scholtz w Nowym Jorku) [Memoirs written in English in 1950-1060 (the original copy is in the files of a family friend, Mrs. Helen Schelling-Scholtz in New York)]
9. Meissner R, ed. Profesor Dr Med. Antoni Jurasz (1882-1961). [Professor Antoni Jurasz, MD, PhD (1882-1961)] Fakty AM ,2003; 7-8: 24-26
10. Bajer M. Forum Akademickie. [Academic Forum] Arch. 1998; 5. http://forumakad.pl/archi-wum/98/5/artykuly/26-rody uczone.htm, [Access: 7.03.2012]
11. Janta-Potczyński A. Wspomnienia o wuju Antonim Juraszu. [Memories of uncle Antoni Jurasz] Archiwum rodzinne. [Family archives]
12. Laskownicki S. Szpada, bagnet, lancet. [A sword, a bayonet, a lancet] Cracow, Wydawnictwo Literackie, 1978:280
13. Centralne Archiwum Wojskowe (CAW): Jurasz Antoni. Życiorys. [Jurasz Antoni. Curriculum vitae] Sygn. Ap1786, k. 1 [Signature Ap1786, book 1]
14. Wrzosek A., ed. Kronika Uniwersytetu Poznańskiego za rektoratu Heliodora Święcickiego. [Chronicle of the University of Poznań when Helidor Święcicki was the rector] Poznań 1924: 262
15. Meissner R, ed. Profesor dr Med. Antoni Jurasz (1882-1961). [Professor Antoni Jurasz, MD, PhD (1882-1961)] Fakty AM ,2004; 3-4: 24-25

Military Institute of Medicine

DAMAGE CONTROL SURGERY – FROM BATTLEFIELD TO TRAUMA CENTRE

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DAMAGE CONTROL SURGERY

MILITARY INSTITUTE OF MEDICINE
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EMERGENCY MEDICINE FROM THE BATTLEFIELD TO TRAUMA CENTRE

From the wide range of educational events offered by the Military Institute of Medicine, we recommend a training series prepared in the Battlefield Medicine Unit of the Military Institute of Medicine, organized in close co-operation with the Trauma Centre operating on the premises of the Military Institute of Medicine.

The training pertains to the area of emergency medicine. Their target participants are physicians, paramedics and nurses. The objective of the training series is to use extensively unique experience derived from everyday work at the Trauma Centre and at the Trauma Room of the Polish field hospital in Ghazni, as well as aspects of pre-hospital procedures, both in everyday practice, and on the battlefield.

The advantage of the training sessions is their content, based only on treatment standards and practice with manikins, but first and foremost, the form of meeting with people who have practical experience in the area they teach.

"Cumulative Trauma Disorders" – the aim of the training is to present the experience in working with severe trauma patients at Emergency Hospital Department and Trauma Centre. Participants will practice elements of techniques used in damage control surgery.

"Tactical and Evacuation Emergency Medical Services" – the aim of the workshop is to present state-of-the-art techniques used on the battlefield in severe trauma. The tactics of emergency procedures and means of evacuation will be discussed. This practical training contains an extensive practice module, including one day of practice in a military training area.

"Ultrasound in the Trauma Room Practice" – description of possible uses of ultrasound examination in urgent surgical conditions, with particular focus on trauma. The program is centered around the training in using FAST-Extended technique; however, the principles of chest examination and ultrasound-controlled procedures will be practiced as well.

"Procedure in Mass Casualty Incidents" – the aim is to practice the procedure in mass casualty incidents. The procedure is based on case analysis and numerous simulations, learning about team-work in mass casualty incidents.

"Workshop on Prehospital Procedure in Trauma" will be extended to include a practical module comprising the most important techniques used in prehospital emergency medical services, as well as presentation of methods of external bleeding control on the basis of military operation theatre experience.

Participation in the training enables obtaining educational points.

Further information on the training: www.medycynaratunkowa.wim.mil.pl