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History of medicine

On Roman military doctors and their medical instruments

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Summary:

The establishment of a standing Roman army during the reign of Augustus resulted in an increased demand for military doctors. The knowledge about the Roman military medicine comes primarily from the excavations at the *valetudinaria*. Medical instruments, medicine containers and remains of medicinal plants found there indicate that the Roman army strived to provide unwell legionaries with excellent care. Surgical instruments found in the grave of a Roman doctor from Bingen (2nd c. A.D.) and in the Surgeon's House in Rimini (2nd c. A.D.) confirm the hypothesis that medicine in the Roman army was at a high level compared to the medical care in other ancient armies. Probes and scalpels are among the medical instruments found most frequently by archaeologists during excavation works. Roman military doctors also used specialized instruments for specific procedures; those included a trepan called *modiolus* and a tool used to remove arrowheads. Doctors serving in the army would perform many procedures intuitively, relying on their own experience. Roman military medicine had been heavily influenced by the Greek doctors' views on health and diseases and also by Roman civil medicine.

Key words: health care in the Roman army, Roman military doctors, ancient medical instruments, history of medicine, *valetudinaria*.

Medical history textbooks usually mention three figures who have had an impact on the development of ancient Roman medicine: two — Asclepiades of Bithynia (2nd-1st c. B.C.) and Galen (2nd c. A.D.) — were physicians; the third one was Cornelius Celsus (1st c. A.D.), an encyclopedist, who wrote the eight books of the medical work *On Medicine*. They contain descriptions of surgical procedures performed at that time, along with descriptions of the instruments used. Written sources have enabled us to identify the medical instruments in the archaeological material.

In this article, we will focus on the activities of Roman military doctors, together with the medical instruments from the period of Roman influences. In the area of Poland, this period lasted from the beginning of 1st c. A.D. until about 4th c. A.D. [1]. During the modern-day archaeological excavations, carried out within and outside of the area of the Roman Empire, archaeologists encounter medical instruments and medicine containers. These artifacts provide us with the knowledge about the procedures performed by ancient physicians. Such a medical instrumentarium can be found in the graves of Roman doctors, in the wrecks of Roman ships, on the grounds of Roman legionary

hospitals (the so-called *valetudinaria*), owing to the ancient custom to equip the dead with everyday use items. The tools were made out of bronze and iron, occasionally out of gold and silver, sometimes ivory. They were used by physicians in ancient Rome and in its provinces.

The second objective of this work is to describe how the wounded and unwell legionaries were taken care of. However, we believe that, in discussing the medical care in the Imperial Roman army, some description should also be provided of the civil health care in Rome and its provinces.

The beginnings of military surgery can be dated back to ancient times. The development of the art of war was accompanied by an increasing demand for people who knew how to treat injuries and wounds which soldiers were most prone to. Initially, wounded and unwell warriors would be taken care of by their companions. Numerous works of art dating back to antiquity often depict warriors taking care of each other, as well as physicians dealing with injured soldiers. One of the vases recovered from a kurgan in the Crimea (5th c. B.C.) shows Scythians, most likely warriors, undergoing medical procedures. The first scene on the vase relates to extracting a tooth with fingers; the other depicts wound bandaging (Figure 1) [2,3]. One of the scenes on the relief of the Trajan's Column (early 2nd c. A.D.) portrays attending to a wounded Roman soldier [4].

In the armies of ancient India and Egypt, attempts were made to provide medical care to soldiers. Also among Celtic warriors there were people capable of dealing with injured companions. Medical instruments were identified in the archaeological material, which were most likely used by those individuals. They include probes, hooks and scalpels. However, based on that material it is difficult to conclude whether those people were typical military doctors which appeared in the Imperial Roman army. The type of grave from the La Tène period (the pre-Roman period – the period of Celtic influence in Europe, which lasted in Poland from 400 B.C. until the beginning of 1st c. A.D. [1]), where surgical instruments can be found next to weapons in the grave hole, is described in the literature as a "*warrior-surgeon*" [5]. These were most probably the graves of warriors who had some medical and surgical skills. Today, it is hard to identify unambiguously whether they used those surgical tools only for their own needs, or if they treated other warriors.

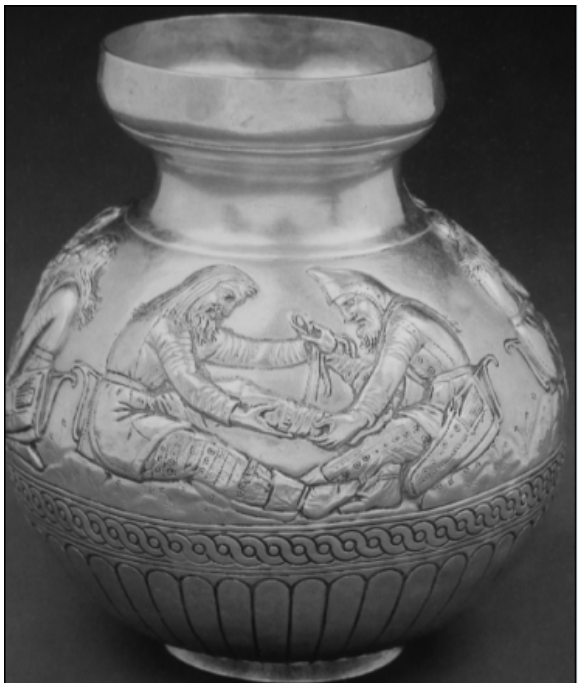

Figure 1: A vase with scenes from the life of Scythians – wound bandaging.

Gold der Skythen aus der Leningrader Eremitage, München 1984 – quoted in the article.

In the period of the Republic, professional doctors were absent from the army. Assistance was provided by more experienced soldiers who, with time, learned how to handle the wounded. They would often form medical corps with the task to attend to the wounded and to transport them to tents specially prepared for the unwell soldiers. More heavily wounded soldiers requiring a longer treatment would be placed in the homes of private citizens. Affluent Roman families owned slaves, many of them from Greece, who had some folk medical knowledge. Their skills are likely to have been used also in treating other injured soldiers. A permanent, regular army was established during the reign of Augustus (27 B.C. – 14 A.D.) [6, 7]. This had an enormous impact on the direction of the development of Roman militarism as well as military health care. The need was noticed for the presence of educated physicians in the army, who would perform medical procedures and attend to ailing legionaries. The inscriptions: *medicus legionis*, *medicus cohortis*, found in the areas where legionary camps were located are proof that every legion, as well as cohort, had its

doctor. Medicus cohortis dealt with sick soldiers in specially designated tents. Those less severely wounded could remain in their quarters. In the Empire period, makeshift hospitals were built within legionary camps, which were composed of tents arranged as a square around an empty yard [6,8,9]. The builders of the first permanent military hospitals are likely to have made an attempt to model them on those early tent hospitals.

Valetudinaria – hospitals, clinics, "places where health is restored" were designed for two groups of people: slaves and soldiers. The former had a character of a care institution and did not enjoy good reputation; the latter aimed to provide care to wounded soldiers [9]. Meanwhile, the residents of Rome would seek healing in the temples of Asclepius and at the *iatreia* where physicians would attend to their patients. The cult of Asclepius developed in ancient Rome around 291 B.C. During an epidemic which broke out in the city, a statue of the god of medicine was brought from Epidauros in Greece. A temple devoted to Asclepius was erected on the Tiber Island [10,11,12]. Healing in the temples was based on prayers, dream interpretation, and was permeated with mysticism, though the priests probably also performed minor surgical procedures. Physicians with specialist education would visit the sick in their homes; in more severe cases, they would provide medical assistance at the *iatreia*.

Archaeologists date the early military *valetudinaria* to the beginning of the 1st c. A.D. The Roman army strived to restore a soldier to health as swiftly as possible in order for him to return to active service.

The looks of the *valetudinaria*, where soldiers would receive treatment, could be reconstructed thanks to the excavation works carried out at military camps within the Roman Empire. Those hospitals were identified in camps located in the strongholds along the Danube: Vindonissa (Vienna), Aquincum (Budapest), Novae (near Svishtov) in Moesia Inferior, as well as in the fortresses along the Rhine: Noviomagus (Nijmegen), Novaesium (Neuss), Vetera (near Xanten), and Bonna (Bonn). In the 1st c. A.D., the rivers Rhine and Danube became the borders of the Roman Empire. Therefore, attempts were made to provide medical assistance to the legionaries stationed there [4,13]. *Valetudinaria* were part of almost every legionary camp along the Empire's border. Based on the excavation data and modern-day reconstructions, we know that the architectural objectives – the arrangement of the buildings around a central, square-shaped or rectangular yard – were similar in all the *valetudinaria*. No two identical hospital buildings have ever been found; they differ in the room count and size as well as their layout inside the buildings. *Valetudinaria* comprised bathrooms (baths), maintenance rooms, sanitary facilities and operating rooms [4,14,15,16]. The latter are where numerous instruments are often found, which were used by military doctors to perform surgeries. The excavations carried out within the areas of the Roman legionary hospitals have revealed cases which had been used to store those tools. They were mostly made out of wood as well as ivory and bronze. They included smaller compartments for various types of tools [17]. A wide range of diverse surgical instruments can be found in this kind of buildings. Thanks to the use of: scalpels, probes, forceps, needles, scoops and spatulas, performing surgeries on wounded soldiers was made possible. Surgical procedures are likely to have been performed not only in specially designated rooms, but also in rooms where patients were kept [14,16]. According to the archaeological data, the number of patient rooms in a military hospital was about 60; one room comprised 3-8 beds. An average legionary hospital was capable of housing about 200 patients [18,19,20]. Efforts were made to ensure peace and quiet for wounded and sick soldiers. It is worth mentioning that this kind of buildings often encompassed separate places devoted to medicine-related gods: Asclepius and Hygieia. Prayers directed to those deities were likely an important component of the patient treatment process, although medical history textbooks claim that surgery was free from magic and incantations.

Remains of medicinal plants can be often found during the excavation works carried out at the former *valetudinaria*. At one of them, the following plants, described by ancient physicians, were found: common centaury (used for digestive problems), black henbane (contains alkaloids: atropine, scopolamine, L-hyoscyamine; used as an anesthetic), St. John's wort (cholagogue, anti-inflammatory and disinfecting properties), ribwort plantain (anti-

inflammatory and expectorant qualities) [21]. They were used for treating wounds and injuries as they would alleviate the pain and accelerate healing. Black henbane, with its poisonous and hallucinogenic properties, might have been used as a sedative and an anesthetic. Another medicine was also used to alleviate the pain, which included the extracts of two plants: black henbane and poppy [22]. It may be emphasized that anesthesia began in the Roman army. Celsus recommended that the diet of sick soldiers should be rich in fruit and vegetables. For this reason, they were fed peas, lentils and figs [21]. In some *valetudinaria*, sick soldiers' diet might have been more varied than that of healthy legionaries.

The person responsible for all the issues related to military health care in the fort was *praefectus castrorum*; he was in charge of hospital administration and educated doctors (medici), while the legionary hospital itself was supervised by *optio valetudinarii*. *Medici capsarii* were likely responsible for looking after a chest containing bandages and for bandaging the injured [6,7]. Roman military doctors dealt with surgery, medicine preparation, and used an appropriate diet to more rapidly restore soldiers to health. Hygiene rules were complied with both in the fort and in the military hospital. It was important that the environment and the soldiers' outfits be clean. The great density of soldiers in a small area was conducive to the spread of infectious diseases. It is likely that all the soldiers were given first aid training. Many of the soldiers serving in the Roman army were of Greek descent.

Roman military doctors were armed with a *gladius*, a short sword [22].

Among the sources of knowledge about the medical instruments used at the *valetudinaria* are also the burials of Roman military doctors. Two findings related to Roman surgery and military medicine will be described in detail in this article. The first one is the cremation grave of a Roman military doctor from Bingen (Germany). It is dated to 2nd c. A.D. It contained about 60 artifacts, which were described as medical instruments [23]. The most numerous group in the surgical kit is composed of instruments with a spatula probe on one end and a scalpel on the other (Figure 2). The latter have varied blade geometry. Usually only the spatula-shaped handle is found by the archaeologists, as scalpels were a replaceable part of this medical instrument.

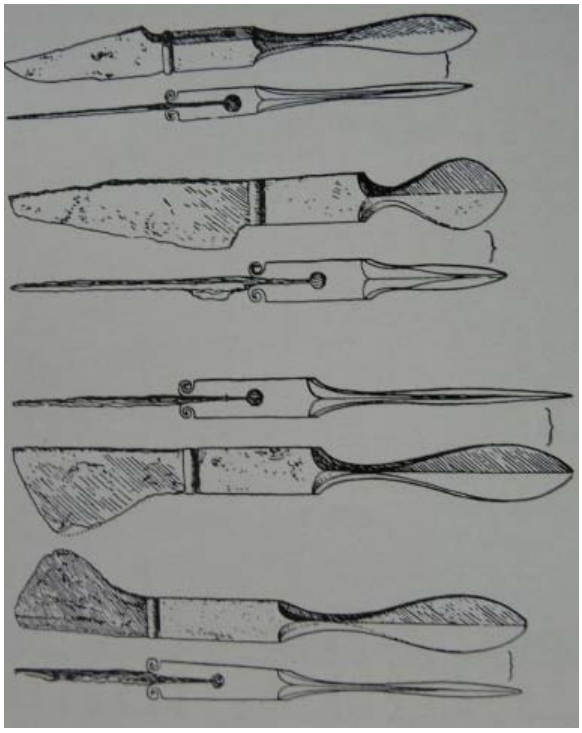

Figure 2: Examples of Roman scalpels with replaceable blades from the grave of a doctor from Bingen.

Davis 1998 – quoted in the article.

Physicians operating across the Empire also used probes as separate tools. They can be divided into three groups, according to the shape of the working part: spoon probes (the working part was spoon-shaped), spatula probes (the working part was spatula-shaped) and ear probes (with a small head on one end) (Figure 3). Medical instruments used by military doctors included also spatula probes. They could have been used to determine the wound depth and to apply medicament to the wound. The toolkit of the Bingen physician also comprised hook-ended needles as well as hooks used to widen the wound opening. Forceps were used to grab and hold tissues (two of them have toothed edges) and also to remove foreign bodies. It is possible that the kit also included tools for cauterization (burning wounds). Unfortunately, their bad condition prevents their complete identification.

However, we do know that such instruments must have been used by Roman military doctors. The kit also comprised three bronze cupping vessels (one bigger and two smaller ones).

According to ancient physicians, cupping was performed to restore the balance of bodily fluids, or in headaches and joint pains. Albucasis claimed that large, medium and small vessels were used in treatment, depending on which part of the body they were being used on [14].

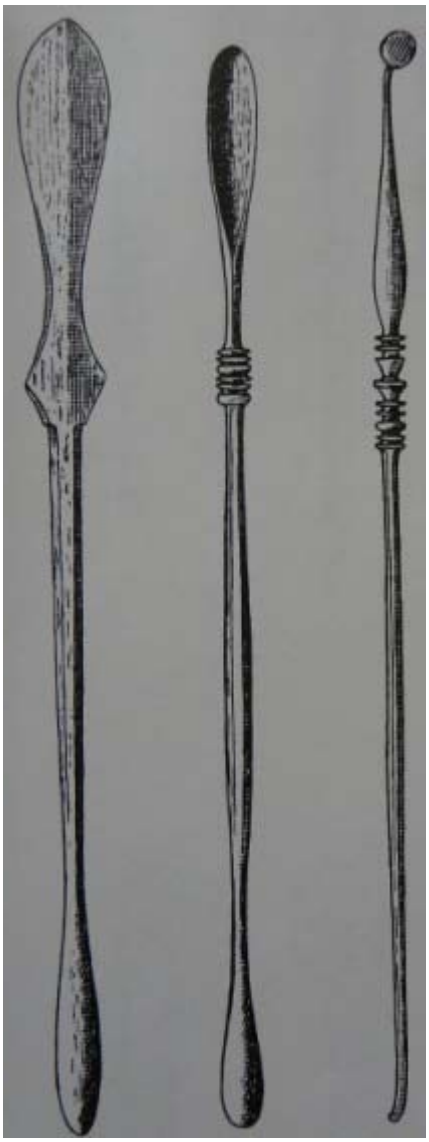

Figure 3: Examples of probes. From the top: ear probe, spoon probe, spatula probe.
Künzl 1981 – quoted in the article.

One of the tools (*modiolus*) was used to perform skull trepanation by means of drilling. The auger would be put into rotation by a string attached to its arched handle. Skull fragments removed during the procedure were round in shape [24]. In ancient times, trepanation was performed for magic and medical reasons. It was often thought that an evil spirit, a demon, inhabits the head and causes the disease; headaches, vertigo, coma, faintings and epileptic seizures were perceived as evidence. Drilling a hole in the skull was an attempt to release the spirit. Cranial cavity would not be opened to perform neurosurgical procedures, though it could have been a method of evacuating hematomas. Skull trepanation was performed in adults; less frequently among children. Various ointments were also used to prevent wound infection.

A range of surgery methods were used. The external table, the diploë and the internal table would be removed; a hole would be cut in the skull using a sharp tool or drilled with an auger. Trepanation was also performed in head injuries, in an attempt to remove a cracked fragment of the skull. Soldiers were particularly prone to head injuries; thus, trepanation surgeries in the Roman army were mostly performed for curative purposes. Special scalpels (blades) can be found in the burials from the La Tène period, with a semicircular cutting edge for performing trepanations by incision [5]. In the Roman army, they were performed by drilling but also by scraping. Trepanation procedures were described by Hippocrates (5th c. B.C.) but also by Roman physicians. The former recommended that trepanation be performed within the first three days after a head injury; he also mentioned complications after the surgery and the way the wound should be dressed afterwards [25]. Galen (2nd c. A.D.) included in his work the techniques for the surgery, listed the indications for its performance and also described the required medical instruments. He thought that trepanation should be performed following skull injuries; the damaged fragment of the bone should then be removed and the sharp wound edges should be smoothed out using a chisel-like tool. Galen provided a description of a method for drilling and scraping bones. The surgery was supposed to bring relief to the patient, alleviate their pain and lower the intracranial pressure [26]. Apart from the *modiolus*, medical instruments used by Roman physicians for trepanations probably included specific scalpels, chisels and hook-shaped tools for lifting bone fragments. Chisels were also used for the trepanation of the skull of the child whose burial is dated to 1st-2nd c. A.D., which comes from the excavation works carried out in the suburbs of Rome [27]. It is interesting that in Greece, in the period before Hippocrates,

also iron scrapers, scalpel-like knives and iron forceps would be used for trepanation [28]. Throughout centuries, scraping was considered to be the safest method of performing the surgery due to a lesser risk of brain damage.

The physician whose burial was discovered in Bingen is likely to have been educated in Alexandria, proof of which is the figurine of a hippopotamus with a cobra on its back [23]. It was there that he became familiar with Greek and Egyptian medicine. Between 3rd and 2nd c. B.C. Alexandria was the main academic centre of the ancient world; it was the place where Greek medicine, the foundations of which had been laid by Hippocrates, was developing. Herophilus and Erasistratus, two popular ancient physicians, were active there. They put great emphasis on the study of anatomy. Autopsies and vivisections were carried out in Alexandria; the results are likely to have influenced the development of surgery [11].

Plenty of information related to medical tools used by military doctors in ancient times can be obtained by analyzing artifacts from the site in Rimini (Italy). The Surgeon's House (*Domus del Chirurgo*), discovered by archaeologists, and dated to 2nd c. A.D., is where about 150 medical instruments were found [29,30]. Most of them had been used for bone surgeries and medical procedures [31]. The house, comprising a surgery, belonged to Eutyches, who was a military doctor.

The use of a bow in military operations resulted in the need for physicians to learn the safest way to remove arrowheads from wounds. This kind of wounds was described in the works of the ancient Indian surgeon Susruta (4th c. B.C.) and was also mentioned by Hippocrates. In the Iliad, Homer pointed out how important it was to deal with such injuries correctly. Celsus described a special tool for this kind of operations, named "the spoon of Diocles" (after its inventor, Diocles of Carystus); an example was found in Rimini [32]. In their practice, Roman military doctors had to deal with specific wound types, hence specialist tools were developed to tackle battle wounds. It was also here that instruments were found with a blade on one end and a leaf-shaped probe on the other.

Eutyches also used forceps and tweezers to remove foreign bodies and fractured bone fragments from the body. Among the artifacts related to medicine, also dental forceps were identified. The surgical toolkit also included chisels and gouges. They might have been used to lift the skull bones in case of some injuries. It is possible that the physician would also perform trepanations.

The proof that Eutyches had links to the Roman army is the votive sculpture of a human hand, also found in the Surgeon's House. It is related to the cult of Jupiter Dolichenus, which was widespread among Roman soldiers [29,30].

Military doctors serving in the army also prepared medicines for their patients. Proof of the above are not only remains of medicinal plants, found at the *valetudinaria*, but also small containers, used to store and make medicines, discovered in the Surgeon's House in Rimini. Dioscorides (1st c. A.D.), who most likely was a military doctor, described, in his numerous works, plant-derived medicaments, their properties and applications [11].

The instruments used by Roman military doctors included general surgery instruments, such as probes, scalpels, hooks, hook-ended needles, as well as specialist tools used for trepanation (modiolus) or to remove arrowheads from wounds ("the spoon of Diocles"). Gynecological instruments (vaginal specula, gynecological probes) have not been found among the medical instruments discovered during excavations at the *valetudinaria* as well as at cemeteries comprising the graves of Roman military doctors. Vaginal specula were discovered in Pompeii; they are also part of the collections of a number of European museums.

Physicians working at the *valetudinaria* are likely to have been dealing with a range of wounds: cuts, stabs, contusions; they would remove foreign bodies and arrows from soldiers' bodies. Improper or incorrect wound handling might have resulted in gangrene and patient death. Outbreaks of infectious diseases were also likely in military camps; therefore, efforts were made to maintain an appropriate level of hygiene.

Greek medicine, the medicine of other ancient armies, along with civil medicine in Rome's provinces influenced the entire Roman military medicine. When comparing medical instruments used by a "*warrior-surgeon*" with later tools used by Roman military doctors, one can identify the same types of instruments. However, Roman

ones were made with greater precision. Civil physicians with specialist knowledge who worked in Roman provinces used the same medical toolkit as Roman military doctors. Certainly they were not as experienced in dealing with wounds and injuries as the doctors at the *valetudinaria*. Civil physicians also used special cases or etuis to carry medical instruments. Thanks to that they could perform some surgeries in the homes of their patients [33]. In addition, the cult of Asclepius (called Asklepios in Greece) was widespread among Roman military doctors.

Most trepanations in the Roman army as well as those performed by civil physicians would be carried out for curative purposes or to remove a fractured bone fragment. Such surgeries were often performed intuitively. Lifting and removing the fragment(s) of a fractured bone, as well as smoothing out sharp wound edges may have resulted in an immediate effect in the form of abating neurological irregularities or regaining consciousness due to the fact that the fragments of a damaged bone had been prevented from applying pressure on brain tissue. For this reason, the surgery was repeatedly attempted. Efforts were also often made to remove the cause of pain, which could result from various pathological changes: injuries, related episcleral and subdural hematomas, inflammatory changes, benign and malignant brain tumors. It was not easy to perform such a procedure; it is likely that a physician with relevant expertise and tools was required. Most historical trepanations were episcleral. Related complications would include wound infection, operational bleeding, as well as damage to the meninges and the brain. Those would result from an improper use of tools and poor surgery technique.

Due to the lack of X-rays, the most common instruments used by Roman military and civil doctors were probes. They could be used to identify the wound depth and the location of a foreign body in it. The second largest group of tools were scalpels, used to make cuts of various depths. Incisions of skin, soft tissue and bones were possible.

Health care began and was developing in the Imperial Roman army. It reached a high level compared to medical assistance provided to wounded soldiers in other armies of the ancient world. The demand for professional medical assistance across the Empire was high. Military doctors probably constituted a large part of educated physicians; they worked permanently for the army, but some of them also ran a private practice.

Archaeological artifacts identified as medical instruments, along with the remains of Roman legionary hospitals, enable us to expand our knowledge about military medical service.

Human body was not penetrated. This was due to the lack of knowledge of anesthesia, antiseptics and blood loss replacement. It was only in the second half of the 19th century that all those methods were introduced to surgery. Surgical procedures in the Roman army related mostly to external injuries. However, the diversity of instruments used by Roman military doctors indicates that they were very good practitioners. There was relatively little anatomical knowledge in the ancient period; thus, Roman physicians had to rely rather on their experience, gained during the work in the army.

References:

1. Kaczanowski P, Kozłowski KJ. Wielka historia Polski. Najdawniejsze dzieje ziem polskich. tom 1. Wydawnictwo Fogra; Kraków 1998.
2. Gold der Skythen aus der Leningrader Eremitage. Ausstellung der Staatlichen Antikensammlungen am Königsplatz in München 19. September bis 9. Dezember 1984. Grebner, Aschheim. München 1984.
3. Wojtkowiak S, Talar J, Majewski W, Piotrowski F. Zarys dziejów wojskowej służby zdrowia. Wydawnictwo Ministerstwa Obrony Narodowej. Warszawa 1974.
4. Davis WR. The roman military medical service. Saalburg-Jahrbuch. 1998; 49: 76-82.
5. de Navarro MJ. A doctor's grave of the middle La Téne Period from Bavaria. Proceedings of the Prehistoric Society.1955; 21: 231-248.
6. Byrne HE. Medicine in the roman army. The Classical Journal. 1910; 5: 267-272.
7. Błyskal O. O medycynie, lekarzach i rzymskich lekarzach wojskowych w I-III w. Annales Universitatis Paedagogicae Cracoviensis. Studia Historica. 2009; 8: 37-54.
8. Crislip TA. From monastery to hospital: Christian monasticism & the transformation of health care in late antiquity. University of Mitchigan Press; 2005.

9. Nutton V. Roman medicine 250 BC to 200 AD. In: Lawrence IC, editors. The western medical tradition: 800 B.C-1800 A. D. Cambridge University Press; 1995.
10. Prioreschi P. A History of Medicine: Roman medicine. Horatius Press; 1996.
11. Brzeziński T. Historia medycyny. PZWL; Warszawa 1988.
12. 12. Elliot SJ. Outlines of greek and roman medicine. Cretikron Company 1978.
13. Tyszler L. Higiena, pielęgnacja ciała i medycyna – wybrane zagadnienia z europejskich prowincji rzymskich. In: Supady J, editor. Szkice z historii medycyny; 2010 Jun 15-16; Łódź, Polska.
14. Baker P. Archaeological remains as a source of evidence form Roman Medicine. [cited 2012 Fab 25] Available from: URL:http://www.ucl.ac.uk/~ucgajpd/medicina%20antiqua/sa_ArchaeologicalRemains.pdf
15. Scarborough J. Roman medicine and the legions: a reconsideration. Medical History. 1968; 12: 254-261.
16. Nutton V. Medicine and the roman army: a further reconsideration. Medical History. 1969; 13: 260-270.
17. Künzl E. Medizinische Instrumente aus Sepulkralfunden der römischen Kaiserzeit. Bonner Jahrbücher. 1982; 182: 1-131.
18. Press L. Odkrycie valetudinarium w Novae. Meander. 1983; 10-11: 385-405.
19. Press L. Szpital legionowy w Novae. Archiwum Historii i Filozofii Medycyny. 1989; 52: 473-483.
20. 20. Press L: Valetudinarium w rzymskiej twierdzy Novae. Balcanica Posnaniensia. 1990; 5: 267-277.
21. Davis WR. Some Roman medicine. Medical History. 1970; 14: 101-106.
22. McCallum EJ. Military medicine: from ancient times to the 21st century. ABC-CLIO; 2008.
23. Como J. Das Grab eines römischen Arztes in Bingen. Germania. 1925; 9: 152-162.
24. Kirkup J.The evolution of cranial related instruments. In: Arnott R, Finger S, editors. Trepanation: History, discovery theory. Swets Zeitlinger Publishers; 2003.
25. Martin G. Craniotomy: the first case histories. Journal of Clinical Neuroscience. 1999; 6(4): 361-363.
26. Toledo-Pereyra HL. Galen's Contribution to surgery. Journal of the History of Medicine and Allied Sciences. 1973; 28: 357-375.
27. Mariani-Costantini R, Catalano P, di Gennaro F, di Tota G, Angeletti LR. New light on cranial surgery in ancient Rome. Lancet. 2000; 355: 305-307.
28. Liston AM, Day PL. Is does take a brain surgeon: A successful trepanation from Kavousi, Crete. In: Schepartz AL, Fox CS, Bourtou Ch, editors. New direction in the skeletal biology of Greece. ASCSA; 2009.
29. Gerrie A. Roman ruins cast new light on a trip to doctor. [cited 2012 Fab 25] Available from: URL:http://www.telegraph.co.uk/news/worldnews/1572030/Roman-ruins-cast-new-light-on-a-trip-to-doctor.html
30. Ghiretti G. Un ambulatoro medico tico: due libri recenti sul "Chirurgo di Rimini". Papyrotheke. 2010; 1: 81-96.
31. Jackson R. Holding on to health? Bone surgery and instrumentation in the Roman Empire. In: King H, editor. Health in Antiquity. London and New York 2005.
32. Karger B, Sudhues H, Brinkmann B. Arrow wounds: Major stimulus in the history of surgery. World Journal of Surgery. 2001; 25: 1550-1555.
33. Bliquez JL. Two sets of Roman surgical tools from the Holy Land. Saalburg-Jahrbuch. 1998; 49: 83-92.

Pharmacology & Pharmacy

Analysis of injection systems ampulla-syringe vs. ampulla with respect to application of parenteral medicinal products on the example of ibadronic sodium

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Summary:

Nowadays, equally to the development of modern pharmaceutical technology and introduction of new biologically active substances to pharmacology we observe a development of techniques with the use of which medicinal products are applied into a living organism. The above regard many types of drug forms, among others, medicinal aerosols, fillers, injections, anal and vaginal forms, etc. Many times the medicinal effect depends on a high technical level of these devices, which are also medical materials. In this work at attempt has been made to analyze the mutual relations between a way of administering an injection in a standard form with the use of a standard syringe and technically higher forms, namely integrated ampulla-syringe systems.

Key words: ampulla-syringes, injections, fillers, parenteral administration.

Introduction

Durability of medicines for injections to a large extent depends on the direct packaging in which the target form of the medicine is stored (a solution, a colloid, an emulsion, etc.) and a way of storing them. Containers to store medicines for injections: ampulla-syringe or ampullas should have the following functions:

- Protect a medicine against the impact of the environment (air, moisture, light);
- Protect against mechanical contaminations;
- Protect against microbiological contaminations [1,2,4];

A direct container having contact with a medicine should be chemically neutral, cannot react with particular substances forming a pharmaceutical form of a medicinal agent, and a biologically active substance itself. Ampulla-syringes and ampullas should be characterized by a proper mechanical durability. They should also have specific thermal durability because of the method of sterilization. Also additional elements such as stoppers, pistons, sealing rings must be chemically and physically neutral, cannot react with the content of the container (a biologically active substance, auxiliary substances), cannot have an impact on any properties of the medicinal product [3,4].

Ampulla

This is a glass container that saves the airtight closing of the particular volume and dosage of the medicinal product after the sealing. An ampulla protects against the air and levels down a problem related to the secondary infection of a sterilized medicine. If a biologically active substance or any of the auxiliary substances is UV sensitive (light, the direct sun light), ampullas made of orange glass are used. However, the intensity of ampulla coloring cannot collide with the visual control of the content assessment. A volume of the containers which serve the purpose of an ampulla is from 1ml up to 20ml, they are mainly designed for solutions [4]. So far in order to open an ampulla one has had to use a file sawing through the structural narrowing of the neck so that the opening of an ampulla was easier.

Currently ampullas are produced in the way which enables the opening by breaking off the top part, without using a file. Such a way of opening the container is risky because tiny mechanical contaminations in the form of glass scraps can get to the solution of a medicine. The opening of an ampulla should take place immediately before injection, however a medicinal product contained in an ampulla after the opening is exposed to the contact with external conditions (moisture, microbiological contaminations!). The content of an ampulla is then taken with the use of a working needle to a syringe. During this process part of the volume of the liquid medicine is lost because it remains either on the bottom of an ampulla or/and in a needle, depending on a suction pressure. The next activity before administering the medicine to a patient is an exchange of a working needle (suction from an ampulla) into a injection needle (introduced to the patient's tissues). After putting an injection needle the air sucked with a medicinal product into a syringe must be removed externally. Some part of the volume of a medicinal product is also lost resulting from the type of a needle used, its diameter, pressure force into the piston and the amount of the ejected medicine directly after the removed air [5].

The above information indicates that administration of a sterile medicinal product ion the form of an ampulla has certain procedural inconvenience, and also gives a possibility of a loss of some part of a medicinal product and/or its potential microbiological contamination. This is more dangerous in a situation when an administered medicinal product contains 'difficult' biologically active substances, e.g. of a low index o biological access or of a narrow therapeutic index. The loss of some medicinal product in the aforementioned stages of an injection procedure can lead to dissatisfying treatment results. Because of small sizes and fragility of glass during handling of a medicinal product a total or partial loss of the content of an ampulla as a result of breaking or spilling. Generally, application of a medicinal product in the form of an ampulla must be administered by a qualified personnel who performs these injections [6,7,8].

Ampulla-syringe

A technological reply to the above presented inconveniences related to the use of ampulla-type containers is the application of modern injection forms combining the functions of ampullas, needles and syringes, namely, ampulla-syringes. An ampulla-syringe is a medicinal product container designed for single use (disposable). It guarantees a fast provision of a medicine in a proper, precisely measured dose. The easiness of the use makes patients use it on their own. An ampulla-syringe is sterile, with the use of it the injection is performed without the need to take the preparation from an ampulla or a flask. The whole set prepared in a factory is sterile and ready for direct use. The use of an ampulla-syringe prevents a loss of a biologically active substance and any form of microbiological secondary infection and/or mechanical contamination [9-12].

The analysis of a loss of an injection preparation administered with the use of an ampulla-syringe and a traditional method with the use of a standard ampulla.

Both in a traditional method and a modern one injection needles are used. In the case of an ampulla-syringe a needle is joined with the set and constitutes it integral part, and during a traditional administration from an ampulla, it is a separate element, exchangeable and exposed to the contact with non-sterile environment. Additionally when exchanging a working needle into an injection one, a medicinal product

contained in an ampulla and in a needle is lost. An injection needle is a pipe set on a cap.

Table 1: Parametric list of most frequently used needles in a pharmacy trade (No. 1-8) and needles with ampulla-syringes in an original medicinal product with ibandronate sodium by Roche (No. 9).

o.	Commercial marking of a needle	Outer width of a needle 2R,[mm]	Measured outer width of a needle 2R,[mm]	Length of a needle L,[mm]
1	0.45 x 16	0.45	0.45	16
2	0.5 x 25	0.50	0.50	25
3	0.6 x 30	0.60	0.63	30
4	0.7 x 40	0.70	0.71	40
5	0.8 x 40	0.80	0.80	40
6	0.9 x 40	0.90	0.90	40
7	1.1 x 40	1.10	1.11	40
8	1.2 x 40	1.20	1.22	40
9	0.6 x 25	0.60	0.62	25

A needle pipe is made of high-class stainless steel. The technological priority is to make needles of the possibly thinnest wall, which leads to the increase of the inner diameter, without the increase of the outer diameter. All needles must have the rigidity and flexibility of a pipe according to the plant-specific and pharmacopeial standards. Razors of needles are modeled in such a way as to ensure a relatively fast and moderately painless penetration of tissues in order to reduce traumatization, as well as minimization of pain.

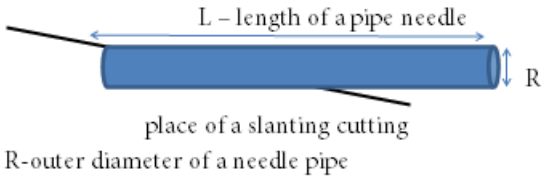

Figure 1: Scheme of a needle pipe with the marked place of cutting.

Depending on a purpose, needles can be cut short (surface of cutting to a needle creates an angle of 16˚-18˚) or needles of long razors (an angle of 11˚-13˚). Injections needles most often used have outer diameters of 0.35-1.4 mm, and preferred lengths of pipes 8-40 mm. a good solution preventing the remains of a preparation is a system of an integrated needle with a cylinder of a syringe as it is used in ampulla-syringe systems [4,8,13-18].

If we assume that a needle pipe from the point of spatial geometry is a cylinder of the height of h and the radius r, (picture 1 and 2), the a cylinder base and a cylinder upper part is a circle, ad its width is in every place the same. This solid figure in a Cartesian coordinate system is described as a collection of points (x, y, z) meeting the criteria of the inequality

$$\begin{cases} x^2 + y^2 \leqslant r^2 \\ 0 \leqslant z \leqslant h \end{cases}$$

where: r>0 and is a cylinder radius and h>0 and is its height.

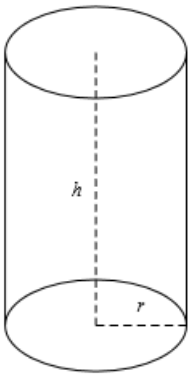

Figure 2: A right circular cylinder of the base radius – r and height – h.

In relations to the aforementioned on the basis of the following dependence:

$$V = \pi r^2 h$$

we can calculate a figure value of a right circular cylinder volume, that is, in our case, an approximate volume of an injection remaining in a needle after operations connected with performing an injection (table 2) [20].

Calculations of volume of a pipe needle – V show that when a length and a measured outer diameter of pipe needle increase, it volume also increases, and at the same time, the content of a solution of a medicine with a biologically active substance. To compare, needle parameters of an original medicinal product with ibandronate sodium by Roche has been listed table 3.

Table 2: List of necessary empirical figure values r and h, needed to calculate volume V of examined types of injection needles

No.	Measured diameter of a needle 2r[mm]	Radius of a base of a needle pipe r [mm]	Square radius of a base of a needle pipe r^2 [mm^2]	Height of a needle pipe h[mm]	Volume of a needle pipe	
					V[mm^3]	V[ml]
1	0.45	0.225	0.050625	16	2.5434	0.0025
2	0.50	0.25	0.0625	25	4.9063	0.0049
3	0.63	0,315	0.099225	30	9.3469	0.0093
4	0.71	0.355	0.126025	40	15.8570	0.0159
5	0.80	0.4	0.16	40	20.0960	0.0201
6	0.90	0.45	0.2025	40	25.4340	0.0254
7	1.11	0.56	0.3136	40	40.9847	0.0410
8	1.22	0,61	0.3721	40	46.7358	0.0467

Table 3: List of necessary empirical figure values r and h, needed to calculate volume V of examined types of injection needles

No.	Measured diameter of a needle 2r[mm]	Radius of a base of a needle pipe r 2 [mm]	Square radius of a base of a needle pipe r^2 [mm^2]	Height of a needle pipe h[mm]	Volume of a needle pipe V[mm^3]	
					V[mm^3]	V[ml]
1	0.62	0.31	0.0961	25	7.5439	0.0075

Table 4: Losses of an active substance in relations with the way of administering an injection.

No.	Declared dose of a medicine [mg/ml]	Volume of a needle pipe V[mm3]	Dose of a medicine in mg/mm3 of injection	Dose of a medicine remaining in a needle pipe [% of a declared dose]
Needle of application system of an original medicinal product				
1	3.0/3,0	7.5439	0.001	0.75
Random needles available in a pharmacy sale				
1	3.0/3.0	2.5434	0.001	0.25
2	3.0/3.0	4.9063	0.001	0.49
3	3.0/3.0	9.3469	0.001	0.93
4	3.0/3.0	15.8570	0.001	1.59
5	3.0/3.0	20.0960	0.001	2.01
6	3.0/3.0	25.4340	0.001	2.54
7	3.0/3.0	40.9847	0.001	4.10
8	3.0/3.0	46.7358	0.001	4.67

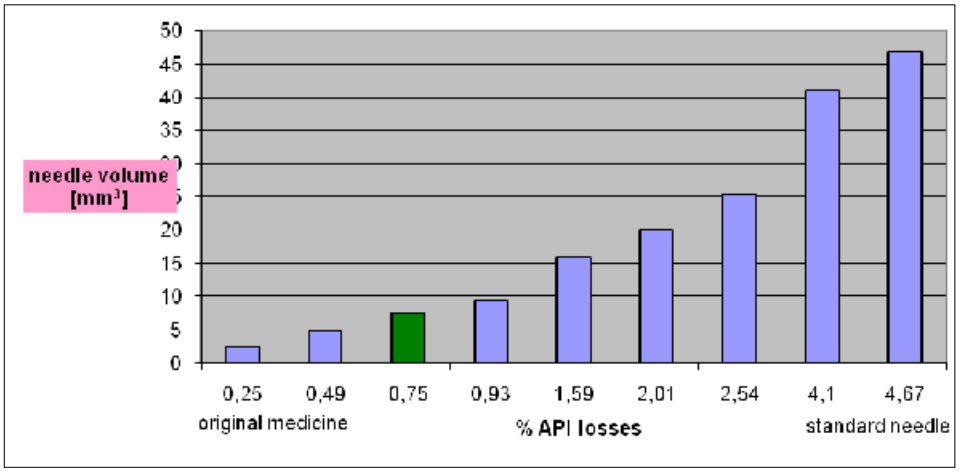

Figure 3: Illustration of a potential loss of an active substance [%] occurring during an injection with the use of an ampulla-syringe with an originally selected needle and a needle chosen randomly.

The data presented show that dozing in an original medicinal product is arranged in such a way that prevents a loss of a biologically active substance. A unit packaging of a medicine contains a needle of specified parameters. Therefore, an error of medical personnel connected with choosing an improper needle is eliminated. In case of using a generic medicinal product being a form of a standard ampulla, a number of potential errors related to administration and influencing on a reduction of an already small active substance increases [21,22].

Conclusions

- the conducted loss analysis shows that a loss value increases proportionally to a size of an needle measured by a volume of a pipe needle.
- application of a needle of the sizes bigger than 0.6 x 25mm makes a risk of administering a dose smaller than a recommended one bigger.
- negative phenomena related to API loss in a product increase, if application is from a standard ampulla, with the use of working needles and an injection needle.
- at this stage of research one needs to state that a way of application of an original medicinal product with sodium ibandronate arranged with a set of ampulla-syringe and needle is an optimal guarantee of providing a patient with a full dose of a biologically active substance expected for an effective therapy.

References:

1. Thurman J.E.: Analysis of Insulin Pen Devices for the Treatment of Diabetes Mellitus, J. Diabetes Sci. Technol. 2008, 5, 2(3), 482–483.
2. Podlewski J., Chwalibogowska-Podlewska A.: Leki Współczesnej Terapii, 2010, vol. 20, Medical Tribune, Warszawa, Polska.
3. Jachowicz R.: Farmacja Praktyczna, 2007, PZWL, Warszawa, vol 1.
4. Farmakopea Polska IX, Urząd Rejestracji Produktów Leczniczych, Wyrobów Medycznych i Produktów Biobójczych, 2011.
5. Jaber A., Bozzato G.B., Vedrine L., Prais W.A., Berube J., Laurent P.E.: A novel needle for subcutaneous injection of interferon beta-1a: effect on pain in volunteers and satisfaction in patients with multiple sclerosis, Neurol. 2008, 8, 38.
6. Chan E., Hubbard A., Sane S., Maa Y.F.: Syringe siliconization process investigation and optimization, J. Pharm. Sci. Technol. 2012, 66, 2, 136-150.
7. Müller R.H., Hildebrand G.E.: Technologia Nowoczesnych Postaci Leków, PZWL, 1998, Warszawa, Polska.
8. Merry A.F., Webster C.S., Hannam J., Mitchell S.J., Henderson R., Reid P., Edwards K.E., Jardim A., Pak N., Cooper J., Hopley L., Frampton Ch., Short T.G. Multimodal system designed to reduce errors in recording and administration of drugs in anaesthesia: prospective randomised clinical evaluation, BMJ, published online 2011, 9, 22.

9. Chan E., Maa Y.F., Overcashier D., Hsu C.C.: Investigating Liquid Leak from Pre-Filled Syringes upon Needle Shield Removal: Effect of Air Bubble Pressure, J Pharm. Sci. Technol. 2011 65, 4, 363-371.
10. Badkar A., Wolf A., Bohack L., Kolhe P.: Development of biotechnology products in pre-filled syringes: technical considerations and approaches. Pharm. Sci. Tech. 2011 12, 2, 564-572.
11. Maarschalkerweerd A., Wolbink G.J., Stapel S.O., Jiskoot W., Hawe A.: Comparison of analytical methods to detect instability of etanercept during thermal stress testing, Eur. J. Pharm. Biopharm, 2011, 78, 2, 213-221.
12. Kayser O., Müller R.H.: Pharmazeutische Biotechnologie, WFmbH, 2000, Stuttgart, Germany.
13. Carr J.A., Nalwa K.S., Mahadevapuram R., Chen Y., Anderegg J., Chaudhary S.: Plastic-Syringe Induced Silicone Contamination in Organic Photovoltaic.
14. Mahvash M., Dupont P.E: Mechanics of Dynamic Needle Insertion into a Biological Material. Trans. Biomed. Eng. 2010, 57, 4, 934–943.
15. Kongsgaard U.E., Andersen A., Øien M., Oswald I.-A.Y., Bruun. L.I.: Experience of unpleasant sensations in the mouth after injection of saline from prefilled syringes, Nurs. 2010, 1, 7.
16. Hansen B., Lilleøre S.K., Ter-Borch G.: Needle with a Novel Attachment Versus Conventional Screw-Thread Needles: A Preference and Usability Test Among Adults with Diabetes and Impaired Manual Dexterity, Diabetes Technol. Ther. 2011, 5, 13(5): 579–585.
17. Paul M., Vieillard V., Roumi E., Cauvin A., Despiau M.C., Laurent M., Astier A.: Long-term stability of bevacizumab repackaged in 1mL polypropylene syringes for intravitreal administration, Ann. Pharm. Fr. 2012, 70, 3, 139-154.
18. Alterovitz R., Branicky M., Goldberg K.: Motion Planning Under Uncertainty for Image-guided Medical Needle Steering, Int. J. Rob Res. 2008, 27, 11-12, 1361–1374.
19. Oferta Handlowa dla Aptek Ogólnodostępnych, PZF Cefarm-Kielce, grupa Farmacol, 2012.
20. http://www.wiw.pl/matematyka/geometria.pl
21. http://www.leki.urpl.gov.pl
22. Kołodziejczyk M.K., Zgoda M.M.: Polimery jako substancje pomocnicze stosowane w technologii tabletek powlekanych zawierających pochodne kwasu ibandronowego (bisfosfoniany), 2012, 42, 1, 5-16.

Emergency Medicine

First aid in cases of wounds, fractures, as well as thermal and chemical burns

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Summary:

In this work classification and characteristics of wounds are given. Subsequently, different types of treatment of patients during different individual stages of medical evacuation are briefly discussed, taking into consideration gas gangrene. Issues concerning the case of tetanus, as well as the rules of surgical aid administration to children, are also discussed.

Key words: wounds, wounds classification, primary delayed suture, qualified medical aid, gas gangrene, tetanus, surgical aid.

1. Wound management procedures

A wound (*vulnus*) is defined as a break in the body covering. The continuity of skin is broken and the inner tissues are in contact with the surrounding environment, thus a portal of infection is formed, through which pathogenic microorganisms may enter the body. During visual wound examination, special attention is paid to the location, size, shape, margin, channel and bottom of the wound. Wound margin may be smooth, nonlacerated, uneven, lacerated, contused, etc. Wound bottom is a part of the wound located between the margins. The bottom may be even or uneven, lacerated, and may have recesses and pockets. Those two characteristics, i.e. the margin and the bottom, are of high importance for the course of wound healing.

Wound, as any injury, induces local and general symptoms, even including circulatory shock. Intensity of pain related to the wound depends on the object which caused it and innervation of the injured body part. A sharp, fast-acting object induces less pain than a blunt one, e.g. a knife or razor blade cut is less painful than a contused wound caused by a hammer blow. Some areas of the body are particularly sensitive to pain due to high density of nerve endings, e.g. fingertips, eyeballs, surroundings of sexual organs. Breaking the continuity of tissues also causes blood vessel damage. Incised wounds usually induce a more intense bleeding, whereas contused wounds bleed to a lesser extent.

Depending on the type of damaged vessels, arterial, venous and mixed bleeding may be distinguished. Once skin is incised, the contraction of elastic fibres causes wound margins to retract and the wound to open. The intensity of this phenomenon is highly dependent on the direction of elastic fibre incision.

2. Classification of wounds

Depending on the cause and characteristics of the injury, several types of wounds may be listed:

1) **Incised wound (*vulnus sectum*)**—caused by a sharp, cutting object, e.g. knife, razor blade, glass shard. Incised wound margin is smooth and has no recesses or pockets. Haemorrhaging is intense due to wide open blood vessels. Blood leaving the wound mechanically removes any impurities. The wound usually heals well and the risk of infection is low.

2) **Slicing wound (*vulnus lobatum*)**—occurs when the cutting object (e.g. knife) is not applied perpendicularly to the skin, but inclined. The characteristics are similar to those of incised wound.

3) **Chopped wound (*vulnus caesum*)**—formed by a forceful action using a heavy cutting object (e.g. axe, sabre, cleaver). Often results in total amputation of the affected body part.

4) **Puncture wound (*vulnus ictum s. punctum*)**—has similar characteristics to incised wound and is caused by a sharp object with a very small cutting surface, e.g. pin, splinter, nail, fork, dagger, bayonet. Puncture wound often induces internal bleeding, while wound secretion accumulating at the bottom has no appropriate drainage due to the narrow and uneven wound channel, which may facilitate the development of infection. Penetrating puncture wounds of the chest and abdomen are particularly dangerous due to the possibility of heart and lung, or intestine damage, respectively.

5) **Contused wound (*vulnus contusum*)**—induced by a blunt or blunt-edged object (e.g. stone, stick, hammer). Wound margin is contused, crushed, the bottom is uneven and has recesses and pockets. Bleeding is scarce, as crushed blood vessels are not open. Contused tissue undergoes necrosis easily and the necrotic tissue constitutes a base for the development of infection.

6) **Crush wound (*vulnus conguasatum s. Guassum*)**—defined as a particularly vast and deep tissue contusion caused by a forceful trauma, e.g. in the victims of mine wall collapse, people covered with earth after mine explosion, run over, or crushed between train cars. The lesions are often accompanied by post-traumatic shock. Moreover, advantageous conditions for the development of vulnar infections, e.g. gas gangrene, are created.

7) **Lacerated wound (*vulnus laceratum*)** – has uneven, torn margin, while the bottom has recesses and pockets. The bottom exposes ragged adipose tissue and muscles. Loss of skin and deeper tissues is often experienced, as the blunt object causing the wound operates at a certain angle and tears some tissue off.

8) **Bite wound (*vulnus morsum*)** – those caused by a dog, cat, horse, or human belong to lacerated-contused wounds. Those caused by a horse are particularly dangerous, as the animal's strong mandible often tears off large fragments of soft tissues. The risk of infection of those wounds is high, since the bacterial flora residing in the animal or human oral cavity is abundant and composed of opportunistic strains.

9) **Gunshot wound (*vulnus sclopetarium*)**—has similar characteristics to lacerated and contused wounds, however, lesions originating from the kinetic energy of the bullet also apply in this case and include overpressure and underpressure wave effects, mechanical injuries and resonance inducing tissue and organ breakage around the wound channel. Tissue and organ water content increases the force of the bullet impact, as the mechanical reactions are accompanied by hydrodynamic phenomena: the bullet's energy is transferred to water molecules which tear the organ apart. Such explosive processes take place when the bullet hits a urine-filled bladder or a full stomach. Gunshot wound has the following characteristic features: inlet (small, with a diameter equal to the bullet calibre, even margin, and scorched skin around the inlet with incorporated gunpowder remains), channel (narrow, straight or sinuous), outlet (often not located opposite to the inlet, large surface, considerable bleeding, bottom and margin lacerated with visible bone shards).

3. Wound treatment during medical evacuation

Treatment of the victims of catastrophes and natural disasters requires clear and detailed injury identification, allowing a precise assessment of the necessary therapeutic actions and evacuation of the wounded. Anatomical identification of the wound type and functional impairment caused by the injury should be thoroughly reported in medical documentation (Evacuation Card).

Three basic types of injury-related risks may occur: haemorrhage, potential entrance of pathogenic microorganisms through damaged body covering, as well as general anatomical and functional impairment of tissues and organs. Therefore the essential aims of the therapy cover: stopping the haemorrhage, combating potential infection along with anatomical and functional reconstruction of the affected tissues and organs.

First aid comprises covering the wound with aseptic bandage and using tourniquets in the case of intense arterial bleeding, impossible to stop by other means. In the case of concurrent bone fracture or massive damage to soft tissues, the damaged limb should be immobilized.

Premedical aid comprises control and, if needed, correction of bandage covering, tourniquet or limb immobilization.

Medical aid involves changing the bandage only if it is too loose or too tight, soaked with blood, or if the patient reports strong pain or oedema around the wound. Before placing a fresh bandage, the skin around the wound should be washed with petrol, ether, or alcohol, then sterilized with iodine. Wound surface should be freed from any foreign bodies using forceps and gauze pads damped with hydrogen peroxide solution. Since a longer use of a tourniquet is disallowed, it has to be released and the bleeding vessel along with the surrounding tissue has to be grasped using Kocher's haemostatic forceps or Pean's forceps, or blocked by applying a tamponade.

All the wounded should be administered anatoxin and antitetanus serum, as well as antibiotics, while the wounded potentially at risk of gas gangrene should be administered antigangrene serum. Serum administration should be noted in the Evacuation Card. Shock prevention therapy may also be introduced (analgesics, Novocaine block, immobilization in the cases of massive damage to soft tissues).

Qualified medical aid involves wound segregation into two groups: requiring and not requiring surgical intervention.

The latter group comprises:

1) small superficial skin wounds,
2) multiple, blind, superficial wounds caused by small grenade or mine debris,
3) gunshot exit wound with smooth inlet and outlet wounds, no signs of serious tissue damage along the wound channel, and no bone fractures or large blood vessel damage.

Optimal conditions for wound treatment are provided by a single surgery leaving no need for further interventions. However, in the case of massive inflow of victims, medical services will be forced to limit **early** surgical interventions to deep wounds, complicated by the damage to internal organs, blood vessels, bones and joints.

Postponed surgical aid applies to the cases of wounds limited in area and covering tissues well-supplied with blood, mainly those of the limbs. The postponement requires antibiotic and immune serum administration, in order to prevent the development of wound infection.

Surgical wound treatment involves performing one the following actions: incision, partial excision or complete excision of the wound.

Wound incision is performed in the cases of infected wounds to facilitate the drainage of purulent secretion. These are particular wounds, as they are caused by debris which produces small wound inlet but seriously damages deeper tissues. The aim of the incision is relieving tissue tension and exposure of its recesses and pockets. The surgery involves cutting through the skin in both directions from wound ends and parallel fascial incision.

Partial excision of fresh wounds is used when complete excision is impossible. Most of all it regards contused, crush and lacerated wounds,

when the assessment of the degree of tissue damage is difficult due to the shock induced by bullet penetration and when it is impossible to determine the border of the area indicated for complete excision. Foreign bodies are removed only when easily accessible. Bleeding must not be stopped using gauze strips, but only by precise ligation of blood vessels. The wound should be finally shaped so that efficient secretion drainage is possible without the use of a filter. Bandages wrapped around the wound should be loose in order not to cause circulatory problems and accumulation of wound secretion.

Complete excision involves the removal of wound margin and bottom so that a new surgical wound is formed. Bleeding sites are temporarily tamponed and wound wiping using gauze should be avoided. The surgery is performed in fully aseptic conditions. The instruments should be changed as often as possible, after every contact with the contaminated areas of the wound.

The operation begins with the skin, whose strips are radically excised approx. 1 cm beyond the visible border of the damaged area. Subdermal tissue is excised to a large extent due to its low resistance to infection. Holes in fasciae and aponeuroses should be cut with oval incisions, with subsequent cuts at both ends. This is to widely expose muscles and remove any haematomas or foreign bodies, at the same time relieving the tension caused by oedema and obstructing proper circulation. The muscles should be removed parallel to their direction, while bearing in mind that ruptured fibres may shrink considerably and may be located outside the wound channel. On muscle excision, it is necessary to pay attention to blood vessel and nerve localization, so that their potential rupture does not cause problems in local circulation and trophic innervation, which might lead to insufficient oxygen and nutrient supply to the muscle, resulting in failure or even necrosis. The most difficult aspect of the surgery is the deformation of regular anatomical structures by the trauma and the sinuous shape of wound channel. On wound excision, the channel should be strictly followed, which is facilitated by the presence of thrombuses and damaged tissue. In deeply penetrating wounds, a channel spanning through the entire wound should be formed, starting from the wound inlet and reaching the wound outlet. A healthy muscle may be recognized by a normal, red colour of the remaining fibres, their shortening or fibrillary contractions. Small blood vessel haemorrhages are managed by applying ligatures or inducing coagulation. If larger vascular trunks are damaged, vascular suture or ligation of both ends of the vessel should be applied.

If the wound contains damaged tendons, their ends should be reformed and joined. This prevents excessive recession of tendon ends and facilitates their later joining in case of suture loosening. Ruptured nerves should be joined once their crushed sections are removed. To prevent their adhesion to the surrounding tissues, sutured nerves should be placed between muscle fibres and covered with adipose tissue grafts. In the case of bone fracture, the intervention is limited to removing lose bone shards lacking periosteum. If the wound penetrates a joint, it should be opened after previous excision of the surrounding tissue, while the margin of the joint wound should be excised carefully, along with the removal of blood, small bone, and cartilage fragments. Joint wound should then be closed tightly, whereas the damaged soft tissue should be left with open wounds. Surgical intervention performed on the second day of the trauma is called **postponed**, while that performed after more than 48 hours of the trauma is called **late,** however, it is based on the same rules as the early type of intervention.

The last step in surgical wound treatment is wound closing. It may be performed:

- concurrently with the operation, by applying the so-called primary suture or using the cyanoacrylate surgical glue,
- by postponing wound closing (delayed primary suture, early and late secondary suture),
- closing of the body covering using dermatoplasty, necessary in the case of a large skin loss.

Primary suture may be applied, when no impurities or necrotic tissue remains after the removal of damaged tissues. After the surgery, the patient cannot be evacuated, requires constant observation by the surgeon,

and the suture should be removed immediately after the occurrence of inflammatory symptoms. An absolute contraindication to applying primary sutures are:

- no possibility of careful tissue excision throughout the wound channel,
- massive haematomas in muscles
- ligation of artery supplying blood to the surrounding tissues of the wound,
- generally grave condition of the patient.

Primary suture, commonly applied in wound surgeries, may be used only in specific cases during war time. Usually the wound remains open after surgical intervention and is drained using filters.

Delayed primary suture is applied to the wound during the primary intervention and aimed to place wound margins close to each other before granulation occurs in those cases, in which no necrotic tissue, infection of inflammation is observed. This condition of wounds may be seen after a careful primary intervention concurrently with antibiotic administration. Sutures are placed directly after the surgery and tied 4 or 5 days afterwards. Stratified suture is indicated in the case of deep wounds.

If pain and inflammation symptoms occur after secondary suture application, the reaction may be relieved by removing 1-2 stitches and freeing the secretion. In every case of acute inflammation, returning to an open-type treatment method is necessary.

Early secondary suture is used for treating wounds with necrotic tissue, applied after the wound's self-cleaning and extinction of inflammatory processes. The suture is usually applied between the 8^{th} and the 12^{th} days of healing, during the granulation process and before scar formation. The stitches may be placed directly after the surgery and tied to join wound margins 4-5 days later.

Late secondary suture is applied in slowly healing wounds caused by maturating purulent inflammation which prevents the placement of stitches in the course of wound healing. The surgery is performed after scar formation and is preceded by the excision of wound margin along with scar tissue throughout its depth. Introduction of antibiotics was a giant step forward in wound treatment; yet they support, but do not substitute surgical therapy. Administration of broad-spectrum antibiotics is necessary in such case. Their local application should be conducted with caution, as they may negatively affect wound healing.

4. Prevention and therapeutic procedures in the cases of gas gangrene during medical evacuation

All activities performed as **first aid** and **premedical aid** involving wound dressing, such as bandage application, immobilization, administration of antibiotics and analgesics (along with a pharmacological kit for individual radiation protection), play a protective role against the development of anaerobic bacterial infection.

Medical aid in the cases of crush or lacerated wounds of lower limbs, buttocks or crotch, thus particularly predisposed areas, as well as in the cases of wounds caused by debris, high doses of broad-spectrum antibiotics are used.

Polyvalent anti-gas gangrene serum is a specific preventive agent, which contains antitoxins protecting against *C. perfringens* (10,000 IU), *Vibrio septica* (10,000 IU); *C. oedematiens* (1,500 IU) and *C. histolyticum* (5,000 IU) in one ampoule.

Prophylactic use of this serum is limited to the cases of wounds containing soil, especially that well-fertilized, with antibodies detectable in the wound and delayed antibiotic administration. According to many authors, polyvalent serum against gas gangrene has no therapeutic effect and has been removed from the index of medications used by the United States Armed Forces. Serum dosage depends on the type of injury and general condition of the wounded. In small wounds and good general condition, 20,000-40,000 IU of serum is sufficient, while in massive crush wounds, 40,000-80,000 IU are administered. Moreover, specific aid should provided at this stage and, depending on the type of damage, the wounds should be washed with oxidizing agents.

At the sites where aid is provided, gas gangrene patients are placed in dedicated isolation chambers. Therapy is administered by surgeons using separate instruments and scrubs.

A surgical intervention is first performed, comprising not only wound excision or incision, but also liberation of muscles and blood vessels to minimize oedema and pressure. To this end, longitudinal fascial incisions are performed in the area of affected muscles and oedema. Then the areas are covered with loose gauze strips soaked with hydrogen peroxide solution. The wound is left wide open with a local administration of antibiotics and anti-gas gangrene serum. In the case of immobilization with a plaster splint or bandaging, drainage tubes are used to deliver antibiotics and the serum. To allow exotoxin binding, high doses of the serum (40,000-60,000 IU every 4-6 hours) are administered until clinical improvement occurs.

In order to obtain higher blood concentrations, the serum should be administered along with blood and electrolytes. On serum administration, performing skin allergy tests is obligatory. Antibiotics used in this procedure are penicillin (up to 20 million IU) and tetracycline (2.0-4.0 g daily).

In case no improvement is visible and infection advances, or when the gangrene process covers the entire circumference of the limb, amputation is indicated. It is conducted by performing a circular cut in one plane (guillotine amputation) and leaving the wound completely open. Before the surgery, 500-1000 ml of blood, antibiotics, and oxygen are administered.

On the whole, provided aid involves general intensive therapy: constant monitoring of blood pressure, heart rate, respiratory rate, as well as auxiliary examinations. Small quantities of blood or blood substitutes with electrolytes (to combat acidosis), colloids (dextran), vitamins, and cardiac medications are administered. Gas gangrene patients require protein-rich food and large quantities of liquids taken orally. Secondary stitches are applied once general and local symptoms have receded; plastic surgery may also be performed.

A novel and significant achievement in gas gangrene therapy is the administration of overpressurized oxygen. The treatment is conducted in a dedicated chamber, in which the patient is placed together with medical personnel for 1-2 hours. Once the pressure is increased to 3 atmospheres, the patient breathes with pure oxygen. Such a high partial pressure of oxygen causes its blood plasma levels to increase 20-fold compared to those in standard atmospheric conditions, enabling a therapeutic role of oxygen in insufficiently oxygenated tissues. The above sessions are performed 2-3 times a day until a significant improvement is obtained. Thus conducted therapy has increased the survival rate to 75%, with the most recent studies reporting even better results.

Tetanus

Tetanus has been a serious wound complication since ancient times. A detailed description of tetanus may be found even in the works of Hippocrates, who claimed that spasms occurring as a result of wounds are fatal. The relation between some soils and tetanus has been noticed quite a long time ago.

During the Franco-Prussian War, the mortality rate due to tetanus in the Prussian Army reached 91%. According to many researchers, the incidence of tetanus was predominantly related to war injuries. The toxic character of the disease was ultimately proved in 1889 r. by Kitarato, who obtained cultures of tetanus bacilli.

The recent major wars were fought in the areas, where large-scale animal breeding and soil fertilization for grapevine crops were used. According to the British Army statistics, among the l,720,000 wounded on the Western Front of World War I, 2,529 (1.47%) of them were infected with tetanus. Concurrently, among the 286,000 wounded on other fronts, only 20 cases of tetanus (0.07%) were reported. Other sources report that tetanus incidence rate on the Western Front was 21 times higher that in the Eastern Front. In World War I and, partially, World War II, seroprophylaxis was the basic preventive measure against tetanus. It was active mass immunization using antitetanus anatoxin which provided effective protection against tetanus infections. In the armies which

used anatoxin, the cases of the disease were extremely rare.

Tetanus is caused by the spore-forming bacterium *Clostridium tetani*, which belongs to anaerobic bacteria. The disease may develop once the bacteria or spores arrive deep into the tissue through an open wound, or rarely in patients who did not sustain an open wound.

Tetanus bacilli may be found in bovine, equine, and sometimes human faeces. This way the bacteria get into the soil. The cells and especially the spores are very resistant and retain the ability to develop up to one year. The portals of infection are wounds, insect bites, burns and frostbite. Tetanus bacilli multiply only in the wound and its surroundings. Host organism is affected only by neurotoxins, rapidly penetrating the central nervous system through the myelin sheath, blood and lymph. Tetanus toxin binds to ganglion cells of the anterior horn of the spinal cord and medulla oblongata. Administered anatoxin is unable to dissociate or neutralize the toxin. Tetanospasmin causes tonic contractions of skeletal muscles and increases muscle contractility leading to clonic spasms.

Proper tetanus identification is extremely important. Incubation period of the infection ranges from l to 60 days, usually lasting 7-11 days. A short incubation period lasting a few days is prognostic of a more severe course of the disease. If the initial point is a head, neck or trunk wound, the course of tetanus is more rapid and severe. The occurrence of tetanus in ⅓ of all cases is preceded by a period of initial symptoms. Jaw paraesthesia occurs along with pain around the wound much stronger than expected, occurring mainly at night, painful spasms around the wound, pain when applying pressure to the nerve trunks serving the wound area, increased muscle excitability, excessive tendon and periosteal reflexes, often covering larger areas. Among general symptoms, excitation or somnolence, increased sensitivity to light and sound, hydrophobia, increased body temperature, headache, or abundant vomiting may be observed.

The symptoms of developed tetanus may represent two forms. The generalized form occurs when the disease develops over a short period of time and tonic spasms regard different muscle groups without any order. The patient is constantly conscious. In the discerning pattern, several muscle groups are affected in the following order: muscles of mastication *(trismus),* mimic muscles *(risus sardonicus)*, neck and back muscles *(opisthotonus),* diaphragm and respiration muscles.

In both of those forms superficial sensation is retained, tendon reflexes are more pronounced, and Babinski's sign may occur. Due to the excitation of the central nervous system, tonic and clonic spasms occur, while the gaps between the spasms may be as short as a few minutes.

In the fully developed disease, the patient lies on his/her back with the head inclined backwards, the trunk heavily bent forward, lower limbs extended in the knees, feet dropped. Upper limbs lie freely. During the spasms, the patient moans, sweats and bends the neck and the trunk to a greater extent. The spasm of arm flexors causes elbow flexion and closes the hand into a fist. Due to increased contraction of the glottis, intercostal muscles, and diaphragm, breathing difficulties occur followed by cyanosis and apnoea. Strong spasms may lead to abdominal muscle rupture, as well as rib, sternal, and vertebral fractures. The cause of death may be central nervous system ischaemia, as a result of recurring periods of apnoea. Secondary causes of death may include bronchial pneumonia and heart exhaustion.

In a catastrophe, every burn or frostbite is at risk of tetanus contraction and requires preventive measures which may only be applied during medical aid.

It is assumed that all victims with wounds, burns and frostbite should receive 3,000 IU of antitetanus serum (antitoxin), which induces passive immunity. The serum should be administered as soon as possible after the injury. Protective role of serum administration becomes doubtful after 12 hours of the injury and pointless after 24 hours. Equine or bovine antitoxin is used for injections. In the case of wounds potentially at risk of tetanus or if some more time passed after the injury, 6000 IU should be administered.

In the case of decreased immunity response (due to radiation), the dose should be 3-4 times higher. Reserve in using antitetanus serum lightly may be due to the possibility of allergic reaction induced by specific antibodies (anaphylactic reaction, serum sickness). The frequency of those complications increases with the serum dose and when a 100 ml dose is administered, serum sickness occurs in 90% cases.

Antitetanus serum should only be administered after an intradermal or intraconjunctival sensitivity test. When allergy is suspected, fractionated administration should be applied, which involves intradermal injection of 0.1 ml serum diluted 1:20 with 0.9% saline. If no local reaction visible as a vesicle with reddening or oedema appears within 30 minutes, the entire serum dose may be administered. In the case of a visible reaction, the appropriate dose is divided and slowly injected during 0.5 to l hour in the following sequence: 0.05 ml of 1:20 dilution, 0.05 ml of 1:10 dilution, then 0.5 ml and l ml subcutaneously. If no clearly visible symptoms appear, the remainder should be administered intramuscularly.

Once an allergic reaction occurs, the administration should be abolished and desensitizing agents should be used *(calcium chloratum,* adrenalin, ephedrine).

Serum sickness usually occurs after 7-10 days. Passive immunity is retained for 14 days after serum administration. Negative consequences of the use of antitoxin are eliminated by the prophylactic use of human antitetanus serum. Using relatively small doses a high level of antitoxin is obtained, which remains in blood serum for longer periods. Difficulties in obtaining human serum limit its use in everyday practice.

The most effective, the simplest, and the cheapest agent inducing active immunity is tetanus anatoxin which contains no protein, therefore its use poses no risk of negative consequences.

It was demonstrated during World War II that thanks to active immunization no case of tetanus due to sustained wounds was reported. Anatoxin is administered intramuscularly in several doses. Two types are used: formol anatoxin and the type adsorbed to aluminium hydroxide or phosphate. Aluminium anatoxin is used at the quantity of 0.5 ml, while the formol type at 1.0 ml. Adsorbed anatoxin is administered in two doses, while the formol type in three doses, with 4-6-week gaps.

In order to retain a high titre of antibodies after the primary immunization, the so-called maintenance dose is administered every 4-6 years. In most cases, actively immunized people have sufficient immunity to tetanus.

If the injury occurs after more than 6 months of immunization, a maintenance dose has to be administered. Some authors advise, however, to keep the patient under observation for 10 minutes after anatoxin administration.

A mixed type of immunization, both active and passive, is used in the cases of wounds potentially at risk of tetanus in nonimmunized or improperly immunized patients. Antitoxin is to provide passive immunity until the organism produces its own antibodies. Anatoxin is injected in a different body part than serum and with a different syringe.

Antibiotics used in tetanus prophylaxis are of dubious use, but in the cases of massive wounds they constitute a form of protection against the development of additional bacterial flora.

As a part of qualified aid provided to the wounded infected with tetanus, apart from previous surgeries, surgical wound treatment is performed. The administration of tetanus serum and anatoxin is obligatory in those who have not received them.

Contemporary tetanus treatment procedures should be performed in separate, dedicated rooms or even separate hospitals. The therapy should be conducted by a surgeon in collaboration with an anaesthetist and using all the available equipment.

Tetanus therapy involves:

- local therapy,
- specific general therapy,
- nonspecific general therapy,
- thorough patient care.

Local therapy is based on surgical wound treatment. One hour before the planned

surgery, the serum should be evenly injected into the wound. The surgery involves opening the wound wide, removal of foreign bodies, damaged tissue, and recesses. Then the wound is washed with hydrogen peroxide solution, or alternatively covered with zinc powder. If the intervention concerns a limb with a concurrent fracture, tight plaster bandaging should be used for limb immobilization. In the case of damage exclusively to soft tissues, only a plaster splint is used.

In order to sequester circulating toxins, 50,000-100,000 IU of equine or bovine antitetanus serum should be injected intravenously and intramuscularly. The injections are performed for 8 days, depending on the course of infection. It is also recommended to inject antitetanus serum intrathecally every two days or, in severe cases, every day. Intrathecal administration should be obligatorily performed in general anaesthesia and with the removal of a volume of cerebrospinal fluid equal to the volume of introduced serum. To this end, concentrated serum containing 30,000-50,000 IU in 20-25 ml is used, previously heated to the body temperature.

During intramuscular serum administration, the injection site should be located above the wound and the injected volume should not exceed 50 ml per site. Intravenous injection poses a risk of allergic reaction, therefore it should be used only in exceptional cases and once protective measures have been taken. The latter involve the following sequence of actions: subcutaneous injection of 0.25-0.5 ml, 4 hours later 0.1 ml is administered intradermally, after another hour the subcutaneous injection site is examined for an allergic reaction. If oedema or reddening occurs, no intravenous administration is performed.

If an allergic reaction appears, 0.2 ml of 1:100 adrenalin solution should be administered subcutaneously, as well as 20 ml of 10% *calcium chloratum* (intravenously) and antihistamine preparations. The quantity, duration and routes of antitetanus serum administration depend on the clinical image of the disease and medical indications.

In all cases, the serum should be combined with 1 ml of antitetanus anatoxin and repeated on days 2 and 4 (3 doses altogether). Depending on the intensity of spasms and the severity of clinical signs, general anticonvulsive therapy should be applied. Mild and moderately severe tetanus therapy may include neuroplegic medications or chloral hydrate up to 3-4 g/day *(chlorali hydrati* 1.0-1.5; *Decocti amyli* 50.0 d.t.d. no. 3), administered intra-anally after heating to 40°C.

The administration of lytic mixture (l amp Dolargan (pethidine) + l amp chloropromazine — pipolphen (promethazine) — and 0,9% NaCl solution brought to 10 ml or l amp Dolargan (pethidine) + l amp. chloropromazine + l amp. promethazine and l% lignocaine brought to 20 ml) depends on patient status and age. The mixture is used every 3-4 hours depending on the spasm occurrence and intensity.

Another recommendable spasm therapy is concurrent neuroplegic and barbiturate administration at 0.5-1.0 g in 1 L of 5% glucose solution.

In a severe course of tetanus, tracheotomy is performed and controlled respiration is conducted using a tube with sealing cuff after the administration of curare preparation. D-tubocurarine may also be used as repeated intramuscular injections, adjusted to every patient individually. Gaps between the injection are gradually extended. Succinylcholine I.V. may be used instead of d-tubocurarine due to higher procedural flexibility.

When neuroplegic agents are used, special attention needs to be paid to maintaining proper blood pressure levels, as a decrease to 80-75 mm Hg is a strong contraindication for further use.

During controlled respiration, air passage through the airways has to be secured by correct body positioning, suction and drainage of airway secretion, air humidification, changing the tracheostomy tube and local antibiotic administration.

Moreover, general therapy involves the administration of antibiotics (2-3 million IU of penicillin/day and tetracycline), liquids and electrolytes. The diet should be fluid, rich in calories and proteins, delivered using a feeding tube during

periods without spasms. Adrenal hormones should be used in severe cases, as adrenal cortex depletion occurs.

Tetanus patient care involves strict isolation, keeping the patient calm, careful and frequent (every 1-1.5 hours) repositioning to prevent pressure ulcers, proper feeding, keeping free the passage of urine in the catheter, controlling fluid balance. It is also necessary to control body temperature, blood pressure and respiratory rate.

5. Principles of providing surgical aid to children

Children constitute approx. ⅓ of the population of Poland, therefore it is vital to protect them against harmful consequences of modern warfare. One of preventive measures is their dispersal. During war time, children typically sustain injuries similar to those of adults. For humanitarian reasons, it is necessary to provide them better conditions of treatment and more carefully segregate them to the expectant category. It is also recommended to provide separate rooms for the treatment of children.

The reaction of a child's organism to harmful factors is different according to age. From the anatomical and physiological point of view, a child is not a miniature of an adult, but an immature organism undergoing dynamic tissue transformations. This explains their high sensitivity to dehydration, insufficient protein supply and electrolyte imbalance. The greatest differences in the reactions to harmful stimuli occur in the early stages of life, while in the later development those changes are less pronounced. High instability of a child's organism makes the differentiation between physiological and pathological state difficult.

Treating wounded children requires applying the same procedures as in adults. However, vulnar infections in children easily become generalized and spread rapidly, often causing sepsis. This requires early surgical wound treatment, more frequent wound drainage and antibiotic administration.

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References:

1. Doraźna pomoc lekarska. Kamiński B, Dziak A, (red.), PZWL. Warszawa, 1988.
2. Ostre stany zagrożenia życia w chorobach wewnętrznych. Kokot F (red.), PZWL. Warszawa, 2009
3. Wypadek Drogowy Pierwsza Pomoc. Szumial J. (red.), Grupa Image, 2008
4. Medycyna ratunkowa i katastrof. Podręcznik dla studentów uczelni medycznych. Zawadzki A (red.), PZWL. Warszawa, 2008.
5. ABC Ratownika, Pierwsza pomoc w nagłych wypadkach. Ziemba R, (red.), Warszawa, 2005.
6. Metody skalowania obrażeń ciała i ich zastosowanie w traumatologii. Bielecki K (red.), 1997.
7. Medycyna Ratunkowa i Medycyna Katastrof. Rasmus A, Gaszyński, W, Balcerzak-Barzdo E, Holyński J (red.), Łódź, 2003.

Forensic medicine

Consultative problems in the cases of acoustic injuries caused by explosions, according to documented medical opinions on injuries sustained by Polish soldiers in Afghanistan

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Summary:

Introduction: The aim of the study was to analyse consultative problems in the cases of acoustic injuries caused by detonation of explosives or use of firearms and resulting in hearing loss detectable in audiometric tests.
Material and methods: The study was based on documented medical opinions released by Forensic Medicine Department, Medical University of Warsaw, and concerning injuries sustained by Polish soldiers serving in missions in Afghanistan. The expert's role was to indicate sustained injuries and provide their legal qualification.
Results: Consultative problems were reported for acoustic injuries due to the specificity of such cases. Sustained damage was related to permanent hearing loss in the high-frequency range confirmed in audiometric tests.
Conclusions: As Polish soldiers serve in military missions abroad, forensic medics often encounter problems releasing medical opinions on injuries sustained by the soldiers. It may be noticed, that changes in military equipment and warfare result in higher incidence of isolated hearing loss. At the same time, damage to the vestibulocochlear organ may limit the ability to continue military service and negatively affect the non-professional activities of the soldier.

Key words: acute acoustic trauma, barotrauma, hypoacusis, explosive detonation, forensic medical opinion.

1. Introduction

Nowadays, as Poland actively participates in military missions, Polish soldiers more frequently sustain injuries during warfare. They become victims of gunfire and explosives, which lead to injuries of various gravity, including damage to the middle and the inner ear.

In this paper, the authors will attempt to answer the question how to provide legal qualification

of middle- and inner-ear injuries caused by detonation of explosives and gunfire and leading to hearing loss, but also how these injuries may affect further professional and non-professional activities of the soldier.

Anatomical basis of sound reception

Sounds from the environment arrive at the outer ear in the form of acoustic waves and, thanks to the properly formed auricle, are concentrated in the external auditory meatus. At the bottom of the meatus, acoustic waves collide with the tympanic membrane and cause it to vibrate. Subsequently, tympanic membrane vibrations induce the motility of the ossicular chain in the middle ear (first the malleus, attached to the tympanic membrane, then the incus and the stapes) [1, 2]. The base of the last ossicle, the stapes, closes the vestibular window (previously denominated the oval window) and its movements are transferred to endolymph filling the membranous labyrinth [1, 2]. Within the latter, a wave induced in the liquid is propagated through the atrium, scala vestibuli and scala tympani and arrives at the secondary tympanic membrane covering the cochlear window (previously denominated the round window), which causes the membrane to deform. Finally, the movement of perilymph stimulates the hair cells in the organ of Corti (spiral organ). High-frequency sounds are received by hair cells localized within the basal part of the cochlear turn, whereas lower frequencies are detected in the apical part of the cochlear turn [1, 2].

Pathology of acoustic trauma and barotrauma

By analysing auditory system injuries diagnosed in the examined soldiers, we tried to specify the pathomechanism of those injuries. Damage to the vestibulocochlear organ in the examined group may appear as acoustic trauma, barotrauma and combined acoustic and pressure trauma.

Acoustic trauma

Acoustic injuries occur, when the auditory system is exposed to harmful noise. According to the time of exposure, the level of damaging factor and the rapidity of hearing damage, acoustic traumas may be divided into acute and chronic types [3, 4]:

- Acute acoustic trauma (AAT) is a rapid hearing loss caused by a short exposure to a high level of noise. It is induced by impulse noise produced by explosions, firearms or fireworks. In some cases, AAT may be caused by non-impulse noise, e.g. industrial noise, in particularly sensitive individuals [3, 4].
- Chronic acoustic trauma is a gradual, bilateral, advancing impairment of hearing due to long-term, often multi-year exposure to noise [3, 4].

Circulation disorders in the inner ear capillaries and decreased partial oxygen pressure in the inner ear liquids with cochlear ischaemia are indicated as the pathomechanism of acute acoustic trauma. What is important, in this type of injury damage to the organ of Corti and the basilar membrane occurs [5]. Hair cell damage within the basal part of the cochlear turn appears as isolated hypoacusis in the high-frequency range, characteristic of acute acoustic trauma, which is presented in Figure 1 [6].

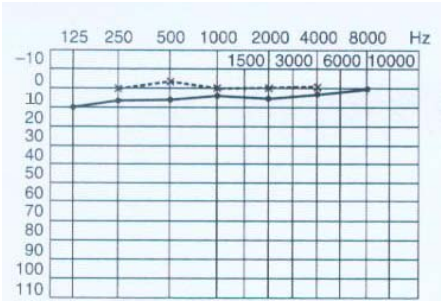

Figure 1: Pure-tone threshold audiometry - correct x-----x bone, •——• air [2].

As time advances, isolated high-frequency hypoacusis may also cover other frequencies in a close range. Among the symptoms of acute acoustic trauma, typical sensorineural hearing loss isolated to high frequencies (usually at approx. 4000 Hz) may be accompanied by tympanic membrane rupture causing conductive hearing loss. Ear pain and tinnitus may also be observed. The above mentioned symptoms may recede naturally within several days, but usually permanent hearing loss occurs, which may aggravate with time [4].

Barotrauma

Barotrauma is caused by a shock wave, a rapid movement of air or liquid encountered by the tympanic membrane. It may be a consequence

of an explosion, increasing pressure gradient or a hit with an open hand near the auditory external foramen. [3, 4]

As a result of suffered barotrauma, both the middle ear and the inner ear may sustain damage including [3, 7]:

- Tympanic membrane rupture;
- Damage to the ossicular chain;
- Perilymph fistulas at the vestibular (oval) window and the cochlear (round) window with possible liquorrhoea;
- Damage to the organ of Corti and the basilar membrane.

Due to the fact, that in the case of barotrauma both the middle ear and the inner ear are subjected to injuries, both sensorineural and conductive hearing loss may occur, leading even to complete deafness. Moreover, symptoms such as balance impairment, vertigo and tinnitus may appear [3, 7].

Subjective and objective examinations used in the diagnostics of both acute acoustic trauma and barotrauma are listed in Table 1 and Table 2, respectively.

Table 1: Subjective tests.

- Acumetry – preliminarily differentiates sensorineural and conductive hypoacusis;

Tuning fork hearing test – preliminarily differentiates sensorineural and conductive hypoacusis;

- Audiometric tests:
  - Pure-tone threshold audiometry – determination of the type and the degree of hearing loss;
  - Pure-tone suprathreshold audiometry – localization of the sensorineural injury;
  - Verbal audiometry – assessment of the ability to understand speech.

Table 2: Subjective tests.

- Impedance audiometry;
- Otoacoustic emission;
- Electrophysiological audiometry.

Among the subjective examinations, the preliminary hearing test and the tuning fork hearing test as indicated by the Polish Society of Forensic Medicine and Criminology (PTMSiK) are of little or no use for forensic medical consultations. In the cases consulted by Forensic Medicine Department, Medical University of Warsaw, the released opinions were based on the available case documentation including the results of pure-tone threshold audiometry. Examples of the results of pure-tone threshold audiometry are presented in Fig. 1, 2, 3 and 4.

This examination method is used to determine the type and the degree of hearing loss. However, the method requires good cooperation between the examiner and the subject. Moreover, what is important in giving a medical opinion is that the subject may modify the results to some extent, for his/her own benefit, by aggravating the symptoms or dissimulating the present hearing loss. In order to avoid such situations, the most appropriate solution is conducting objective hearing examinations, which prevent the subject from manipulating the results.

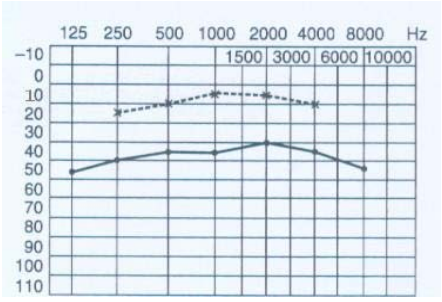

Figure 2: Pure-tone threshold audiometry – conductive hearing loss x-----x bone, •——• air [2].

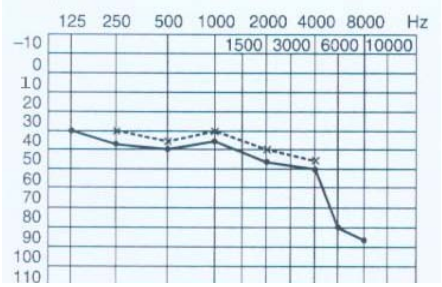

Figure 3: Pure-tone threshold audiometry- sensorineural hearing loss x-----x bone, •——• air [2].

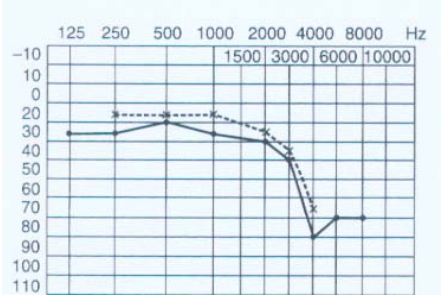

Figure 4: Pure-tone threshold audiometry - sensorineural hearing loss at approx. 4 MHz x-----x bone, •——• air [2].

2. Material and methods

The study was conducted based on several series of documented medical opinions released by Forensic Medicine Department, Medical University of Warsaw in 2010 and 2011, concerning 18 Polish soldiers serving in military missions in Afghanistan. Among the consulted cases, 12 soldiers sustained injuries from detonation of explosives, whereas 5 soldiers did not experience any type of injuries.

In three analysed cases, the soldiers died of lesions caused by explosive detonations, among whom two died at the site of explosion and one died after long-term hospitalization. It is not known whether hearing loss occurred in those three cases. In other six cases, damage to the auditory system was reported and in three of them hearing loss was accompanied by other injuries regarding e.g. the back and the lower limbs. In the two remaining cases, no hearing loss was reported, yet one of the soldiers suffered from lower limb and head injuries.

Apart from the cases described above, reported was a single case of a soldier, who sustained upper limb injuries including damage to nerve and vessel trunks while being under attack by long-range gunfire.

3. Results

In the cases of hearing loss consulted by Forensic Medicine Department, Medical University of Warsaw, the results of pure-tone threshold audiometry were available, both obtained soon after the injury (within a few days) and derived from 2-3 control tests conducted after several weeks or months of the injury.

Among the six discussed cases of soldiers with hearing loss, the following characteristics were observed:

- two cases of bilateral hearing loss accompanied by inner ear problems, including vestibular disorders (Fig. 5);
- two cases of bilateral hearing loss with no symptoms of inner ear disorders;
- two cases of unilateral hearing loss (Fig. 6).

Among all consulted cases, only in one case the soldier was explicitly reported to have been wearing protective earmuffs at the moment of explosion (which occurred within a close range) and this fact prevented him from sustaining hearing loss.

Considering the circumstances of the occurrence of damage to the auditory system, i.e. detonation of explosives in close proximity, two mechanisms of injury should be taken into consideration. Apart from acute acoustic trauma, components of barotrauma may also be expected. Nevertheless, we are unable to clearly assess the extent, to which barotrauma is responsible for the sustained damage. Assessment difficulties originate from the fact, that the hearing loss determined in audiometric tests may be a result of either acute acoustic trauma

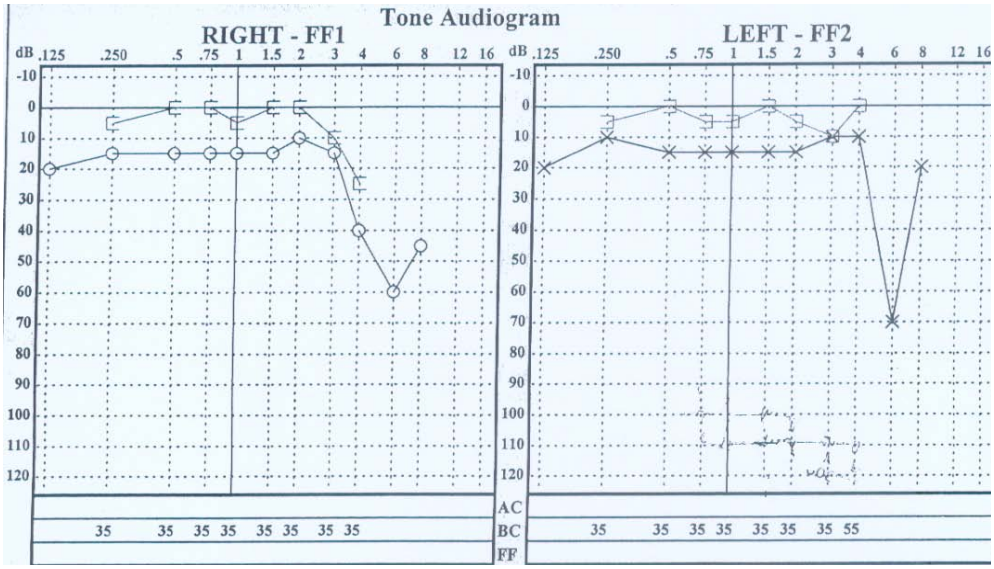

Figure 5: PTA of one of the soldiers – bilateral sensorineural hearing loss at approx. 6 kHz.

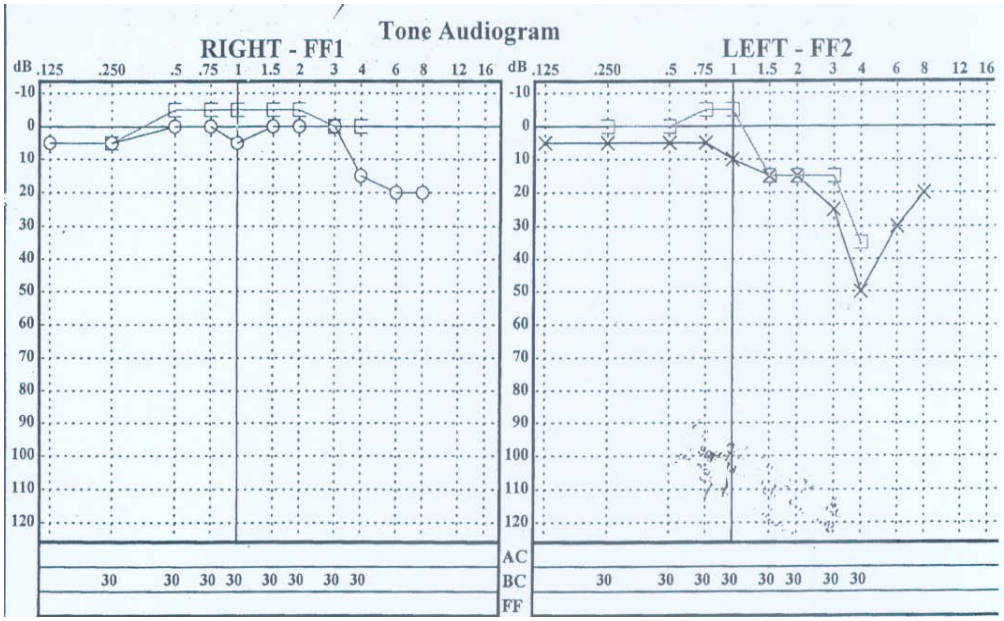

Figure 6: PTA of one of the soldiers – left-sided sensorineural hearing loss at approx. 4 kHz.

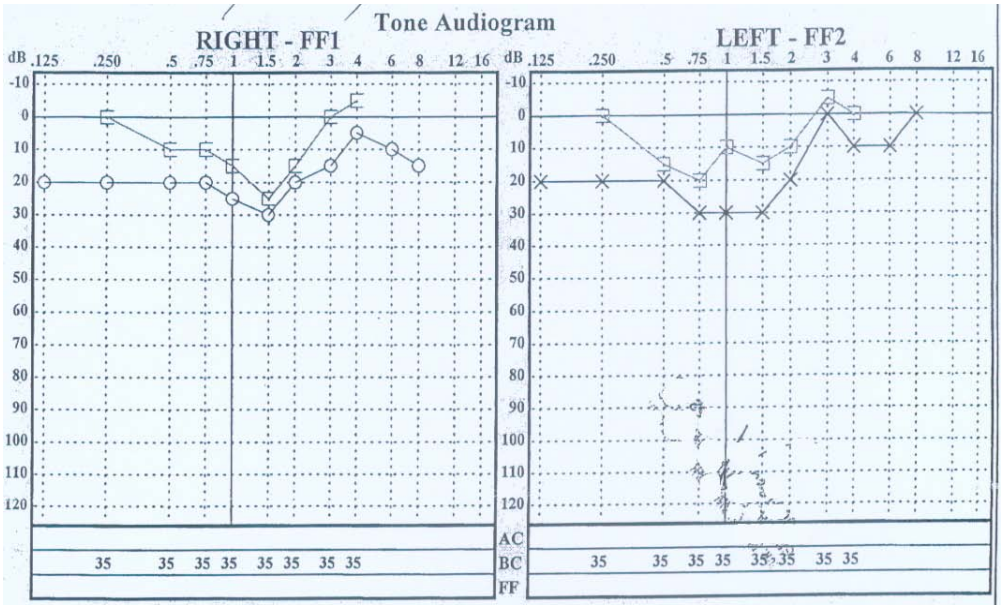

Figure 7: PTA of one of the soldiers – mild bilateral hearing loss, unusual for AAT.

or barotrauma. At the same time, no middle ear damage was reported in the discussed cases.

In the cases of hearing loss consulted by Forensic Medicine Department, Medical University of Warsaw, several consultative problems were encountered. Even though permanent hearing loss likely to undergo progression was reported, there were no cases of complete deafness. Moreover, in the cases of isolated hearing loss in the high-frequency range, the ability to hear may be regarded as socially efficient. People suffering from this condition may be disoriented by not being able to understand their interlocutor in certain situations (e.g. large and loud gatherings), but in comfortable conditions (speaking to one person in a quiet room) they are able communicate [8]. Considering the above fact in the consulted cases, impairment of the auditory system lasting over 7 days according to Art. 157.1 of the Polish Penal Code was reported.

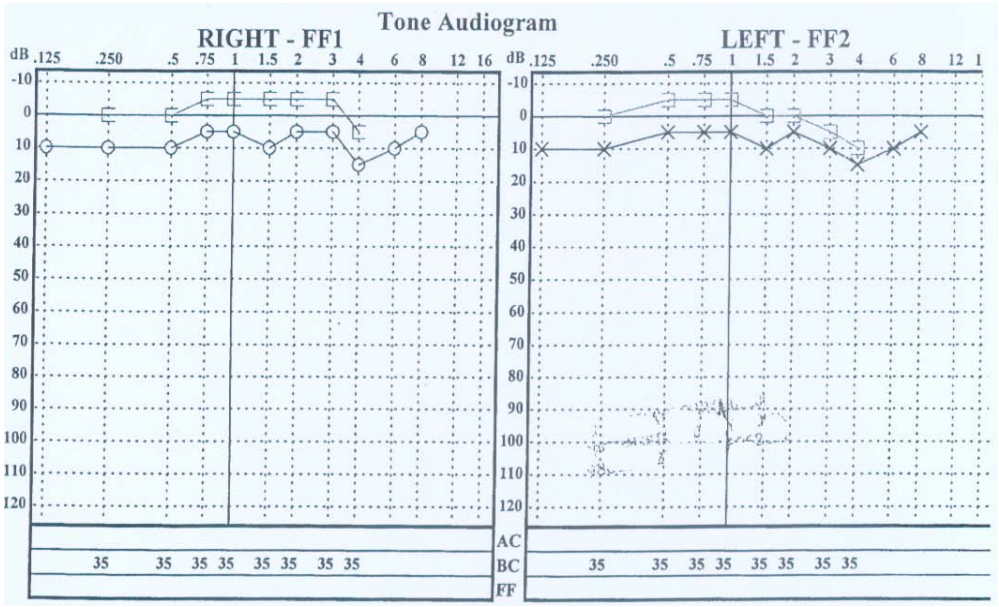

Figure 8: PTA of one of the soldiers – correct.

4. Discussion

The problem of hearing loss in people exposed to impulse noise may be found in the literature. Many of the described cases concern soldiers, who were exposed to gunfire during their military service (including both practice and combat shooting), explosive detonations and other types of noise derived from military equipment [8, 9, 10, 11]. Both bilateral and unilateral hearing loss were reported, but unilateral injuries were attributed by some researchers to the shooting position [12, 13]. In the cases consulted by Forensic Medicine Department, Medical University of Warsaw, either unilateral or bilateral hearing loss were observed, although the conditions were caused exclusively by explosive detonations and not by using firearms. Some authors emphasize the fact, that besides obvious symptoms of acute hearing loss, such as hypoacusis, special attention needs to be given to such vestibular disorders as vertigo, balance impairment and nystagmus [11]. Symptoms of vestibular disorders also occurred in two cases consulted by Forensic Medicine Department.

Nonetheless, soldiers are not the only group descri-bed in the context of acute acoustic trauma. Studies of other social groups using firearms may be found in the literature. Those are e.g. police officers and hunters [14] or people accidentally witnessing gunfire [15]. There are also reports of hearing loss as a consequence of explosive detonations in large gatherings [16].

In the cases reported in the literature, injury circumstances, symptoms, diagnostics and treatment were taken into consideration. The need of acute acoustic trauma prevention by using earplugs or earmuffs was also indicated. Yet, the problem of legal qualification of the reported damage to the auditory system remained unsolved.

As Polish soldiers serve in military missions abroad and civilian prosecutors are obliged to investigate warfare injuries and deaths, forensic medics face the problem of providing opinions on injuries, which are less frequent among civilians, but are characteristic of military activities. Moreover, there are no straightforward guidelines for the consultancy of permanent functional impairment of the vestibulocochlear organ. Providing a proper opinion requires considering many variables, such as the permanence of damage, its range and effect on further functioning of the victim.

5. Conclusions

1) Due to warfare changes, cases of isolated injuries to the vestibulocochlear organ with no other health damage may occur more frequently.

2) Isolated sensorineural hypoacusis in the high-frequency range may affect proper military service.

3) Isolated sensorineural hypoacusis affects the non-professional activities of the soldier.

4) Despite many reports on acoustic traumas in the literature, there are no straightforward guidelines for the consultancy of permanent, isolated sensorineural hypoacusis in the high-frequency range.

References:

1. Bochenek A., Reicher M. Anatomia człowieka tom V. Warszawa: PZWL, 2006 (dodruk).
2. Aleksandrowicz R., Gielecki J., Gacek W. Anatomia topograficzna – Przewodnik anatomiczny do ćwiczeń prosektoryjnych polsko-łaciński. Warszawa, PZWL, 1998.
3. Janczewski G. (red.) Otolaryngologia praktyczna. Gdańsk: Via Medica, 2007.
4. Latkowski J. B. (red.) Otolaryngologia dla studentów medycyny i stomatologii. Warszawa: Wydawnictwo Lekarskie PZWL III Wydanie, 2004.
5. Kuokkanen J., Aarnisalo AA., Ylikoski J. Efficience of hyperbaric oxygen therapy in experimental acute acoustic trauma from firearms. Acta Otolaryngologica 2000; 543: 132-134.
6. Harada H., Shiraishi K., Kato T. Prognosis of acute acoustic trauma: a retrospective study using multiple logistic regression analysis. Auris Nasus Larynx 2001; 117-120.
7. van de Weyer P., Praetorius M., Tisch M. Update: blast and explosion trauma. HNO 2011; 59: 811-818.
8. Ylikoski M., Ylikoski J. Hearing-loss and handicap of Professional soldiers expose to gunfire noise. Scandinavian journal of work environment & health 1994; 93-100.
9. Psillas G., Constantinidis J., Triaridis S., Vital V. Acute Unilateral Total Deafness and Vestibular Findings after Gunshot Noise. Laryngo-Rhino-Otol 2007; 879-882.
10. Psillas G., Pavlidis P., Karvelis I., Kekes G., Vital V., Constatinidis J. Potential efficacy of Elary treatment of acute acoustic trauma with steroid and piracetam after gunshot noise. Eur Arch Otorhinolaryngol 2008; 1465-1469.
11. Golz A., Westerman S.T., Westerman L.M. I wsp. The Effects of Noise on the Vestibular System. American Journal of Otolaryngology 2001; 190-196.
12. Moon, In Seok Noise-induced hearing loss caused by gunshot in South Korean military service. Millitary medicine 2007; 421-425.
13. Konopka W., Pietkiewicz P., Zalewski P. Badanie emisji otoakustycznej u żołnierzy przed strzelaniem i po strzelaniu. Otolaryngologia polska 2000: 745-749.

Toxicology

Microbes indicators of cosmetic preservation efficiency. Part I – *Pseudomonas aeruginosa*

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Summary:

The bacterium *P. aeruginosa* is used, among others, as an indicator of the official assessment of the effectiveness of cosmetics preservation. In the hereby study the general characteristics, morphology and culture, diagnosis of infections caused by P. aeruginosa, the role of *P. aeruginosa* in the environment, Pathogenicity of *P. aeruginosa*, *sensitivity and resistance to antibiotics* and current interest with *P. aeruginosa* in cosmetic microbiology were discussed.
The aim of the study is to strengthen the belief of producers and users of cosmetics to the validity of the selection of indicator organisms for assessing the effectiveness of added preservatives.

Key words: *Pseudomonas aeruginosa*, cosmetics, pollution, maintenance of biofilm, antibiotics.

Introduction

In cosmetics, as in other products made from organic material, there may be microbial contamination of various types. Apart from the same raw materials, the source of pollution can be: the environment of production facilities, apparatus and equipment, and improper hygienic method of manufacture and packaging cosmetic. Microbial enzymes that could potentially contaminate the product, causing decomposition of organic components which contribute to lower values of cosmetics. Environmental micro flora presented in air or settled, and taking the form of a biofilm, often causes contamination of the product. Saprophytic species (usually non-pathogenic) bacteria and microscopic fungi occur in the product.

According to current regulations in order to prevent spoilage of cosmetic products, producers are required to determine the minimal but effective concentrations of preservatives. For this purpose, they use the force method called controlled environmental microbial contamination.

In this contaminating micro flora microorganisms of hygienic importance may be found. For this reason, the legislation require to carry out similar pollution-controlled studies using representative

species of conditionally pathogenic microorganisms: *Pseudomonas aeruginosa, Staphylococcus aureus* and *Candida albicans* [1].

The hereby study consists of three parts which characterizes the abovementioned micro-organisms with particular reference to pathogenic properties and it aims to strengthen the belief of producers and potential users of cosmetics for the validity of the selection of indicator organisms for assessing the effectiveness of added preservatives.

Part I of the study concerns the development of bacterial indicator *P. aeruginosa* that represents a lot of environmental mesophilic and aerobic gram-negative bacilli.

General characteristics, morphology, and culture of *P. aeruginosa*

This species, formerly known as *P. pyocyanea*, is widespread in nature. It occurs in damp areas (soil, water, sewage) [2]. Among the species of the family *Pseudomonacea* is a species responsible for most infections in humans. It can cause opportunistic infections in patients with immune deficiency, even sepsis [3]. This organism can also be pathogenic to animals and plants [4].

Pseudomonaceae are straight or slightly curved gram-negative bacilli, with dimensions of 0.5x1.5 micron, covered with cilia, decomposing glucose. They have very low nutrient requirements, can use non-conventional carbon sources, and are widespread in nature. These bacilli have a significant part in the biodegradation of various chemical compounds polluting the environment.

They are common in hospitals, often in places with high humidity (siphons of sinks, humidifiers of ventilators, drug and disinfectants solutions and in distilled water, where they use even trace amounts of organic substrates to proliferate.

Pseudomonaceae family bacilli showing the following common features:

1) They grow at temperatures from 5 to 45^{0}C;
2) They are moveable, endowed with cilia arranged pole or on the entire surface;
3) They typically produce cytochrome oxidase. *They are capable of growing under aerobic and anaerobic conditions*;
4) Most tribes produce pioverdin pigments and the other ones different colors: pyocyanin, pyorubin, melanin.

There are several divisions of the *Pseudomonadaceae* family bacilli on serological groups and serotypes, biochemical divisions and divisions on different enzymatic profiles.

Genotypic divisions are more accurate, using restriction profiles, ribotyping, caryotyping and profiling by amplification production. [4].

The discussed species of *P. aeruginosa* under aerobic conditions generates energy by organic substrates fosforization: carbohydrates, acids, aromatic compounds (14). However, in the absence of oxygen *Pseudomonas aruginosa* has denitrifying ability due to having dissimilation nitrate reductase [3]. This enzyme is located in the cytoplasmic membrane, and its synthesis is inhibited by oxygen. It should be distinguished from assimilative nitrate reductase – cytoplasmic enzyme, which allows bacteria to use nitrate as a nitrogen source [5].

P. aeruginosa is a bacterium which was developed at the earliest map of chromosomes [3]. The size of the chromosome of *P. aeruginosa* measured in millions of base pairs (MBP) is 5.36 [2] with the number of 7384 genes [3].

In the world of microorganisms, resulting in lisogenic conversion, many plasmids encode proteins secreted extracellularly or short peptides, which kill or inhibit the growth of related bacteria. These substances called bacteriocins and produced by *P. aeruginosa* are known as pyocin [5].

Diagnosis of infections caused by *P. aeruginosa*

The routine procedure of the drawn material for testing is inoculated on selective medium. Nowadays the substrate with the following selectivity factors is used: 0.02% cetrymid (bromide of ethyl trimethyl ammonium) and 15 mg/l nalidixic acid.

Planted sample is incubated at 37 ^{0}C for 24-48 hours.

P. aeruginosa forms on substrates gray, large colonies with a diameter of 2 mm, slightly dull (sometimes metallic) with irregular edges and carried over middle. Breeding on agar media is accompanied by a pleasant scent of jasmine.

Pigment production

Pigments produced by these microorganisms are secondary metabolites, i.e. they do not belong to the compounds that are present in all organisms. It is obvious from their structure that they come from a normal cell metabolites or its building subunits. Some pigments have antibiotic activity, and many microorganisms producing pigments produce antibiotics as well. It can be assumed with high probability that the microorganisms that produce pigments will also produce antibiotics and other active substances [3].

Production of diffusing pigments into the medium is quite common in aerobic gram-negative bacilli of low-maintenance nutrition. This is an important feature of identity, but is not characteristic of the species. Produced pyocyanin from light green to dark blue shade, is soluble in water and chloroform.

Pyocyanin is also produced on a selective medium containing cetrymid. This pigment is only produced by strains of *P. aeruginosa*, but except from pyocyanin they also produce other fluorescent pigments under UV light: yellow-green fluorescein and yellow pioverdin, brown biomelanine and red piorubrin. The best conditions for pigments production are on special substrates: Pseudomonas pyocyanin agar (PP), Pseudomonas agar fluprosceins (PF). Salts included in the substrates – magnesium chloride and potassium sulphate, stimulate the production of pigment. Pyocyanin secreted extracellularly stained the medium from light green to dark blue.

Production of chrome oxidase

In contrast to bacilli belonging to *Enterobacteriaceae,* species belonging to *Pseudomonaceae* produce cytochrome oxidase and decomposing glucose with oxygen. Cytochrome oxidase is the final enzyme of the respiratory chain in aerobic respiration. Cytochromes are found in aerobic, anaerobic and microaerophilic. Test for presence of cytochrome oxidase is important for the differentiation of many types of bacteria. It can be performed using two methods:

1) Reagents – 1 % solution of HCl di – or tetramethyl-p-phenylodiamin is dripped directly to colonies on Hugh-Leifson surface:
2) On a piece of paper bacterial mass is triturated collected from the substrate with glass rod, on bacteria 1% aqueous solution of HCl tetramethyl-p-phenylodiamin is dripped.

In both cases dark blue color (blue indolophenol is formed) of bacteria occurring within minutes indicates a positive reaction.

Saccharolytic properties

As with other bacteria biochemical identification, study of saccharolytic properties is carried out on a peptone medium supplemented with 1% of the corresponding substrate sugar (carbohydrate) and a pH indicator. A set of such several tests is called ordinary sugar series. During the metabolism of carbohydrates products are produced that acidify the medium and there is change of colour. During the biochemical identification of many bacteria, it is also important to determine ways of carbohydrate metabolism: oxidation or fermentation.

The test is performed on the buffered substrate-Leifson Hugh. In contrast to the above-described series of sugar, it contains five times less (only 0.2%) peptone. Addition to the medium 0.3% agar, gives it a semi-liquid consistency. The substrate contains 1 % carbohydrate and bromothymol blue, which at neutral pH is green.

The medium is poured out into the test tubes forming the high column. Prior to inoculation, in order to get rid of the residual oxygen, the medium was incubated at 100^0C 30 minutes. After cooling test strain is inoculated to two test tubes with the medium. After the culture, one of the test tubes is covered with a layer of liquid paraffin. Cultures are carried out at 35-37 ^{0}C for 2-5 days.

The test tube uncovered with paraffin below substrate there is a change of medium colour from green to yellow (aerobic conditions) and no change in the test tube covered with paraffin (anaerobic conditions).

Substrate colour change to yellow in both tubes indicates the distribution of carbohydrate fermentation. This process is independent of oxygen and occurs in both aerobic and anaerobic conditions.

Bacteria cultures of non-distributed carbohydrates do not change substrate colour. During the propagation of the test tribes of bacteria alkalization of cultures can become, resulting in formation of blue color of the substrate.

Table 3: The most important biochemical properties of *P. aeruginosa*.

Carried out feature	Result
Cytochrome oxidase	+
Oxidation of glucose	+
Oxidation of xylose	+
Oxidation of lactose	-
Growth at 42 ^{0}C	+
Growth at 4 ^{0}C	-
Hydrolysis of esculin	-
Denaza	-
Indole	-
Reduction of NO_3 to NO_2	+
Reduction of NO_3 to O_2	+
Decarbolsylation of lysine	-
Pigmemts production	
Pyocyanin – Z to N	+/-
Fluorescein – F	+
Cilia (movement)	+
Growth in McConkey's substrate	-/+

For diagnostic purposes, methods using molecular biology are developed. A very promising method seems to be the SS-PCR (species-specific), in which conservative, species-specific sequences for *P. aeruginosa* in the 16SrRNA [8] are specified.

The role of *P. aeruginosa* in environment

Bacteria of *Pseudomonas* group, due to low requirements, are met everywhere: in soil, water, wastewater and air. They represent about 90 % of waste water micro flora. This is because that tribes of this species are extremely resistant to disinfectants and antimicrobial agents. Natural habitat of these bacteria are therefore also the surface water of varying degrees of contamination. They are usually the first to colonize new places if there are mineral salts, organic acids or carbohydrates. They can often use a wide variety of organic substrates, non-degraded by other bacteria, including heterocyclic and aromatic compounds. The presence of *Pseudomonas* can be identified by the formation of water-soluble dyes, i.e. blue-green pyocyanin and yellow-green fluorescent pigments. Some of the secreted pigments act as siderophore [3]. Some species of *Pseudomonas* incompletely oxidize carbohydrates and release acid derivatives (gluconic acid, acid, 2-ketogluconic) into the environment.

A man is also a reservoir for *P. aeruginosa*. Carriers in the gastrointestinal tract occurs in `5 % of the population. In recent years, the presence of these bacilli in the feces of people and the environment has greatly increased, due to the increasingly widespread use of antibiotics in humans and animals.

Low nutrient requirements make it possible to proliferate in water poor in organic carbon. This means the risk of infection in food, pharmaceutical, cosmetic, and even in the hospital, even by distilled water as an ingredient in medicines, cosmetics, etc. [9]. For these reasons, apart from the group of bacteria *E. coli*, *Pseudomonas aeruginosa* bacilli, in addition to *Enterococcus faecalis* and *Clostridium perfringen*, are additional indicators of water pollution.

Participation of P. aeruginosa in bioremedition

Due to the high efficiency of microbial surfactants (biosurfactants), they are increasingly used to remove of heavy metals (lead, zinc, copper and cadmium) from soil, and then to create lasting connections with them. This type of action is performed, among others with the use of

biosurfactants of rhamonolipides obtained from cultures of *P. aeruginosa* [9].

Microbes also change iron in a soluble form. The resulting complexes containing Fe^{3+} are transported into the bacterial cell. Substances of this type are called siderophore. In terms of chemical structure siderophore are included in phenolic compounds and hydroksamats. They are, almost without exception, water-soluble substances, binding iron with a very high specificity and affinity. The first of these groups contains enterobactin having six phenolic hydroxyl groups. Some enteric bacteria emit this compound.

Greenish fluorescent pigment secreted by *P. aeruginosa* are of siderophore nature as well.[3].

P. aeruginosa is one of the microorganisms that produce useful egzopolisaharide. One of them is alginate (combination of 1,4 glucoside mannouronic acids) found in seaweed.

It is used to produce ice cream, instant puddings and custards. It has also application as a surface for paper and textiles production as well as a hydrophilic shield of plants roots and healing [3].

Biofilms

Phenomenon of high sanitary and economic importance is vegetation of microbial in the form of biofilms. In contrast to the growth of single cells called planktonic, biofilm is a complex of colony interconnected with network of canals and proliferating in the matrix surrounding space filled with fluid. Proteome of bacteria in the biofilm is different from planktonic bacteria. Moreover, the proteome is dependent on the nature of the substrate.

Currently there are 3 main types of biofilm structure:

1) Flat, virtually two-layer structure. Carefully examined on dental board appear to be qualitatively heterogeneous, because they are even created by over 500 species of bacteria belonging to more than 30 families;
2) Micro colonies forming storey structures. They are surrounded by the matrix structure of the compounds of the polymers. They look like a column surrounded by a liquid phase. Other organisms, such as protozoa, can occur in it. It is a model "heterogeneous mosaic", which is produced by pathogenic organisms as well. *P. aeruginosa* forms a type of biofilm in the lungs of people with cystic fibrosis;
3) Model of the fungus. Short stem supporting a much larger part of the top is created. Multiple channels combined by pores with the external environment run over the whole.

Biofilm formation resembles the formation of fruit bodies of mucous bacteria. Maturation and development depend on the availability of nutrients, osmolarity, oxygen concentration inside the biofilm, and reaction (pH).

As far as *P. aeruginosa* is concerned philus type IV (TFP) are involved in micro colonies creation. *P. aeruginosa* subpopulation producing TFP can even build colonies similar to the cap of the fungus.

In the development of single-species biofilms formed among others by *P. aeruginosa*, as well as in multi-species biofilms an interesting phenomenon of activation of cell death program that runs with the participation of intercellular signaled by specific regulatory factors were observed.

During maturation of the biofilm a single bacteria or large portions of the biofilm are continuously discharged. The biofilms formed by *P. aeruginosa*, cell loss occurs as a result of changes in micro colonies, after reaching the appropriate size (approximately 80 microns) or when cell density reaches a critical value. Bacteria showing moveable features wander inside the colony, leaving a wall built of non-moveable bacteria. This functional differentiation of cells (belonging to the same species) is reversible and is probably associated with their unequal access to oxygen and nutrients.

Biofilm is an interesting natural microbiology phenomenon. The knowledge gained from the culture of microorganisms propagated under optimal natural conditions, is different from the knowledge we can gain from the proliferation of microorganisms in the laboratory.

Biofilm formation in infected body significantly increases the resistance of *P. aeruginosa* to antibiotics and protects bacteria in biophilies against phagocytes. *P. aeruginosa* in the biofilm overcomes additionally the processes of phagocytosis

by proteins effector of the secretion system type III (Exos and ExoL) [6].

Pathogenicity of *P. aeruginosa*

The virulence factors

The effectiveness of pathogenic of any pathogen is determined by the possessed virulence factors. In the case of *P. aeruginosa* the most important virulence factors are:

1. Fimbriae (philus)
Constructed of thousands of protein subunits philin are important factors of virulence of many species of gram-negative bacteria. They participate in the processes of the impact of pathogen – host, pathogen – pathogen, and determine bacterial motility [4]. Their activity depends on many features of the bacterial cell. In addition to motility and adhesion facilitating, include the ability to create micro colonies and biofilm, invasiveness, and phages binding can be mentioned.

2. Envelope
It is made of alginate, and found only in pathogenic tribes. Envelope has a particular affinity with lung epithelial cells [3].

3. Toxin
P. aeruginos exotoxin works inside the targeted cells by inhibiting protein synthesis in them, which leads to the whole organs damage [5].

4. Alkaline proteases of P. aeruginosa hydrolyze elastin protein being in large amounts in the lungs and the walls of blood vessels. Another enzyme – thermolabile heat-phospholipase C (lecithinase) disrupts the phospholipids in the infected cells.

5. Enterotoxin is present in tribes of *P. aeruginosa* in tropical climates.

6. Thermostable glycolipid causing blood cells hemolysis.

7. Leucidin belongs to hemolisine and is an important virulence factor.

8. Mucous coating
On the surface of some tribes mucinous material indicating the protective properties of the bacteria is observed.

9. Egzopolisaharide
An important factor in the pathogenesis of infections are egzopolisaharide [4]. They participate in creating micro colonies *P. aeruginosa* in the lungs of patients with cystic fibrosis [5].

10. *P. aeruginosa* is able to resist phagocytosis by having proteins that protect it frominternalisation [6].

Forms of *P. aeruginosa* infections

With such a rich set of virulence factors *P. aeruginosa* produces many forms of infection.

Infections caused by *P. aeruginosa*, as well as by some protozoa, yeasts and other fungi are very rare in people with a properly functioning immune system [3]. Most are opportunistic infections.

Infectious of lung, eye, urinary tract, heart, central nervous system, other opportunistic and infections have been described in literature so far. [8].

P. aeruginosa is most frequently mentioned as the perpetrators of clinical hospital-acquired infections [5] and bacteremia in patients with severe burns [7].

1. Infections in lungs.
Pneumonia and various forms of infections of the upper and lower respiratory tract.

In particular, they are common in people with cystic fibrosis [3] and nosocomial pneumonia: after intubation, artificial ventilation, aspiration pneumonia and pneumonia in patients hospitalized in intensive care units.

2. Eye infections.
P. aeruginosa is described among others as the etiologic agent of infections of the cornea and conjunctiva leading to various forms of inflammation, and serious infections of eye-ball.

3. Infections of urinal system.
P. aeruginosa is the most common factors of inflammation of the prostate (prostate cancer), acute pyelonephritis and nosocomial urinary tract infections associated with urinary catheters.

4. Infections of heart muscle.
Infections usually occur after invasive diagnostic and therapeutic intervention.

5. Infections in central nervous system.
Infections in this area usually lead to inflammation of meningitis and even brain abscesses in older people.

6. Infections of skin and skin structure.
P. aeruginosa is essentially unable to cause infection of the skin healthy, but it can cause serious infections in people with compromised immune systems resulting from genetic defects, treatment or certain virus infection (HIV) [5]. In addition to these infections, *P. aeruginosa* is considered among others to be etiological factor for inflammation of hair follicles and sweat glands [8].

7. Wound infections.
They lead to suppurative inflammation of burn wounds (infections is often complicated by *S. sureus*), and after the cuts of contaminated soil. In hospitals there are often the surgical site infection and infections after organ transplantation

8. Due to the importance of clinical relevance a separate discussion of chronic *P. aeruginosa* infection in human patients with cystic fibrosis is required.

Cystic fibrosis (CF) is a monogenic autosomal disease associated with gene defects of the transmembrane transition regulator (CFTCR-cystic fibrosis transmembrane conductance regulator).

The main problem in this disease are chronic, unmanageable bacterial infections. The main culprit of these infections is *P. aeruginosa* [3].

CFTCR protein is a receptor that causes the recognition and absorbing of *P. aeruginosa* to epithelial cells. Absorbed bacteria cause inflammation, in which the body reacts by removing of epithelium infected by *P. aeruginosa*.

Tribes of *P. aeruginosa* isolated from patients have a tendency to produce exopolysaccharide alginate discussed above (acylated polymer of mannuronic acid and glucuronic). Alginate allows bacteria to avoid non-specific host defense mechanisms.

Tribes isolated from patients produce alginate, called mucoidal, very quickly return to non-mucoidal phenotype [7]

In addition, *P. aeruginosa* can cause various forms of other infections. These infections are reported in people suffering from leukemia. *P. aeruginosa* can cause septicemia (after the fracture of bones and joints), ear infections in swimmers and divers (the swimmer ear), foot infections in diabetic (so-called diabetic foot).

P. aeruginosa and antibiotics

In addition the minimum nutritional requirements P. aeruginosa is characterized by significant resistance to many antibiotics.

The origin of the phenomenon of antibiotic resistance of pathogens is to be found in soil, to be more precisely, in soil bacteria that encode genes for antibiotic production. Closely related transposons may be conveyors of resistivity genes. The plasmids transposons using *P. aeruginosa* can be built to bacteria that infect the human body [10].

Another mechanism of resistance is the impermeability of the cell membrane of bacteria to antibiotics. It is this natural immunity *P. aeruginosa*, as it is claimed, to be associated with poor penetration of antibiotic into the bacterial cell.

Very worrying phenomenon for antibiotic therapy perspective is increasingly frequent appearance of tribes in the hospital environment, among others. *P. aeruginosa* – producing beta – lactamase class B [10].

The sensitivity of *P. aeruginosa* to antibiotics

P. aeruginosa is sensitive to the following antibiotics:
1) Antibiotics penicillin derivatives. Semisynthetic penicillins;
2) Aminoglycosides;
3) Quinolones;
4) Cephalosporins;
5) Monobactam (aztreonam);
6) Carbapenems (imipenem) [2];
7) Polymyxin.

Antibiotics penicillin derivatives. Semisynthetic penicillin:

1) Carbenicillin, semi-synthetic penicillin;
2) Tycarcylin carboxy derivate penicillin (resistant tribes are present);
3) Azlocylin (ureidopenicylin) betalactam antibiotic with a broad spectrum of activity with particular activity against *P. aeruginosa*. It may be associated with an aminoglycoside.
4) Mezlocylin. Betalactam antibiotic of acyloureidopenicylin group with a broad spectrum of activity. It is active against *Pseudomonas* as well;
5) Piperacillin. Betalactam antibiotic. Piperazine derivative of penicillin. The broad spectrum of activity, including in relation to *P. aeruginosa*.

Aminoglycosides

Among aminoglycosides, in preventing from *Pseudomonas* infections, gentamicin has been used for the longest period of time due to a broad spectrum of action. In the case of *P. aeruginosa* it is often used it in combination with beta – lactam antibiotic [10].

Quinolones

Despite the effectiveness in combating *P. aeruginosa* infections, an increasing number of resistant tribes, even to the new quinolones: ciprofloxacin and ofloxacin. In addition *P. aeruginosa* shows a lack of sensitivity to nalidixic acid, a typical representative of the older quinolones. The mechanism of resistance accumulation is the mutational changes leading to the formation of a "pump" MDR (multi-drug resistance), effectively removing quinolones from bacterial cell [10].

The use of quinolones in *P. aeruginosa* infections monotherapy also leads to selection of tribes cross resistant to imipenem belonging to the carbapenem beta-lactam antibiotics, closely related to penicillin and cephalosporins. However, strains resistant to quinolones and imipenem are sensitive to penicillin and cephalosporins [2].

The first and second generation of cephalosporins are inactive against the bacteria of *Pseudomonas*. The third and fourth generation act on gram-negative bacilli, including ceftazidime and cefoperazone for *Pseudomonas* type, with four runs on tribes resistant to the third generation producing chromosomal cephalosporinases.

P. aeruginosa resistance to ceftazidime occurs only at sites where this antibiotic is widely used in departments such as treating patients with cystic fibrosis, hematology, burn and intensive care units.

Semisynthetic syderophoric cephalosporin have especially high activity against *P. aeruginosa* [10].

In some cases one observed a paradoxical effect of the low dose of antibiotics manifested by the increased ability to adhesion of *P. aeruginosa* to the surface of cells.

Monobactam (aztreonam)

These are beta-lactam antibiotics. Among them aztreonam is used in the treatment of bacterial infections. It presents bactericidal activity only against gram-negative aerobic bacteria such as *Pseudomonas*. It is highly resistant to betalactamase of gram-negative bacteria. It shows a cross allergic reaction.

Carbapenems (imipenem)

They are betalactam antibiotics, the affinity of penicillins and cephalosporins, but chemically different. Carbapenems are used in the empirical treatment of among others severe infections caused by *P. aeruginosa*, and may be safely associated with aminoglycosides [2].

Imipetem is such carbapenem that shows resistance to these betalactamase and thus it is found in medicine. In the renal tubular epithelium it is degraded by two pepdisae hydroxy. To avoid this degradation it is associated with it which cilastatin being competitive reversible dehyrogenase inhibitor. Cilastatin also protects kidneys from the toxic effects of the antibiotic. Side effects are similar to those described for penicillin and cephalosporins [8].

Polymyxin

Polymyxin are the most commonly used cyclic peptide antibiotics produced by *Bacillus polymyxa*. These antibiotics and colistin have a limited spectrum of activity including only some gram-negative bacilli, mainly *Pseudomonas spp* [10].

Bicyclomycine of inhigitors belongs to the cell wall synthesis by inhibiting synthesis of lipopropeid of gram-negative bacteria. *P. aeruginosa* is extremely sensitive to this antibiotic [10]. It is used to treat urinary tract infections [2].

Current interest in *P. aeruginosa* in cosmetical microbiology

Current trends in studies on *P. aeruginosa* in cosmetics concerns looking for new recipes, natural preservatives, permitting the growth of microorganisms and spoilage of cosmetics.

Among other things, an assessment of the effectiveness of the preservative composition of the composition of water, silicone, glycol, siloxane with 1% retinol palminynian.

It was shown that after 7 days of proliferation to the conservation composition, all test organisms, including *P. aeruginosa* were eliminated, with the exception of *Aspergillus niger*, which proved to be viable even after 28 days [11].

In search of preservatives one also assessed the effectiveness of antimicrobial colistin as an alternative preservative cosmetics. This natural sugar derived from plants, fruits and vegetables has antimicrobial properties. It was determined that the MIC colistin for microbial testing among others *P. aeruginosa* was 1 % to 1.25 % [12].

Similarly one assessed the antimicrobial activity of oils of lavender, tea tree and lemon in body and bath lotions. In relation to *P. aeruginosa*, these oils were effective at a concentration of 1% in liquids and 0.5% in lotions. In a mixture of synthetic preservative MDM hydantoin and 3-iodo-2-butyl carbamate efficiency were achieved already at a concentration of 0.1 % and 0.3 % [13].

In combination with phenylethanol the most popular preservative efficacy was achieved at low concentrations. Such preservation has many advantages. The effectiveness of antimicrobial preservatives, perfumes and known allergens of different power [diazolidinyl urea, Methylchloroisothiazolinone / Methylisothiazolinone (MCI / MI), Methylisothiazolinone (MI) and Phenoxyethanol] examined separately or in various associations of two or three preservatives together.

Preservatives were tested to determine the MIC and the possible synergy using a fractionation inhibitory concentration. MCI / MI was the only preservative showing low levels of MIC against all four microorganisms: *Staphylococcus aureus, Pseudomonas aeruginosa, Candida albicans* and *Aspergillus niger*. Various associations have the additional impact on preservatives on microorganisms. No association of preservatives has no effect on each of them. Challenge tests with different concentrations and associations have been carried out on cosmetic creams. Diazolidinyl urea and MCI / MI alone proved ineffective against *C. albicans* in the challenge test at concentrations of more than 16 times higher than the observed value of the MIC. When phenoxyethanol associated with other allergenic preservatives diazolidinyl urea, MCI / MI or MI, cosmetic cream was adequately maintained at concentrations below the preserving MIC, and 10-20 times less than the maximum permissible concentration. Using the combination of preservatives, effective preservance can be achieved at lower concentrations of allergenic preservatives [14,15].

Considering that even minimal contamination of pathogenic bacteria are undesirable, methods of molecular biology were applied. One tested successfully ability to detect contamination of calcium carbonate powder used in cosmetics with bacteria *Staphylococcus aureus*, *Pseudomonas aeruginosa, Salmonella spp and Escherichia coli*. It was estimated that the analyst can be very useful for the detection of a variety of contaminants in both raw materials and finished cosmetic products. Molecular analyst can be valuable in detecting the presence of undesirable microorganisms in cosmetic products with enhanced microbiological purity requirements (cosmetics for children and eyes). Guidelines for the quantitative determination of bacterial contamination were developed [14].

Conclusion

The presented characteristics of bacteria *P. aeruginosa* shows the scale of the risks for the use of cosmetics poorly preserved and could be a medium for its growth. Emergence of these threats is supported by such properties of this bacterium as: the minimum nutritional requirements, very rich and diverse set of virulence factors which demonstrate their abilities in the form of pathogenic infections or complications of diseases of many organs and systems of the human body. In these respects *P. aeruginosa* shows a typical opportunistic bacterium and is superior

to other gram-negative indicator knobs, like the very important sanitary E. coli and bacilli of Salmonella gene.

Current trends in studies of *P. aeruginosa* in cosmetics reflect the need to explore the composition of the required preservative efficacy with minimal concentrations.

The future belongs to genetic testing and methods for detecting small quantities of impurities of cosmetics with the required high microbiological safety.

References:

1. Amaral L.F.B., Camilo N.S., Pereda M.D.C.V., Levy C.E., Moriel P., Mazzola P.G.: Evaluation of antimicrobial effectiveness of C-8 xylitol monoester as an alternative preservative for cosmetic products. International Journal of Cosmetic Science. 2011; 33 (5): 391-397.
2. Baj J., Markiewicz Z.: Molecular Microbiology of bacterial. Polish Scientific Publishers PWN, 2006
3. Błaszczyk M.K.: Microorganisms in Environmental Protection. Polish Scientific Publishers PWN. 2007
4. Chorilli M., Leonardi G.R., Salgado H.R.N., Scarpa M.V.: Evaluation of preservative effectiveness of liquid crystalline systems with retynil palmitate by the challenge test and D-value. Journal of AOAC International. 2011; 94 (1): 118-127
5. Dzierżanowska D: Practical antybiotics therapy. Alf-media press, Bielsko Biała, 1994
6. Di Maiuta N., Schwarzentruber P.: Molecular detection of bacteria in calcium carbonate powder used in cosmetic formulations. International Journal of Cosmetic Science. 2011; 33 (5): 426-431
7. Kunicka-Styczynska A., Sikora M., Kalemba D.: Lavender, tea tree and lemon oils as antimicrobials in washing liquids and soft body balms. International Journal of Cosmetic Science. 2011; 33 (1): 53-61
8. Libudzisz Z., Kowal K., Żakowska Z.: Technical Microbiology. Polish Scientific Publishers PWN. Warszawa 2009
9. Lundov M.D., Johansen J.D., Zachariae C., Moesby L.: Low-level efficacy of cosmetic preservatives. International Journal of Cosmetic Science. 2011; 33 (2): 190-196
10. Markiewicz Z., Kwiakowski Z.K.: Bacteria, antibiotics and medicines resistance. Polish Scientific Publishers PWN 2006
11. Nicklin J., Graeme-Cook K., Killington R.: Microbiology. Polish Scientific Publishers PWN, Warszawa,2004
12. Rozporządzenie Ministra Zdrowia z dnia z dnia 23 grudnia 2002 roku w sprawie określenia procedur pobierania próbek kosmetyków oraz procedur przeprowadzenia badań laboratoryjnych.
13. Szewczyk E.: Bacteriological Diagnosis. Polish Scientific Publishers PWN, Warszawa, 2005
14. Schleger H.G.: General Microbiology. Polish Scientific Publishers PWN, Warszawa, 2003
15. Zaremba L.: Medical Microbiology. Wydawnictwo Lekarskie PZWL. Warszawa.1997.

History of medicine

Medical care in the unit of major Henryk Dobrzański aka „Hubal"

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Summary:

The fact that Major Dobrzański gave his unit military character, required it to live under permanent threat, in very difficult conditions, in strict discipline and subordination, as well as his wish to avoid unnecessary conflicts, made it impossible for women to join the unit.

The soldiers themselves (with some first-aid training) provided sanitary and medical care, assisted by the local population and doctors from the region. The wounded found shelter in forest cottages (dressing points) and at the Rectory in Ruski Bór, from where appointed persons moved them to the hospital in Opoczno. Wounded or sick soldiers were also treated, operated and looked after in the hospital in Tomaszów Mazowiecki. For a small unit operating in fairly good living conditions this could be considered sufficient medical care. Constant expansion of the unit, hunger, exhaustion, absence of permanent quarters and atmosphere of constant threat brought with itself the inability to maintain personal hygiene, disinfect clothing and get rid of insects effectively, as well as to treat diseases affecting the soldiers. Absence of a decision to enlist doctors in the unit may be considered negligence on Major Hubal's part.

Good fortune as well as the determination and commitment of two nurses arriving from Warsaw, Ludmiła Żero and Genowefa Ruban, resulted in regular supplies of uniforms, medicines and dressing materials, as well as professional medical care nearly till the last moments of Major Hubal's life.

Key words: 1939 Defensive War, Polish underground military units after September 1939, Kielce region, major Henryk Dobrzański aka "Hubal", medical care.

A great deal has been written about „Hubal's" unit and about Henryk Dobrzański himself. The burial place of the "crazy major", as the Germans called him, has been searched for. The subsequent fate of Hubal's soldiers was traced in detail. The importance of the Separate Polish Army Unit, which initiated the activities of the armed underground movement, was emphasized on numerous occasions.

The moral and political significance of its activities was also underlined, since it helped the Polish society in the first period of the War to overcome the grief caused by the September defeat. Many pointed to the propaganda overtones of the fight taken up spontaneously by Major Dobrzański and his soldiers, which for foreign observers, was proof of the Poles' unyielding attitude towards the invader. However, the sources, of which the authoress may name several dozen, rarely mention such mundane matters as everyday life in the unit or sanitary and medical care provided to Major Hubal's troops. It is therefore worthwhile to devote some attention to this issue. The place to start is an overview of the unit's history.

To feel and love freedom …major Dobrzański's War with the Germans

The Kielce District brought its own approach to the concept of continuing combat developed by the Home Army. The District was one of the initiators of guerilla warfare in Poland, and was one of the most active regions in this respect. It was here that the unit of Major Henryk Dobrzański, aka "Hubal", later called the last soldier of the II Republic or the first guerilla of the Second World War, endured longest, fighting in the area between the Spała Forests and the Świętokrzyskie Mountains until late spring 1940.

In fact the latter definition is not quite appropriate, for the Major was not engaged in guerilla warfare, and called his unit a Separate Polish Army Unit. In military terminology this means a unit designated on an ad hoc basis for executing a specific task. It may be composed for instance of an infantry battalion supported by sections of other units, such as an infantry artillery platoon or an antitank company, all of which return to their parent units after the mission is accomplished. This unit was to execute a specific task, and then it would be disbanded or incorporated into military units which would be formed in the future [1]. The soldiers wore full uniform and were armed. After the end of the September Campaign they did not lay down arms, and together with a group of volunteers they continued fighting the Germans in the Kielce region.

Major Dobrzański, a born cavalryman, an outstanding soldier, a sportsman with numerous prizes won at equestrian events, member of the Polish Olympic team at the Amsterdam Olympics in 1928, turned out to be a rebellious man. Regardless of the order to ground arms he gathered a group of volunteers and commanded them to depart in the direction of still besieged Warsaw. He crossed the Vistula near Maciejowice at dawn on 1 October 1939 and found himself in the Radom area. He went on, towards the Świętokrzyskie Mountains, to reach the Spała Forests. He decided to stay in Poland and continue the fight until, in the spring as he thought, the victorious allied offensive would start.

He had a small group of eleven soldiers under this command, but the size of the unit was immaterial. He believed that the strength in terms of number is not as important as the presence of soldiers among his countrymen, so brutally oppressed by the Germans. He knew that it was much more difficult for a bigger unit to operate on a territory besieged by the enemy. He therefore decided not to expand his special unit. It was to play more of a propaganda role, inspire the creation of a conspiracy network in the field [2].

The Major was in absolute command, and did not share his plans with anyone. In November and December he prepared a plan of creating the so called „Kielce" Combat District. The organizational chart of the District assumed that the fight for freedom will be continued on two fronts, the open and the underground front, and laid out the scope of activity of individual underground sections. His reason for creating the "Kielce" Combat District was the inflow of a large number of volunteers, the rising spirit to fight the invader, the wish to overcome the infamy of the September defeat, and opposition against the Germans' endless transports of men, food and all material goods out of the country with impunity. One of the tasks set for the District, apart from direct military action, was to organize and prepare the society for a military strike. Hubal also developed the concept of the composition of the District command and staff, as well as the scope of responsibility for individual organizational units, including the quartermaster's unit and heads of sanitary, armament, inventory and veterinary units. The District created by Major Dobrzański covered a relatively small territory and was not directly associated with any military or political organization in conspiracy [3].

Hubal understood the need to cooperate with the emerging underground movement and established contact with the commanders of the SZP [Służba Zwycięstwu Polski – Service to Polish Victory]. In November 1939 met with General Karaszewicz-Tokarzewski. He thus gained official support for his activity and received an offer to take up the position of deputy commander of the SZP district in Kielce. To this he agreed, although he never actually functioned in this capacity because he did not want to leave his unit. After the briefing with the General Commander of the SZP on 24 December Major Dobrzański returned to his unit and engaged in expanding it. Although Hubal received the orders of the General Command of the ZWZ

[Związek Walki Zbrojnej — Union of Armed Combat – successor to the SZP] to dismiss his unit, he never took off uniform. He let his men make their own decision. Some executed the order and went home. Several dozen men went to the addresses they knew in Warsaw, and several dozen others were incorporated into the ZWZ network in Łódź. In December 1939 about 30 men remained with the Major [4].

In time more and more volunteers joined the unit. The Major enlisted each one personally. He did not encourage anyone to join, he described the actual state of affairs, sometimes even exaggerating the difficulties the soldiers had to face. He did not promise an easy life, he talked about the dire living conditions, about the danger facing them each day, the severe discipline in the unit. He immediately sent home those who were too young of physically weak. The unit accepted people of different social stature, peasants, workers, intelligentsia (including secondary school graduates) and freelancers. According to the statements of Mr Zbigniew Wroniszewski, one of the few soldiers of the unit still alive, women found it most difficult to join.

Hubal believed that they are not physically strong enough, and that they may become a reason for conflicts which must be avoided. It was possible to maintain full discipline only among men. The only woman soldier in the unit, and promoted to the rank of senior uhlan, was Marianna Cel aka „Tereska", who was accepted only because of the need to have a permanent liaison person, as well as a help in household chores such as clearing, cooking, washing, mending uniforms and dressing wounds [5]. The Major quickly created a strong military unit (of 300 men in March 1940), which, he hoped, would hit the Germans at the right time and inspire others to do the same. Although the Kielce underground authorities were still skeptical about his activities, the nearby towns of Tomaszów and Opoczno cooperated closely with the Major. Hubal's troops had outposts in Tomaszów, Opoczno, Radzice, and even in far away Radoszyce. Couriers came from Warsaw and maintain contacts between the unit and the Warsaw scouting organization as well as a group of persons involved in the pre-War organization Women's Military Training.

Surviving through the Next Day. The prose of everyday life under Nazi occupation

War is not only a time of great raptures of the heart, a time of heroism worthy of poetry or statues. It is most of all an effort to survive, to endure poverty, dirt, hunger, disease, lice and danger, a challenge to character, an opportunity to learn about one's own strengths and weakness as well as those of others. As the poet said, "*We know ourselves only to the extent we have been tested*". It is interesting to look at the everyday life of Major Hubal's unit. It is worthwhile to recall the people for whom this time of trial was not a time of personal defeat, people risked their own life and offered help to Major Hubal's separated unit.

In every village in the administrative districts of Łowicz, Skierniewice and Rawa appropriate people were appointed to collect food, uniforms and arms for military needs [6]. Tomaszów Mazowiecki was mainly focused on providing food, underwear, medicines and blankets. This assistance provided by the citizens of Tomaszów was habitually called „Action Hubal".

With the outbreak of the War all Polish youth organizations, especially older scouts, headed by the Fourth J.Kiliński Squad, started to work in support services, for instance in the battalions of the 4th artillery regiment, or provided water for Hubal's horses. Young people carried around baskets with bread and cold meats prepared for the soldiers by the Polish White Cross. Girls enrolled for hospital service or reported for duty in Polish Red Cross units [7]. Bursars from the underground organization, Hanna Dryńska („Wierzba"), Amelia Chleba, Z. Skorkowa–Adamowicz („Gwiazda") and Halina Osińska, as well as other young leaders engaged in collecting warm clothing, military equipment, shoes, gloves and blankets for the troops.

Mieczysław Lange „Graf" (died in Auschwitz) used his own horses to transport uniforms, arms, medicines and food. Other people who provided support for Hubal's soldiers were Maria Mieczkowska, Helena Kotarska, Helena Bartczakowi, Helena Klimkiewicz and Irena Lange.

A Self-Help Committee was organized in Tomaszów, headed by Edward Byczewski,

a sanitary controller from the local medical center. The Committee's objective was to distribute received food coupons among the poor and to organize the collection of clothes, food and money for members of the ZWZ and Hubal's soldiers.

The population of all the villages in the Świętokrzyskie region received the unit with curiosity and sympathy, sharing their meager resources with it, providing the men with food, maps, compasses and dressing the wounded. The most important task was to feed the men and their horses. Hubal ordered that the village population be paid market prices for the food and feed given to the unit, so the peasants frequently volunteered to bring various food products for the soldiers.

The administrative district of Opoczno was a safe base which enabled the unit to organize garrison life. For lack of a field kitchen and canteen meals from the allocated products were prepared by housewives at individual quarters. In exchange the soldiers lent a hand on the farm. The unit's baker took care of baking bread, which meant that the soldiers had fresh bread every day. Flour was obtained from two sources, the first being donations and supplies organized by supply outposts, the second requisitions from compulsory deliveries of flour to flour mills and of wheat and rye from estates inhabited by Germans. Meat supplies were obtained by requisition of pigs and cattle from the *volksdeutsche*. Meat was also purchased from peasants, who frequently refused to accept money. Hunting in the Spała Forest was an additional source of meat supply, Hubal himself occasionally taking part.

One of the supply posts was Radzice. After the unit moved to Gałki it intensified its operations. The peasants from Radzice imposed a voluntary tax on themselves in order to supply the unit with wheat and rye, the women baked bread for the soldiers. Meat was obtained from the school farm. The Agricultural and Trading Cooperative in Opoczno provided financial and in kind assistance, gifts of money were also received from the public. Individuals, mainly representatives of freelance occupations, owners of forest estates and gamekeepers paid in specific sums for the unit (from one to three thousand Zloty). The unit's purse also received a cash injection the retrieved coffers of the regiment. Sugar, salt and spices were bought in shops. Potatoes and milk were obtained from farmers. Thanks to the loyalty of the population and organizational skills of the supply patrols food supply was sufficient, bread was given out in unlimited amounts. The soldiers spent Christmas in forest cottages and received gifts from the local population in the form of gloves, warm scarves, socks and cigarettes [8].

Hubal was very strict on impeccable appearance. The soldiers had to be clean shaven every day, their uniforms clean. The Major's mother, Maria Dobrzańska, sent him parcels with clean clothing from Cracow [9]. The soldiers rested in the forest camping and making fires, only spending the nights in cottages or distant farmhouses. Colder days were spent in the hay in barns. During their stays in farmhouses the soldiers dried their uniforms and ate quickly cooked means.

In time their situation began to deteriorate. Occasionally the Major intentionally avoided combat in order to give the men and the horses some rest after difficult and frequently long, physically and mentally exhausting marches and skirmishes, to which cavalrymen were not normally accustomed. Only the sick and wounded, and those sent on patrol, rode on horseback. All the supplies (sugar, spices and bread packed in sacks) were carried on the backs of all the soldiers of the unit in turn, only Major Dobrzański was excused from this duty [10].

A bucketful of potato soup was cooked for them in desolate farmhouses. All were hungry and exhausted. In the woods they set up camp, built shelters from poles, branches and moss. Wooden logs made up the floors to protect them from the humid earth. Cold and hunger ruled, the soldiers were infested with insects. Those who were unable to endure the tension, the desperation of nighttime marches, cold and hunger, simply fled. Only 10 officers and 12 non-commissioned officers remained with their commander [11].

Terra incognita. The body of knowledge about sanitary and medical support for major Hubal's soldierS

As mentioned above, the issue of medical assistance provided to Hubal's men is still an unknown (a „terra incognita"), very little indeed has been revealed on the subject. It has never been

never the object of thorough investigation. The information collected below is the result of an arduous search among source text, which reveal the following data.

Major Dobrzański was wholly dedicated to combat and organizational work. In his own way he was also concerned with the hygiene of the men under this command, but the unit did not „employ" a doctor or nurses. The situation of sick soldiers was difficult. Absence of a doctor and basic medication meant that they had to resort to the rules of folk medicine. The universal remedy for colds was melted pig fat mixed with milk or a warm blanket and glass of moonshine with pepper. Maintaining personal hygiene was beyond the men's means, the inability to disinfect clothes resulted in widespread pediculosis which could not be overcome in these conditions. Various means and methods were used to get rid of the insects. At night clothes were hung on fences, the insects carefully shaken off in the morning and the clothes worn again. The soldiers mainly complained of ischias, leg lesions and wounds, pneumonia. On Hubal's decisions soldiers left the unit due to bad health. The wounded were sent away on leave, giving them time to rest and regain a respectable appearance. Hubal did not tolerate scruffiness.

The heavily wounded and very ill were sent, with the help of the local conspiracy organizations, to hospitals in Opoczno and Tomaszów [12]. Józef Ignacy, the cart driver from the hospital in Opoczno, and Ignacy Urban from the village of Huciska, used their own horses to transport the wounded men to hospitals [12].

In the municipal hospital in Opoczno the wounded and sick soldiers were looked after by doctors Kazimierz Ekielski, Piotr Rudnicki, Józef Pietrus, Leon Tomaszewski, Jeremi Loba, Lindmanowski, professor Tomaszewicz from Łódź, students of medicine Antoni Czerniejewski („Tosiek") and Stanisław Szczygieł and a doctor from the health center Zbigniew Sobieszczański[14].

During the Nazi occupation the Sister Superior of the local hospital, Mamerta Sienkiewicz, along with nuns Ludwika, Anna, Donata Gniazdowska, risking their own life and the lives of the other sisters and hospital staff, cared for and hid Hubal's wounded men, found clothes for them and then moved them to nearby houses [15].

In January 1940 the entire municipal hospital in Tomaszów Mazowiecki became involved in the conspiracy effort.

All the staff joined forces under the leadership of Doctor Augspachem, a German by descent. Work continued uninterruptedly till the end of the War. The untiring Doctor Alfred Augspach, with his meager staff, Dr Leonard Jaśkiewicz, Dr Zenon Szczech, student of medicine Tadeusz Bazylewicz („Tadek"), assisted by volunteers from outside the hospital, day and night performed dozens of complicated operations. The hospital was enlarged and took over the buildings at Św. Antoniego 41 and 57 street. Overall general it treated 350 wounded soldiers [16]. This is where wounded and sick soldiers, Marian Brajer and Tadeusz Berus, received help and care. It was from here that Antoni Sokorski, a hospital employee, supplied the unit with dressing materials and uniforms left over from the Polish soldiers who fought in the September Campaign.

A young doctor from the medical center in Tomaszów, Maurycy Mittelstaed, joined the medical support effort. His apartment served as a permanent contact point for ZWZ. Working at the same time in the Gestapo prison at Św.Antoniego 20 street he treated Hubal's soldiers who were imprisoned and tortured, and looked after them with the help of the nurse Janina Sierosławska. He passed messages from the prisoners to their families and the underground authorities. He was arrested on 6.08.1940 in the Tomaszów military barracks, where he was executing an order of the underground organization (his mission was to find Major Hubal's body). He was taken to the concentration camp in Ravensbrück and later freed by the approaching Red Army.

Among the people involved in supplying the guerillas with medicines and dressing materials were the employees of the Social Insurance Institution Marian Kotarski aka „Sarna" and Zdzisław Józefowski aka „Kierski" (both shot by the Gestapo). Together with the pharmacists Butkiewicz and Ambroziewicz they provided batches of medicines and dressings to Hubal's unit [17].

Others who engaged in the same activity were Antoni Świtalski, dentists Batkowska and Krauz-Tymianko who supplied medicines and dressings, and the Sikorski family, who supplied the soldiers with medicines from their own pharmacy [18].Doctor Albin Urbanowski from Zagnańsk was another who looked after Hubal's men (he committed suicide by poisoning himself with sublimate during his arrest by the Gestapo in 1943)[19].

Some of the soldiers themselves, who had undergone first aid training, provided medical care for the unit; for instance Lieut. Marek Szymański aka „Sęp", the last commander of Hubal's infantry and his last deputy, a quartermaster with nursing practice (he worked as an orderly in a military hospital in Lublin from September to October 1939). The local population was also helpful [20].

On Hubal's orders the wounded were left in the forest cottage in Rosochy or transported to the rectory in Ruski Bród, into the care of Father Ptaszyński. Dressing points were located in the forest cottages in Kapocin, Celiny, Michniów, Dęba, Bielawy, Rosochy and Radzice [21].

Support also arrived from Warsaw. With the help of Ludmiła Wróblewska from Dęba the unit contacted the Polish Red Cross. This contact was maintained by two courier-nurses, Genowefa Ruban („Gienia") and Ludmiła Żero („Ludka"). Their contact with the unit was a result of a coincidence. Genowefa Ruban's cousins were searching for their only son who did not return from the War. The parents were looking for him to no avail. Meantime news came to Warsaw that a Polish Army unit was still fighting in the Świętokrzyskie Mountains. The parents decided to look for their son in the unit, accompanied by Genowefa Ruban. Unfortunately they did not reach the unit. „Gienia" went on another search expedition with a friend Ludmiła Żero. In order not to arrive to the unit empty handed they took with them some medicines received from Women's Military Training. They found the unit and after a discussion with the commander they undertook to supply it with medicines, dressings, warm clothing, uniforms and ammunition. Both were students, and shortly before the War they completed a Polish Red Cross nursing course. During the siege of Warsaw and the first months of occupation they worked as nurses in the Holy Spirit hospital, which was full of wounded soldiers from the September Campaign. After the outbreak of the war Ruban got in touch with the members of the Women's Military Training organization and with scouts. She encouraged a school friend who also worked in the hospital, Ludmiła Żero, to join her. On their own they gathered clothing, medicines, food and ammunition for Hubal's troops in Warsaw. In the winter of 1940 they reached the combat unit and found the men infested with insects and disease. From then on regularly, once in two weeks (from February till the end of April) they supplied the troops with underwear sewn in conspiracy by Warsaw girl scouts, as well as uniforms, medicines and dressings obtained from the Ujazdowski Hospital which treated Polish soldiers. In exchange for civilian clothes supplied to convalescents they collected uniforms. They were also the ones who distributed the unit's last communication, about Hubal's death, in the administrative districts of Opoczno, Konin and Radomsko.
Later Genowefa Ruban worked in conspiracy as a liaison officer in ZWZ military intelligence. She was shot in the Białystok prison in 1942. After her death Ludmiła Żero did not engage in underground work. She continued her economy studies, and after the War went on to study music in the Warsaw Music Academy [22].

There are no victors in a war. about the (in)justice of history

If history is the teacher of life, it is certainly not a fair teacher. It allows nameless heroes or ordinary people, whose small victories that enable many people to survive but are not worthy of medals, to disappear without a trace. This is how history treated the doctors, pharmacists and nurses and countless inhabitants of villages and small towns who helped the soldiers in their strife against the unseen enemies: hunger, pain, disease, and everyday human fears.

This is why it is so important to recall the names of these courageous people. In the best way available to them they waged their own war against the occupier. In "times of propaganda" and "times of Apocalypse fulfilled" they gave the most beautiful proof of humanity. For this we salute them.

References:

1. Szymański M., Oddział Majora Hubala, Warsaw 1986:43.
2. Kosztyła Cz. , Oddział Wydzielony Wojska Polskiego Majora „Hubala", Warsaw 1987, pgs. 62 – 95.
3. AMBWD i M, Oddział mjr H. Dobrzańskiego „Hubala". Okręg Bojowy Kielce, sygn. III/1/5, pgs. 9 – 15.
4. Rodziewicz R., Zapiski z oddziału Hubala, „Kontrasty" issue 10/1980:21.
5. Statement by Mr Jacek Zbigniew Wroniszewski, rewident in Olsztyn, ul. Radiowa 26 m. 6 (in the author's possession).
6. Gmitruk J., Na tropie żołnierzy mjr „Hubala", „Zielony Sztandar" issue 30/1978: 8.
7. Wachowska B. (red.) Tomaszów Mazowiecki. Dzieje Miasta, Łódź 1980:387.
8. Fąfara E., Obrońcom świętokrzyskich wsi, Warsaw 1973:15 – 19.
9. Szymański M., Oddział majora Hubala, Warsaw, 1986:49.
10. Wyrwa J., Wspomnienia partyzanta, London 1991:17.
11. Sekulak J., Zapiski z oddziału „Hubala", „Kontrasty" issue 11/1980:6.
12. Derecki M., tropem majora „Hubala", Lublin 1982:8.
13. Wyrwa J., Tropem legendy majora Hubala, London 1977:82 – 87.
14. Fijałkowski W., Wieś w ogniu, Warsaw 1972, pg. 68.
15. Meducka M. (red.) Opoczno, Studia i szkice z dziejów miasta, Kielce 2003:378.
16. Wańkowicz Ml., Dwie Prawdy, Warsaw 1974, pg. 117.
17. Szpital Miejski w Tomaszowie, Księga Główna Chorych 1939/40.
18. Doctorali dissertation of Halina Kępińska – Bazylewicz, Warsaw 1974, WAM (used with the author's consent).
19. Bazylak H., Hubalowym szlakiem po czterdziestu latach, „WTK" nr 18/80:6.
20. Leki dla Hubala, „Przekrój" nr 1485 z dn. 23. IX. 1973:11.
21. Stachy J., Gniewnie szumiał las. Wspomnienia leśników polskich 1939 – 1945, Warsaw 1982:116 – 125.
22. Derecki M., Tropem Majora Hubala, Lublin 1982:232–243.

Military medicine

Selected agents of biological warfare

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Summary:

The article, describing the characteristics of the means of biological warfare based on the CDC classification of bioterrorism agents, presents the most significant pathogens which may potentially be used as biological weapons of mass destruction. Selected infectious diseases, routes of infection and ways of transmission are characterized, along with short descriptions of the most severe symptoms accompanying those diseases

Key words: biological warfare, identification, detection

1. Introduction

The events of 2001, such as the biological terrorism acts using anthrax, demonstrated the need of a profound turnover in perceiving biological agents by global society, and the protection against biological agents of mass destruction gained in significance [1]. Successful protection against biological attacks requires the creation of efficient early detection systems [2], management procedures and crisis simulations. Yet, it has to be taken into account, that acts of biological terrorism do not involve infrastructural damage, but rather mass infections with high mortality rate along with a psychological effect leading to mass panic [3]. This article presents the characteristics of biological warfare, classification of bioterrorism agents according to the Centers for Disease Control (CDC) and selected infectious diseases which may potentially be used as biological weapons of mass destruction.

Definition of biological weapons
Biological weapons may include such organisms as bacteria, viruses, protozoans and fungi along with their chemical products, but also some higher organisms, as insects and rodents constituting vectors for diseases [4].

2. Characteristics of biological weapons

Among the characteristics of biological agents decisive for their use as biological weapons, the following features may be listed:

- low infectious dose;
- high mortality rate (e.g. approx. 80% for anthrax);
- ease in obtaining and mass production;
- low molecular weight facilitating aerosol dispersion;
- long-lasting postproduction virulence;
- no efficient therapy available;
- low cost allowing the use as a warfare agent [1,4,5].

The form, in which a biological weapon of mass destruction may be used depends mostly on the technical capabilities of the terrorist [4,6]. Infection with a biological agent occurs mainly via respiratory ways, digestive tract and open wounds.

The aerosol variant, i.e. air contamination, constitutes the most realistic and the most dangerous method of biological agent dispersion by terrorists. Skin is another potential locus of infection.

3. Bioterrorism agents according to *The Centers for Disease Control*

According to CDC (Centers for Disease Control and Prevention, Atlanta, USA), hazardous biological agents considered as potential biological weapons are divided into three categories: A, B and C (Table 1).

Table 1: Classification of bioterrorism agents according to the CENTERS FOR DISEASE CONTROL.

Category	Agents
A • easily spread or transmitted from person to person, • resulting in high death rates and having the potential for major public health impact, • potentially causing public panic, • requiring special preparedness from public services (mainly public healthcare).	Variola vera Bacillus anthracis Yersinia pestis Clostridium botulinum toxin Francisella tularensis Filioviridae: Ebola, Marburg virus Arenaviridae: Lassa, Junin virus
B • moderately easy to spread, • resulting in moderate illness rates and low death rates, • requiring enhancements in diagnostic capacity and enhanced disease monitoring.	Coxiella burnetti Brucella spp Burkholderia mallei Alphavirus Ricin Clostridium perfringens epsilon toxin Staphylococcus aureus enterotoxin B Salmonella spp Shigella dysenteriae Escherichia coli O157:H7 Vibrio cholerae Cryptosporidium parvum
C • easily available, • easily spread.	Nipahvirus Hantavirus Arboviridae Flavivirus Mycobacterium tuberculosis Filioviridae: Ebola, Marburg and other haemorrhagic fever viruses

Category A comprises pathogens with the highest priority due to their high virulence and mortality rate, as well as their ease of transmission and required preventive measures. Category B encompasses pathogens with the second highest priority due to their ease of transmission and high virulence, but low mortality rate. Analogically, Category C groups pathogens with the third highest priority, characterized by the ease in obtaining and production, high virulence and mortality rate [4].

4. Selected infectious diseases

Among the pathogenic agents inducing infectious diseases, four groups may be distinguished: bacteria, viruses, Rickettsiae and toxins of bacterial and fungal origin (Table 2) [1,4].

Table 2: Selected infective agents of biological weapons of mass destruction.

Bacteria	Viruses	Rickettsiae	Toxins
Anthrax	Smallpox	Q Fever	Botulinum toxin
Plague	Viral haemorrhagic fevers	Typhus	Ricin
Tularaemia	Venezuelan equine encephalitis		
Cholera			

Anthrax is an acute zoonosis caused by the bacterium *Bacillus anthracis*, which forms spores endowed with very high resistance to environmental conditions [7]. The disease occurs mainly in sheep, goats, cattle and horses. Humans may contract the disease by direct contact with infected animals or their meat, whereas the locus of infection may be the respiratory ways, digestive tract and skin lesions [8,9]. In human population, the disease may occur as three different syndromes: inhalational, cutaneous or gastrointestinal. In the case of inhalational anthrax, flu-like symptoms develop over 1-6 days, with a short, transitory improvement lasting a few days. At this stage, it is difficult to differentiate anthrax from influenza due to the aspecificity of the symptoms, however, typical symptoms for anthrax may be shortness of breath and gastrointestinal problems of increased severity. Introduction of therapy at this stage often saves the patient's life. Within three days of the occurrence of the initial symptoms, signs

of respiratory failure (cyanosis, dyspnea, stridor) occur, followed by circulatory failure with lung oedema, as well as pleural and pericardial exudate. Lack of inflammatory infiltrate within the pulmonary parenchyma is characteristic for this syndrome.

Consumption of restricted animal products is the most common cause of gastrointestinal anthrax. The symptoms include nausea, vomiting, fever and lack of appetite, followed by severe abdominal pain with haemorrhagic diarrhoea and vomit. Typically, characteristic clinical signs of this syndrome are mouth and throat ulcerations (black pustules) along with fever and neck oedema [10]. Gram-positive bacteria are usually detected in blood cultures after 2-3 days of infection, similarly to the inhalational syndrome. Cutaneous anthrax occurs most commonly on the head, forearms and hands. In the initial phase, intense itching may be noticed at the infection site, which then forms a nodule resembling an insect bite within two days. Subsequently, the lesion forms a blister filled with fluid, which turns into a painless, hollow ulcer covered with a necrotic eschar [9,11].

Plague is caused by the Gram-negative bacterium *Yersinia pestis*. Wild rodents are the reservoir of the disease, which is then transferred to humans by rat fleas. The bacterium is resistant to heat and disinfectants [10]. Plague may occur in two principal clinical forms: pneumonic, contracted via respiratory ways, and bubonic, developing in humans infected by fleas preying on animals. The pneumonic form is considered as one of the most severe human diseases, as it may advance into haemorrhagic bronchogenic pneumonia [13]. Frequently occurring respiratory and circulatory problems with concurrent lung oedema are the most common mortality factor. The bubonic form demonstrates such symptoms as high fever, headache and vertigo, disorders of consciousness, vomiting. Incubation period of the pneumonic form ranges from 1 to 5 days, whereas in the bubonic form incubation period lasts up to 7 days [12,13].

Tularaemia, similarly to plague, constitutes a highly infectious zoonosis. It is caused by the bacterium *Francisella tularensis*. Two forms of the disease may be distinguished: Eurasian, less virulent in humans, and American, endowed with higher virulence [14]. Infection usually occurs by direct contact with infected animals. The disease may also be transmitted by ticks previously preying on infected animals. Clinical image includes acute headaches, chills and high fever. In some cases, cutaneous eruptions may be observed [4]. Considering the clinical image of the patient, seven forms of the disease may be identified: glandular, pneumonic, oropharyngeal, oculoglandular, ulceroglandular, gastrointestinal and its subtype, typhoidal. Diagnosing tularaemia based on clinical signs is very difficult, therefore the identification is conducted in laboratory tests. Incubation period averages 3 to 5 days.

Cholera is an infectious disease induced by the bacterium *Vibrio cholerae*. The disease is characterized by one of the most severe courses and may be contracted by direct contact with an infected person or via food and water. The symptoms include acute vomiting and abundant, pinkish diarrhoea resulting in quick, severe dehydration of the patient [4]. In the case of dry cholera (cholera sicca), diarrhoea does not occur due to intestinal motility impairment with fluid accumulation in the bowels and death occurs short time after contraction. Incubation period is approx. 2-3 days.

Smallpox is one of the diseases with strict quarantine requirements. The epidemiological factor of smallpox is a virus of the *Orthopoxvirus* genus [15]. Infected patients themselves are the reservoir of the virus. The disease is characterized by purulent blisterous eruptions. Initially, flu-like symptoms appear, such as: acute headache, vomiting, sore throat, sacrum and limb pain. Typical incubation period is 10 to 12 days [16]. Thanks to prophylactic vaccinations, immunity to the disease has covered almost 100% of global population [15].

Viral haemorrhagic fevers are a large group of viral diseases, whose main common element is the occurrence of haemorrhagic diathesis [17]. Examples of those diseases include Ebola haemorrhagic fever and Lassa fever. In the former case, the aetiological factor is a virus of the Filoviridae family, whereas the main reservoir are monkeys. Incubation period ranges from 2 to 21 days. Clinical signs occur suddenly and include acute headache and muscle pain, sore throat, cough and vomiting. Mucosal eruptions

and cutaneous rash also appear. After approx. 7 days of infection, signs of haemorrhagic diathesis occur, such as bleeding from the gastrointestinal tract, nose, respiratory ways and, in women, vagina. The above reactions lead to multiple organ dysfunction. Positive diagnosis for those clinical signs confirms the disease, however, Ebola haemorrhagic fever has to be distinguished from malaria, yellow fever, typhoid fever or Lassa fever, the latter mentioned above as an example of viral haemorrhagic fever. Ebola virus disease is caused by a virus of the Arenoviridae family, whose reservoir are rodents (especially rats) with complete carrier state. Humans may contract the disease via respiratory ways or by direct contact with the faeces of infected animals. Occasionally, cases of infection through bites by an infected animal are reported. Characteristic symptoms include high fever, muscle pain, mouth ulceration and haemorrhagic cutaneous eruptions. Incubation period is 6 to 14 days [4,17].

Venezuelan equine encephalitis (VEE) is caused by Alphaviruses belonging to the Togaviridae family. The vectors transmitting VEE are blood-sucking arthropods, whereas the reservoir species comprise wild mammals, birds and arthropods [4]. Humans contract the disease by mosquito or tick bites. The most common clinical signs are headache, vomiting, pareses and tremors. In almost 100% of cases, symptoms of encephalitis occur. Incubation period ranges from 2 to 6 days.

Q fever is a zoonosis caused by *Rickettsia burneti* [4]. The disease is characterized by a particularly high infectivity, while the course of the disease exhibits such symptoms as pneumonia with high fever, often accompanied by headache and weakness. Incubation period spans 2 to 4 weeks. Sources of infection include the blood, meat, milk and its products, as well as the faeces of infected animals.

Typhus, also known as rickettsiosis, is induced by the *Rickettsia prowazekii* species. Both the reservoir and the source of infection is an infected person [18]. Two forms of typhus may be distinguished: "classical" epidemic typhus and delayed relapsing typhus, also known as Brill-Zinsser disease. In the first case, the vector transmitting the disease is the body louse, whereas in the latter case, endogenous infection occurs. Characteristic patches of haemorrhagic rash are a typical symptom of the disease.

Botulinum toxin or "sausage poison" is produced by the anaerobic bacterium *Clostridium botulinum*. Currently, several phenotypic groups of this microorganism are known, but those causing infections in humans are the A, B, E and F types [19]. The reservoir of the bacteria are the superficial layers of soil, as well as silt deposited at the bottom of water bodies. Poisoning with botulinum toxin, botulism, is a particular form of food poisoning [20]. The occurrence of the symptoms of botulism may vary in time, according to the gravity of poisoning, from several hours to several days. Clinical signs include vomiting, diarrhoea, weakness, vision disorders and neurological problems: swallowing difficulties, dilation and uneven size of the pupils or strabismus [19,21]. In the later phase, the above symptoms may be accompanied by limb weakness, loss of facial expression, paralysis of thoracic muscles and the diaphragm.

Ricin is a neurotoxic protein obtained from the plant *Ricinus communis*. The substance interferes with protein synthesis. Clinical signs of poisoning are bad disposition and weakness [22]. Large doses may induce septic shock and eventual death of the patient. The symptoms appear after 5-12 hours of the contact with poisonous aerosol.

5. Conclusions

Many reports of the use of biological weapons of mass destruction may be found in the literature, occurring from the ancient times until present. Technical advances resulted in eradication of some diseases, but this does not preclude the fact, that infectious biological agents may be stored in secret laboratories. During the Geneva conference in 1925, General Sosnkowski warned, that "biological weapons may be easily, cheaply and secretly produced." The above characteristics mentioned by Sosnkowski are encourage various terrorist groups to use that kind of agents. Protection against infectious diseases should be based on the systems of early case detection, efficient treatment methods and isolation of patients to prevent the occurrence of epidemics.

References:

1. Binder, P. and H. Delolme. "[Hazards, threats and risks: lessons from the past to a defensive attitude for the future]." C.R.Biol. 325.8 (2002): 887-96.
2. Ziemba R. "The establishment and functioning of a environmental pollution monitoring system." Military Pharmacy and Medicine. 4(2011): 77-82.
3. Ziemba R. "Rules for the use of collective protection measures against BST contamination in accordance with NATO normative dociments." Military Pharmacy and Medicine. 2(2011): 48-59.
4. Brian, Perry W. "Biological weapons: an introduction for surgeons." Surg.Clin.North Am. 86.3 (2006): 649-63.
5. Akcali, A. "[Viruses as biological weapons]." Mikrobiyol.Bul. 39.3 (2005): 383-97.
6. Bigalke, H. and A. Rummel. "Medical aspects of toxin weapons." Toxicology 214.3 (2005): 210-20.
7. Boutiba-Ben, Boubaker, I and Redjeb S. Ben. "[Bacillus anthracis: causative agent of anthrax]." Tunis Med. 79.12 (2001): 642-46.
8. Doganay, L. and P. D. Welsby. "Anthrax: a disease in waiting?" Postgrad.Med.J. 82.973 (2006): 754-56.
9. Riedel, S. "Anthrax: a continuing concern in the era of bioterrorism." Proc.(Bayl.Univ Med.Cent.) 18.3 (2005): 234-43.
10. Vranes, J. "[Bioterrorism]." Lijec.Vjesn. 124 Suppl 2 (2002): 74-77.
11. Szafraniec, S., P. Grzesiowski, and W. Hryniewicz. „[Anthrax as a bioweapon]." Przegl.Lek. 61.3 (2004): 177-80.
12. Bossi, P. and F. Bricaire. "[The plague, possible bioterrorist act]." Presse Med. 32.17 (2003): 804-07.
13. Ligon, B. L. "Plague: a review of its history and potential as a biological weapon." Semin.Pediatr.Infect. Dis. 17.3 (2006): 161-70.
14. Bossi, P. and F. Bricaire. "[Tularemia, a potential bioterrorism weapon]." Presse Med. 32.24 (2003): 1126-30.
15. Bossi, P., et al. "[Risk of smallpox, vaccination, bioterrorism]." Presse Med. 34.2 Pt 2 (2005): 177-84.
16. Nafziger, S. D. "Smallpox." Crit Care Clin. 21.4 (2005): 739-46, vii.
17. Grygorczuk, S. and T. Hermanowska-Szpakowicz. „[Viral hemorrhagic fevers as a biological weapon]." Pol.Merkur Lekarski. 14.80 (2003): 146-49.
18. Azad, A. F. and S. Radulovic. "Pathogenic rickettsiae as bioterrorism agents." Ann.N.Y.Acad.Sci. 990 (2003): 734-38.
19. Patocka, J., M. Splino, and V. Merka. "Botulism and bioterrorism: how serious is this problem?" Acta Medica.(Hradec.Kralove) 48.1 (2005): 23-28.
20. Shukla, H. D. and S. K. Sharma. "Clostridium botulinum: a bug with beauty and weapon." Crit Rev. Microbiol. 31.1 (2005): 11-18.
21. Shukla, H. D. and S. K. Sharma. "Clostridium botulinum: a bug with beauty and weapon." Crit Rev. Microbiol. 31.1 (2005): 11-18.
22. Spivak, L. and R. G. Hendrickson. "Ricin." Crit Care Clin. 21.4 (2005): 815-24, viii.

Psychology

Psychopathology of combat stress – suicide risks

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Summary:

The multitude and variety of stressors connected with battle activities lead to qualitative and quantitative differences in the psychobiological results combat stress. One of the many threats resulting from disorders connected with combat stress may be depressive-anxiety disorders, suicide thoughts or tendencies. In this paper one presented some causes, mechanisms and conditionings of higher suicide risk in the course of combat stress connected with the multifactorial model of the results of combat and its influence on the mental well-being of soldiers.

Key words: psychopathology, combat stress, suicide risks.

Stress-inducing factors generated in battlefield activities and related circumstances are numerous and diverse.
Combat stress can be experienced by participants of both fighting parties and soldiers' reactions to so-called war stressors play crucial role in battlefield actions.

Armed forces commands are aware of the fact that human factors influence war even to a higher extent than the technique and material aspects and work on methods and startegies aiming at the increase of psychic, physical and emotional stress of enemies which simultaneously lead to immunization of their own army in terms of stress [1].

Combat stress can be used as a weapon and is a kind of challenge for the command which gives them a chance to verify their personal competences and values [2].
There are a few groups of specific war stressors: physical, cognitive, emotional, social and spiritual. Potentially the most destructive are those which are the strongest and the most dangerous; however, on the other hand, it is known that apparently not threatening stressors which last adequately long, may result in a number of negative outcomes, especially if they are cumulated. A majority of war stressors is quite specific and does not appear in other than battlefield situations—it particularly refers to cognitive, emotional and social stresses.

Cognitive stressors which increase soldiers' burden are, among others, factors connected with lack of information or information surplus, disinformation, changeability of tasks, roles and their ambiguity, loyality conflicts, monotony fatigue of everyday tasks and obligations, revaluation processes of so far existing value systems.

Also emotional stressors can play a distinct role in combat stress development e.g. emotional shock being result of a friend's or colleague's loss,

constant feeling of physical danger, death and disability fears, shame and sense of guilt, helplessness, exposure to a direct contact with death and injuries, causing death.

However, factors such as isolation from the social support, lack of privacy and personal space, media's and public opinion's influence as well as some actions of the supervisiors and leaders are considered to be social ones which have a strong, potentially destructive, impact on soldiers who are on the battlefields.

Soldiers' exposure to such a big number of stressors may be a reason for existence of a variety of adaptation reactions and serious or chronic stress disorders. A type and course of such disorders depend on the one hand, on intensity and duration of a stressor, on the other one, on efficiency of self-defence mechanisms, adaptation and compensation abilities of a soldier and ways of copying with stress. The ability to neutralise and oppose to negative impacts of combat stress is individual, varies and is always limited.

Results of combat stress vary from adaptation strategies regarding ability to cope with it.. The differences stem from a number of reasons; it has been proved that, among others, in case of soldiers exposed to combat stress, there are constant central neurobiological and psychic disorders and stress symptoms may sustain in different forms for many years after completion of participation in war operations.

The American researchers have distinguished three main categories of combat stress indicating types of stressors which are responsible for disorders: traumatic stress as an outcome of fear, horror or helplessness, operation stress resulting from accumulation of different factors – mainly those which overburden, cause fatigue and stress – as a reaction to the death of a close person.

Traumatic stress appears when a person experiences, witnesses or participates in an event., situation which was directly connected with a 'real-life' danger, a serious body injury or a danger of physical integrity of this person or others. While experiencing such an event, an intense fear appears including sense of helplessness and horror. Also other dissociative symptoms such as derealization, depersonalisation or dissociative amnesia, stupefaction and 'switch off' may occur.

Afghan and Iraq war experiences prove that witnessing friends' or leader's death, responsibility for children's death, accidental shelling of own army, unexpected enemy attack by ambush may result in an acute reaction to stress (ASD) [3].

Sometimes a kind of strong activation, excitation may appear and it can last long even if danger comes to an end. It is a main symptom of acute stress disorder (ASD) and post-traumatic stress disorder (PTSD). There are suggestions that excessive activation can lead to brain neuron damages, degeneration in the areas responsible for overcoming fear and integrating traumatic experiences [4].

Dissociative disorders, disturbing information processing, result in a situation when soldiers exposed to traumatic stress are disabled to integrate their observations, emotions and their own identity [5].

The test results regarding pathomechanism of neurons' structural and functional changes in brain in stressful conditions, especially in respect to hippocampal neurons responsible for integrating thoughts, impressions and feelings but in a stressful situation – for generating dissociative symptoms and fear seem to be quite interesting [6].

The tests conducted on animals proved unambiguously that hippocampal damage is a biological consequence of stress and that cortisol plays here an important role [7]. The research conducted on people suffering from PTSD proved that persons suffering from PTSD had lower hippocamps volume than the control group. However, cortisol's influence on the hippocamp damage has not been explicitly confirmed [8].

Central neurotransmitters, especially noradrenaline and serotonin, also play an important role in pathogenesis of psychic disorders present in acute and chronic stress, as their level decreases. Decrease of these system's activity results in deterioration of brain's ability related to the balanced and easily adopted functioning [9].

Some of psychobiological and psychosocial conditionings related to generation and course of stress disorders connected with war actions prove that in a number of cases they may constitute favourable basis for suicide risks among persons suffering from the above mentioned disorders. This danger seems to be quite realistic, especially if one takes into consideration very often dramatic character of combat stressors and, observed in a number of cases, chronic and long course of traumatic stress disorders among veterans.

The results of many tests prove that people who suffered from the combat stress are prone to other diseases, including psychological diseases and disorders, cardiological diseases, those of nervous system and others. It is also closely connected with increased mortality [10].

It has been stated that, among others, veterans of the Vietnam war suffering from PTSD more frequently committed suicides and their death was triggered by the harmuful use of alcohol and psychoactive substances [11]. Reports on the veterans of wars in Iraq and Afghanistan also highlight increased indexes regarding their psychological problems, disorders and higher suicide risk after coming back to their country [12].

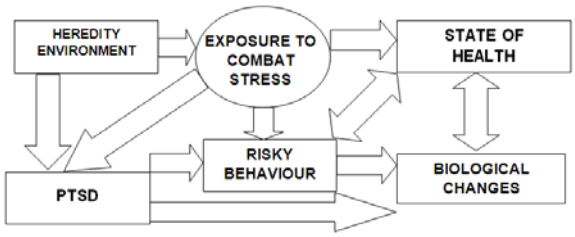

Figure 1: Multifactor model of combat stress impact and results.

Source: Boscarino J.A.: The mortality impact of combat stress 30 years after exposure: implications for prevention, treatment, and research.In: Figley Ch.R.,Nash: Combat stress injury. Theory, research and management, PWN-WIM ,Warsaw, 2010:134.

If a combat stress danger and post-traumatic disorders related to it can be treated as a suicide risk factor, the necessity to take preventive actions seems to be obvious.

Such actions should be conducted in the army not only within the scope of standard psychoprophylaxis on the level of recruitment, selection and trainings organized before a war takes place, but also during and after its completion. In the US army there are special groups of stress control (combat stress control – CSC) whose key mission is to prevent reactions to combat stress and provide short-term treatment of stress disorders on the war territory. These teams consist of a psychiatrist or a psychologist, psychiatric nurse, occupational therapist, psychic health and occupational therapy specialists. CSC units, provided they are properly used, can help soldiers with stress symptoms to recover from it and come back to the earlier level of functioning. The soldiers who suffer from stress generated disorders or those who have it after coming back from battlefield actions usually require a long-term therapy [13].

American Psychiatric Association recommends in such cases antidepressants such as SSRI, IMAO or TLPD. Also the second generation neuroleptics prove to be effective. The anti-epileptic medicines and those blocking andrengeric receptors may be prescribed in individual cases as supporting treatment. Benzodiazepines are ineffective in the treatment of PTSD symptoms however, given for a short period of time may improve the quality of sleep [14,15].

Psychotherapy, especially cognitive and behavioural therapy to distorted evaluation, dangers in order to convert disfunctional models of thinking connected with PTSD symptoms, play essential role in prevention and treatment of PTSD. Promising results have also been achieved by conducting virtual reality exposure therapy (VRET) reflecting time and place of traumatic battlefield actions [16,17].

Reduction of PTSD symptoms, obtained as a result of conducted therapy, decreases risks of future negative health consequences including suicide dangers, as half of soldiers suffering from PTSD have depression symptoms and fear which often accompanies depression increases suicide risks. The effectiveness of the therapy applied in case of the soldiers with PTSD should be also evaluated in terms of effectiveness regarding suicide prevention.

The answer to the question on suicidology borders in combat stress psychiatry may only be an attempt to present a complex multifactor problem and its numerous conditionings. Prevention of suicides among soldiers in combat stress conditions i..e. psychoprophylaxis of suicidal behaviour, faces limits resulting from the specifity of this particular type of stress and on the other

hand, from difficulties with applying optimal diagnostic methods, psychological and psychiatric treatment. Mainly, it refers to the soldiers participating in the battlefield actions and staying in the areas where war takes place. Veterans with PTSD symptoms resulting from combat stress can mostly be provided with a complex specialist care including anti-suicide treatment however, a number of them are not willing to obtain it or they do not know how to do it. It also consititutes a barier decreasing effectiveness of psychiatric treatment offered to the combat stress victims and simultaneously a cause limiting effectiveness of prophylaxis against suicide.

References:

1. Grossman D. On killing: the psychological cost of learning to kill in war and society. Boston,Little Brown, 1995.
2. Goldstein J.S. War and gender: how gender shapes the war system and vice versa. Cambridge,U.K.,University Press, 2001.
3. Hoge C.W.,Castro C.A.,Messer S.C.,Mc Gurk D. et al. Combat duty in Iraq and Afghanistan, mental health problems and barriers to care. New Engl. J. of Med. 2004:351,1798-1800.
4. Stahl S.M.Essential Psychopharmacology. New York, Cambridge University Press,1996.
5. Marshall R.D.,Spitzer R.,Liebowitz M.R.Review and critique of the new DSM-IV diagnosis of acute stress disorders. Amer.J.Psychiatry 1999:56,1677-1685.
6. Vianna M.R.,Cointinho A.S.,Izquierdo I.Role of hippocampus and amygdala in the extinction of fear – motivated learning. Cur.Neurovasc.Res.2004:1,55-60.
7. Sapolsky R.M.Glucocorticoid and hippocampal atrophy in neuropsychiatric disorders. Arch.Gen.Psychiatry 2000:57,925-935.
8. Smith M.E. Bilateral hippocampal volume reduction in adults with posttraumatic stress disorder: a meta-analysis of structural MRI studies. Hippocampus, 2005:15,798-807.
9. Stahl S.M.Essential psychopharmacology: neuroscientific basis and practical applications. New York, Cambridge Univ.Press,2000.
10. Boscarino J.A. Association between posttraumatic stress disorder and physical illness: results and implications from clinical and epidemiologic studies. Ann. New York Acad. of Sciences,2004:1032,141-153.
11. Boehmer T.K., Flanders W.D., Mc Geehin M.A., Boyle G., Barrett D.H. Postservice mortality in Vietnam veterans:30-year follow-up.Arch.Inf.Medicine,2004:164,1908-1916.
12. Kang H.K.,Hyams K.C. Mental health care needs among recent war veterans. New England J.Medicine 2005:352,1289.
13. Department of the Army. Combat stress; field manual 6-22.5.Washington D.C.,2000.
14. American Psychiatric Association. Diagnostic and statistical manual of mental disorders. Washington D.C.,2000.
15. Ursano R.J.,Bell C.,Eth S.,Friedman M.,Norwood A.,Pfefferbaum B. Practice guideline for the treatment of patients with acute stress disorder and post-traumatic stress disorders. Am.J.Psychiatric, 2004,161(11suppl.):3-31.
16. Rothbaum B.O., Schwartz A. Exposure therapy of posttraumatic stress disorders. Amer.J.,Psychother., 2002:56,59-75.
17. Zimand E.,Anderson P.,Gershon G.,Graap K.Virtual reality therapy: innovative treatment for anxiety disorders .Prim.Psychiatry 2003:9,51-54.

Military medicine

Defense Strategy of the Republic of Poland as foundation of Military Medical Service

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Summary:

Defense Strategy of the Republic of Poland is one of the most important documents that regulate actions in the field of the defense of Poland. It influences among other things, tasks of the Polish Armed Forces, and also, indirectly, the goals and assignments of Military Medical Service in case of threat to the country. Based on the content of the Defense Strategy, the authors indirectly set tasks for Military Medical Service. Based on that they proposed exact solutions concerning actions, structures and organizational procedures of Military Medical Service, that would prepare the Military Medical Service for a possible situation of threat to Poland.

Key words: Defense Strategy of the Republic of Poland, Military Medical Service, threat to the country.

„The Republic of Poland, together with its partners and allies, will respond to present-day challenges and threats, guided by its national interests identified in the National Security Strategy of the Republic of Poland" [1].

The Defense Strategy of the Republic of Poland is based on the National Security Strategy of the Republic of Poland and it details and develops the defence provisions adopted by the Council of Ministers, and subsequently approved by the President of the Republic of Poland on 13 November 2007. Provisions of the Defense Strategy formulate guidelines for documents in the area of defence; they identify the functions and structure of the state's defence system and map out the main directions of the development of its subsystems [1]. In the light of the above, the Defense Strategy of the Republic of Poland is a supreme document which established general and basic actions in the field of defense of Poland. Its application within the Military Medical Service is preceded by appropriate decisions and conclusions at lower levels. However, based on the provisions of the Defense Strategy of the Republic of Poland, we may try to generalise actions and tasks that would be assigned to The Military Medical Service. More specific assumptions should be developed by lower authorities planning and introducing the guidelines of defense of the Republic of Poland. Important for the discussed matter are the Republic of Poland's main strategic goals in the area of defense:

1) ensuring independence and sovereignty of the Republic of Poland, its integrity and inviolability of its borders;
2) defence and protection of all the citizens of the Republic of Poland;

3) mplementing commitments arising from Poland's NATO and European Union's membership;

Taking all that into consideration, the main mission of the Polish Armed Forces is to defend Poland and to take part in the defense of allies. These actions will be carried out in the national and allied structures [1].

The main assumption is to carry out defence tasks on the territory of Poland, to protect its citizens. Next, actions will be carried out within allied structures and partnerships. The next step includes participation in defence and peacekeeping operations on a broader scale, when possible.

The State's defense system consists of three subsystems, including the military subsystem formed out of the AFRP (Armed Forces of the Republic of Poland) responsible for:

- guaranteeing defence of the state and counteracting aggression;
- participation in the process of stabilization of the international situation and in crisis response and humanitarian operations;
- supporting the internal situation and assisting the population.

Waging of defence operations on the territory of Poland excludes the possibility of a concurrent use of the AFRP in crisis response operations outside the country's territory. Assignment of forces and resources to participate in operations outside of Poland has to be subordinated to the need to maintain capabilities ensuring security and inviolability of the Republic of Poland's borders [1].

The operational army of the AFRP includes medical components within the group of combat service support units. Moreover, the support army groups station medical posts. Military Medical Service is also connected with planning and implementation of tasks relating to the preparation and use of public and nonpublic health service to meet the state's defence needs. These include increasing the hospital base and changing its profile, the creation of substitute hospital places, activities relating to outpatient care, the organization of public blood service, sanitary and epidemiological protection, rules on how to proceed in case of radiation and other effects of the use of weapons of mass destruction and the provision of benefits to certain organization units [1].

The role of the Military Medical Service is to fulfil general provisions of defence strategy as concerns the manpower of the armed forces, especially in the face of threat. Thus, the following issues should be considered and then implemented:

- determination of tasks for the Military Medical Service;
- development and improvement of the system of medical support of the military operations;
- determination of forces and resources for the Military Medical Service;
- studies estimating expected sanitary losses.

These issues are a subject of interest of military medicine division—Organisation of Military Healthcare.

The basic tasks of the Military Medical Service include:

- protection of life and health of soldiers (including full psychological well-being) and prevention of development of diseases, especially the infectious ones and their epidemics;
- provision of medical aid, treatment and rehabilitation of the wounded and sick soldiers.

These tasks are implemented in detail within the developed system of medical support of the army during military operations.

Medical support of the military operations includes all undertakings of the Military Medical Service to preserve the fighting ability of soldiers and to protect their health, to provide medical aid to the wounded and sick in due time, to evacuate them, rehabilitate, decrease the level of disability, as well as to prevent the dissemination of infectious diseases [2].

The guidelines concerning medical support, commonly accepted by the Republic of Poland with alliances include:

- availability of medical aid to all soldiers, taking into consideration the provisions of humanitarian law and medical aid according to the clinical status, with the use of available means and possibilities;
- the standard of medical aid during crisis and

war should possibly follow the standards of medical aid in the times of peace;
- prevention of infectious diseases is the basic condition to preserve a good health of soldiers;
- when saving life and limbs, all means should be employed to adhere to the rule of six hours;
- triage should be followed at all stages of medical evacuation, leading to a rational and economical use of medical equipment;
- medical aid should be continuously provided at all stages of medical evacuation and during medical evacuation;
- at particular levels of medical aid rendered at medical facilities, there should apply gradation of medical aid provision - from the basic forms (the first aid) to specialist help and rehabilitation;
- the clinical status of the wounded and sick influences the time and means of medical evacuation [3,4].

Medical support of military operations employs professional (full-time) forces and resources of subdivisions and divisions of the health care. It includes:

I. Protection of treatment and evacuation:
- development of particular stages of medical evacuation and evacuation of the wounded and sick from the battle field to well-established dressing stations;
- provision of medical aid to the wounded and sick;
- temporary hospitalization of the wounded and sick not suitable for evacuation – outpatient treatment of mildly wounded and ill patients [2,5,7].

This is the basic group of tasks assigned to the Military Medical Service. Their implementation requires having professional (full-time) medical subdivisions, preferably modular, i.e. allowing for any configuration of the system of staged treatment at levels of medical aid provision, as well as for the possibility of exchanging and replacing medical components of the system. The function of medical subdivisions follows from the characteristics of the provided medical aid at particular levels of medical aid, based on the above presented criteria.

II. Sanitary-hygienic and antiepidemic support:
- sanitary and hygienic as well as epidemiological reconnaissance in the areas of military operations;
- supervision over: food, uniforms, accommodation, provision of water and observance of rules of hygiene;
- sanitary, hygienic and antiepidemic actions aimed to prevent the development and dissemination of infectious diseases;
- isolation of patients with infectious diseases or suspected infectious diseases [5,6,7].

In this field, the basic tasks should be performed by tactical health care services. Complex activities on the territory of Poland should be carried out by Military Centres of Preventive Medicine (WOMP, Wojskowe Ośrodki Medycyny Prewencyjnej), and in interoperative situations also by the Epidemiological Reaction Centres of the Polish Armed Forces (CRESZ, Centrum Reagowania Epidemiologicznego Sił Zbrojnych).

III. Sanitary protection against weapon of mass destruction (WMD):
- reconnaissance of radioactive and chemical contamination of areas of developed medical components;
- reconnaissance of radioactive and chemical contamination of the wounded and sick, presenting to the dressing stations;
- provision of partial and total sanitary procedures to the wounded and sick as well as special procedures, sanitary transportation, uniforms, and management of the wounded and sick [5,6].

As far as the discussed group of tasks is concerned, the main role is played by tactical health care services, provided with specialist equipment, and within WOMP on the territory of Poland.

IV. Provision of medical equipment and materials:
- provision of individual sanitary equipment to the soldiers;
- provision medical equipment and materials to subdivisions and divisions of health care services [5].

These extremely important tasks conditioning efficient execution of a military function of health care services should be carried out based on simplified rules of management, national resources but aiming at unification within alliances, systematically updated and improved.

V. Management of health care:

- development of a plan of medical support of military operations;
- management of forces and resources of health care services during military operations [5,6,7]

Existing planning procedures concerning this matter should be updated to include current data on provision of medical support, and especially the expected sanitary losses, as well as (in case of interoperative operations) take into account procedures following from alliances. It is absolutely necessary to modify the system of health care management based on the medical information management system (MIMS).

VI. Sanitary training:

- training of manpower to provide first aid; professional training of health care personnel [5,7].

These tasks require extreme attention because they condition the efficiency of the system of medical support. Recruitment and training of medical personnel, especially of higher rank and highly specialised, is currently a problem which must be solved. Sanitary training of manpower must be carried out continuously by medical personnel of a military unit. Training of medical personnel should be conducted by certified training centres.

VII. Keeping records and reports required by law.

This requires attempts to introduce MIMS procedures and to increase the application of IT and ICT solutions in unification with allies.

The authors believe that the above presented main groups of tasks influence appropriate function of the Military Medical Service and the system of medical support of military operations. Further studies on the discussed issues and their modification in the face of current challenges is absolutely necessary. It is important to obtain a coordinated system of procedures in combination with appropriate manpower, equipment and infrastructure which will be a baseline for implementation of assumed tasks for Military Medical Service.

References:

1. Strategia Obronności Rzeczpospolitej Polskiej: Ministerstwo Obrony Narodowej, Warszawa 2009.
2. Trybusz A, Krężel J, Magier et al: Ogólna charakterystyka systemu leczenia etapowego z ewakuacją wg wskazań: Lek. Woj, 1996; 1: 21-4.
3. Dójczyński M, Słowiński A: Zabezpieczenie medyczne działań bojowych wojsk w armiach NATO. Valetudinaria. Postępy medycyny klinicznej i wojskowej. Suplement. Bydgoszcz, 2001: 24-5.
4. AD 85–8 – ACE Medical Support Principles and Polices. Policies and Planning Parameters. 1993: 2-5.
5. Krężel J, Trybusz A, Kapusta H et al: Struktura organizacyjna, przeznaczenie i możliwości służby zdrowia szczebla taktycznego: Lek. Woj, 1996; 1: 32-3.
6. AJP 4.10 (A) – Allied Joint Medical Support Doctrine, 2006, 3001-25.
7. FM no.4-02.21 Division and Brigade Surgeons Handbook Tactics, Techniques and Procedures. Headquarters Department of The Army. Washington. DC. 2000, 1-29: 3-1,23.

Emergency Medicine

Criteria of procedures in life-threatening states

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Summary:

In this work, after presentation of legal basis of first aid, first aid chain issues and principles of medical first aid are described. A scheme for procedure of assessment of the injured person health state, rules to follow during call for professional medical aid, as well as during transport of the patient, are presented.

Key words: first aid chain, health state assessment, medical first aid, transport of the injured person.

1. Introduction

In everyday life, one may often find themselves in a situation when it becomes necessary to administer first aid to another person. Those may include:

- sudden indisposition,
- an accident at home,an accident at work; as well as
- a random occurrence in the street.

Therefore, it is necessary that as many people as possible be trained in administering first aid to accident victims and be able to administer it in a professional way prior to the arrival of specialist rescue services.

Often it is the professionally administered first aid that is crucial to the health and even the life of an individual.

2. Legal basis for administering first aid

Everyone may become a witness to an accident and we are all required to – under the provisions of the law—to render first aid, which may be decisive for the life of a victim of an accident or indisposition, for their further fate and potential disability.

The Penal Code includes relevant provisions:

Article 162.
§ 1. *Whoever does not render assistance to a person who is in a situation threatening an immediate danger of loss of life, serious bodily injury, or a serious impairment thereof, when he is able to so do without exposing himself or another person to the danger of loss of life or serious harm to health shall be subject to the penalty of deprivation of liberty for up to 3 years.*

§ 2. *Whoever does not render assistance necessitating the submission to a medical operation, or under conditions in which the prompt assistance of a responsible authority or person is possible, shall be deemed to have not committed an offence.*

The reason for rendering aid is the occurrence of the situation of necessity (injury, sudden health deterioration). It is insignificant whether or not the injured person is culpable of their situation (a suicide attempt, a result of neglect or carelessness).

Rescue measures are required as long as they do not pose additional risk for the rescuer's life or health; however, potential material losses should be allowed for (the use of one's own first aid kit, damage to one's clothing).

The person administering aid may not, however, neglect their own professional duties insofar as to present danger to the safety of other people. For example: a paramedic carrying a patient may not stop in order to administer aid to someone in the street; a railway gateman may not abandon a railway crossing unsupervised.

In addition, it is required of an individual qualified in first aid that their actions should be executed in the best possible way and in the most effective manner, in compliance with their knowledge.

Criminal responsibility is provided for failure to administer aid or for a conscious act to the detriment of an accident victim. Criminal responsibility is not provided for potential non-culpable complications related to the undertaken rescue measures.

In the civil law, administering aid is considered to be non-commissioned task performance, where the contractor is responsible solely for the damages resulting from a deliberate or explicitly negligent action. In addition, the provisions of civil law make it possible to claim damages or compensation both on the part of the rescuer (for material losses incurred during the action), and on the part of the victim (for potential losses resulting from deliberate or explicitly negligent task performance).

Also the health and safety regulations relating to first aid impose an obligation on employers to organize and render such aid to the employees who have become victims of an accident, poisoning or sudden indisposition in the workplace.

The Labor Code also imposes an obligation on the employer to organize and administer first aid.

Article 224.
§ 1. *Employers whose activities can cause a sudden hazard to health or life of employees shall be obliged to take measures to prevent such hazard arising.*

§ 2. *In the event referred to in paragraph 1 above, the employer shall be obliged to provide:*
(1) *rescue facilities and equipment suitable for a given kind of danger and a service in connection therewith by properly trained persons.*
(2) first aid to injured persons.

§ 3. *The provisions of paragraphs 1 and 2 above shall not prejudice the requirements specified in separate provisions in respect of disasters or other extraordinary hazards.*

Article 225.
§ 1. *Employers shall be obliged to ensure that work which can be especially hazardous to human health or life is performed by at least two persons, for the purpose of security.*

In addition, one should remember that a company is obligated to do the following:
- to secure the scene of an accident until its circumstances and causes have been established,
- to immediately establish the circumstances and causes of the accident and take relevant precautionary measures,
- to immediately notify an inspector of the State Labor Inspection and a prosecutor as well as its own superior unit about each fatal, severe or collective accident at work.

Today, as a result of joining the European Union, the role of a normative organ is performed by the European Resuscitation Council.
Its guidelines relating to medical rescue are updated every three years. An anniversary conference was held in Antwerp in 2000, where the most optimal and the most up-to-date resuscitation standards were set for Europe (in compliance with the WHO standards).

The most recent guidelines relating to the resuscitation procedures were published also by the Heart Failure Society of America and the European Resuscitation Council.

The new guidelines for procedures in life-threatening states include:
- cardiopulmonary resuscitation,

- the use of automatic external defibrillators; and
- the performance of ACLS and PALS procedures.

New studies are based on the analysis of the most recent research. Since 2000, when the previous recommendations were published, science has made significant advances in understanding pathophysiology of a sudden cardiac arrest, which provides greater possibilities for its effective prevention and treatment.

The Polish version of the 2005 guidelines for cardiopulmonary resuscitation of adults and children were prepared by the Polish Resuscitation Council. In the event of a sudden cardiac arrest, the current guidelines are based around easy-to-learn rules for rendering first aid, including:

- immediate, knowledgeable application of pressure to the chest; and
- performing mechanical ventilation (30 presses and 2 breaths).

Those changes make it possible to create good conditions to perform an effective defibrillation and restore normal heart action.

Once the heart action has been restored – although the victim remains unconscious – the 2005 guidelines recommend lowering the body temperature in order to create conditions to restore normal brain functions.

3. Ability to save life

The chances of survival of an accident victim or an individual suffering from sudden indisposition depends primarily not on the qualified rescue services but on immediately administered first aid by the witnesses present at the scene of the incident.

Even the severely wounded: with breathing difficulties, cardiac arrest, hemorrhages, and those in post-traumatic shock can be rescued if life-sustaining measures with regard to them are taken immediately.

Such procedures are not overly complicated and do not require administering drugs or special apparatuses; only the basic knowledge and good will on the part of the random rescuer are needed.

The person administering first aid may not allow for additional injuries or severe complications and must carry out a rescue operation until professional rescuers arrive at the scene.

The idea of the first aid chain additionally includes:

- immediate actions aiming to secure the scene of the accident,
- calling for professional help,
- administering first aid,
- transport and final medical aid.

Figure 1: First aid chain.

Even the most efficiently organized hospital care and comprehensively trained immediate aid teams will be unable to substitute the actions of random rescuers at the scene of an accident.

4. Victim rescue training

It is advisable that potential measures to be taken in a sudden situation should be somehow prescribed. One may prepare by means of theoretical and practical acquisition of the ability to administer first aid, as well as by preparing an effective system of communication and the necessary rescue equipment.

Depending on the conditions at the event scene and the needs—one will modify only the scope of their preparations.

The basic knowledge required for rendering pre-medical first aid can be sourced from several independent sources:

- textbooks,
- raining videos; or
- specialist courses.

Pre-medical first aid staff training is included in the obligatory curriculum of the health and safety training (Article 237 of the Labor Code).

There should be additional training courses carried out for the staff in compliance with § 41.1. of the Ordinance of the Minister of Labor and Social Policy of 26 September 1997 on general health and safety regulations (Journal of Laws, No. 129, item 844 of 23, October 1997).

The entities organizing the training courses are required to carry out exercises on training mannequins and to take into account the specificity of a given workplace.

First aid training courses are provided by numerous Rescue Schools along with the Polish Red Cross and the Training Centre of the State Labor Inspection including its subsidiaries.

When selecting textbooks it is best to be guided by the up-to-date works including tested knowledge (source material).
Textbooks published prior to 2006 and textbooks based on standards different from the guidelines of the European Resuscitation Council should not be used (*resuscitation* means the restoration of the action of circulatory and respiratory systems – reanimation).
Training videos should be complementary to practical classes and should always include the trainer's commentary.

One should also remember about the need to constantly update their knowledge and to periodically test the acquired skills.
Training courses should be run by trainers: rescuers holding European certificates, appropriately trained lecturers as well as by training centers.

Elementary training courses should be complemented by issues related to the specificity and the profile of the workplace, e.g.: chemical industry will require a separate curriculum and qualifications in chemical rescue; similarly, the mining industry will run training courses comprising mining rescue. Also the employees of companies dealing with the distribution of toxic chemical substances (such as plant protection products) are required to complete separate specialist courses.

The rules for administering medical first aid. What is medical first aid?
Medical first aid comprises all the actions performed by an individual (individuals) providing care until the arrival of professional medical aid (physician, ambulance) or until the sick person has been transported to a health care unit (hospital, ER). These actions may relate to procedures performed directly on the injured person (bandaging, immobilization, reanimation measures, etc.).

Medical first aid includes also any actions performed around the injured person (securing the scene of the accident, protection from further injuries, carrying the victim out of the danger area, disconnecting electricity, ventilating the room, etc.), although these belong rather to the category of general rescue.

The scope of medical first aid encompasses also calling for professional assistance (ambulance) and potentially organizing transport for the victim, if it is impossible (or there is not enough time) to transport the injured person by ambulance.

A very important factor when rendering first aid is to remain calm. Calm is needed both by the victim of the accident and the rescuer as well as by people surrounding them. The conversation with the victim (if they are conscious) should be calm and to the point. This will allow the accident victim or the sick person to feel more secure. During the conversation, it should be established what memories the victim has from the accident, where they can feel the pain, whether or not they have a history of chronic diseases, such as diabetes. One should also identify how and which next of kin should be advised about the situation.

5. Situation assessment

The knowledge of basic first aid rules should be widespread. According to the statistics, a great proportion of deaths caused by accidents or sudden indisposition occur before the professional medical aid arrives. Often performing simple tasks such as changing the victim's body position, clearing the respiratory tract by lifting the chin or stopping a bleeding may be life-saving.

Before performing first aid procedures on an accident victim (or victims) one should swiftly assess the situation.

The following should be done:
- determine the likely cause of the accident and the victim count,
- identify whether or not the victim(s) is/are still in danger,
- ensure that the rescuer (person administering first aid) is not in danger,
- establish if there are other people who might assist in saving the accident victims if need arises,
- determine if it is possible to call for professional medical aid (ambulance), technical assistance (fire service, police, and gas and electricity emergency services).

PLEASE NOTE: As part of first aid, note should be taken of the start time of the rescue operation – time relations of the operation might be vital for a variety of measures taken afterwards, such as the decision to begin the reanimation procedure.

Actions taken by the rescuer (person administering first aid) have to be rapid and unhesitating, yet sensible. Hasty actions may put the rescuer at risk from injury and add delay to the provision of aid (e.g. suffering an electric shock as a result of approaching the victim without prior disconnection of electricity source or finding an appropriate isolator).

Parallel to situation assessment and accident circumstances, the health status of the victim (victims) should be identified:
- whether or not they are conscious,
- whether or not they are breathing.

If a victim of an accident or a sudden indisposition is unconscious and not breathing, reanimation procedure should be initiated immediately. Subsequently, the following should be assessed:
- injuries resulting in a hemorrhage,
- potential fractures requiring immobilization.
- Further, if there are other people who can join in helping the victims, the following rescue tasks have to be assigned:
- securing the accident scene (e.g.: placing a warning triangle; turning on the lights; signaling with a flashlight; warning flairs, etc.),
- calling for professional medical aid (ambulance); possibly police, fire service,
- providing a first aid kit – transporting the victim to a safe place (only when absolutely necessary).

Often involving third persons or those mildly injured in supervisory or care tasks prevents or diminishes the possibility of a hysterical reaction or panic breaking out.

Health status assessment (action scheme)
The basic task of a rescuer (person administering first aid) is to assess the health status of the victim of an accident or a sudden indisposition. The most important task is to determine if the processes decisive for the life of the victim are sustained:
- consciousness,
- clear airways,
- breathing.
- Listen for breathing in the injured person. Simultaneously, perform a visual check for breathing movements of the chest.
  - Injuries have caused bleeding,
  - Fractures and sprains resulting in a shock,
  - Other circumstances which may influence health status – alcohol, acetone.

A random (non-professional) rescuer does not have to look for the pulse of the victim in order to undertake resuscitation (BLS ERC 2000, 2005). Examining the injured person will enable the assessment of their health status.

6. Examination scheme

The examination is carried out with both hands, simultaneously on both sides. Start from the victim's head and neck, the upper and lower limbs.

The head should be closely examined for injuries by palpating gently; look for dents – potential cranial bone fractures.

PLEASE NOTE: Do not perform needless movements at spine injuries.

Face
- Observe skin color – paleness or cyanosis,
- Facial features in victims in a shock become sharper,
- Sweat – in a shock the skin is covered with cold sweat.

Eyes
- Observe pupil width – are they the same size in both eyes?
- Check reactions to light, e.g. by directing a flashlight at them—the pupils should narrow.

Other reaction may indicate brain damage,
- Check for any injuries or burns to the conjunctivae.

Ears
- Observe skin color, cyanosis may indicate hypoxemia,
- Check for a blood and serum discharge from the ears, which occurs, for example, in cranial bone fractures.

Nose
- A blood and serum discharge from the nose may indicate cranial bone fractures,
- Check for a nosebleed (nose injury—blood running from the nose to the throat may block the airways),
- Check for unrestrained breathing, wheezing, or creaking

Lips
- Check for foreign bodies in the mouth (such as a prosthesis which needs to be removed),
- Mouth odor,
- Bitten tongue (indicative of epilepsy),
- Lip cyanosis – an early symptom of hypoxia.

Neck
- Palpate the neck gently, run your fingers down the spine, from the skull to the back, looking for painful spots or potential deformations which might indicate spine fracture,
- Check the pulse on the carotid artery.

Undressing

In order to perform examination or apply bandaging it may become necessary to undress the sick person.

The following should be done:
- undress them only as far as it is necessary to render aid,
- ensure privacy for the victim if possible,
- if possible, undress them without cutting through clothing; any potential cuts should be made along the seams,
- start removing the coat, jacket or shirt from the healthy limb,
- remove the trousers having cut through them and having lifted the hips gently,
- remove the shoes while holding the leg at the ankle.

Body
- Observe the chest movements when breathing; is the chest moving equally on both sides (if it is impossible to undress and observe the sick person, you may determine the chest movements by touching the chest with your hands on both sides—unequal chest movements may indicate rib fractures and/or pulmonary edema),
- Ensure that there are no injuries to the chest or the abdominal cavity,
- Check for painful spots, sensitive to touch, by gently palpating the chest
- Palpate the pelvic bones, hold the pelvis with both hands on both sides and check if this causes pain,
- Check whether or not the accident victim is urinating or defecating unconsciously and if there is any bleeding,
- Check by delicately moving your hand down the spine if there are any particularly painful spots or deformations which may indicate spine fractures.

Limbs
- Palpate for particularly painful spots or limb deformations which may be indicative of fractures,
- Ask the victim to move their fingers, hands, feet – inability to do so may indicate a spine or spinal cord injury
- Check the limbs for injuries and the correct temperature,
- Check whether the limbs are in a natural position, if there are no irregular bends in limb joints.

Calling for professional help

Alongside the rescue tasks performed while administering first aid, one should think of calling for professional aid (ambulance). Searching for a phone and notifying about a sudden indisposition is best left to a third person. Ask them to confirm the fact of calling for an ambulance. If there are no other people who could call for an ambulance, then the life functions of the victim(s) should be ensured first (breathing, circulation, appropriate positioning, stopping the bleeding, etc.). Only then professional help should be called for.

When calling for an ambulance by phone, vital information should be given:

WHERE the accident has occurred – a fairly precise description of the address or the place where the caller will be waiting for the ambulance (Always include the following: city/town, neighborhood, street, house number, apartment number – or a company name or the road number – the name of the nearest town, mile marker); **HOW MANY** victims there are, **WHAT HAS HAPPENED:** a description of the accident, if there is still danger; if possible, advise about the victims' type of injuries. Finally the caller should identify themselves (first and last name) and the phone number used for the call.

The information should be succinct and should be given in a calm manner. The person who receives the call (a dispatcher) may request additional information which should be provided if possible.

If need arises to additionally call for the fire service (general rescue), police, technical services, gas and electricity emergency services, this should be done by the ambulance service or the Emergency Notification Center dispatcher.

Transporting the victim

The basic rule for transporting accident victims is to avoid further, additional injuries.

If the victim is not at risk from a direct danger, it is better to wait for the ambulance to arrive to provide professional aid. When it is impossible to leave the injured person at the accident scene or it is impossible to call for professional aid, the victim should be evacuated.

Figure 2: Example of the ways to transport victims

All the tasks should be performed with great care. The sick person may be carried away or pulled away from the accident scene using a blanket.
Example of the ways to transport victims is shown below.

Acknowledgements:

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References:

1. Doraźna pomoc lekarska. pod red.: Kamiński B., Dziak A. PZWL Warszawa 1988.
2. Ostre stany zagrożenia życia w chorobach wewnętrznych. Pod red. Kokot F. PZWL Warszawa 2009.
3. Wypadek Drogowy Pierwsza Pomoc. pod red. Szumial Jan. Grupa Image 2008.
4. Medycyna ratunkowa i katastrof. Podręcznik dla studentów uczelni medycznych. pod red. Zawadzki A. PZWL Warszawa 2008.
5. Pierwsza pomoc w nagłych wypadkach i zachorowaniach, pod red. Ziemba R. Warszawa 2011.
6. Metody skalowania obrażeń ciała i ich zastosowanie w traumatologii. Pod red. Bielecki K. 1997.
7. Medycyna Ratunkowa i Medycyna Katastrof. Pod red. Rasmusa A., Gaszyńskiego W., Balcerzak – Barzdo E., Holyńskiego J. Łódź 2003.

Emergency medicine

Rescue operations in biological hazards

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Summary:

In the last decades, various acts of terrorism have been reported. The most common events involve the use of explosives and chemical warfare agents, while the risk posed by biological agents in the hands of terrorists remains neglected. Appropriate procedures including early risk identification, patient segregation, medical evacuation and disinfection are the key elements of reducing the risk of an epidemic.

Key words: emergency service, procedure, terrorism, medical care, biological warfare.

1. Introduction

Constant development of global civilisation is accompanied by the increasing risk of terrorist attacks. Thus far, terrorists have been equipped mainly with conventional arms as they are easy to obtain and use. The events of September 11th drew public attention to the risk of terrorist attacks using weapons of mass destruction. Such weapons are defined as "biological, chemical, nuclear and radiological weapons (…) causing mass damage to humans as also as animals, along with large-scale damage and contamination of infrastructure, soil and vegetation" [1]. It is commonly believed, that acts of terrorism using pathogenic agents constitute the highest potential risk for civilians [2].

Terrorists possess high capacity of adapting to new circumstances, hence they constantly attempt to obtain biological weapons, including viruses, bacteria and toxins. Achieving this goal is possible using natural sources or laboratory cultures. Biological weapons are also popular with terrorists thanks to their psychological effect expanded by mass media. Even small quantities of such agents may be sufficient to induce a psychosis capable of impairing the functioning of the state.

Biological warfare agents (BWAs) have several advantages [1,2]. They employ living organisms or toxins produced by those organisms to kill or wound humans and animals. Modern biological weapons provide a multitude of both the exerted effects and the ways of dissemination. Several categories of BWAs may be listed:

- Bacteria – anthrax, brucellosis, plague, typhoid fever;
- Rickettsiae – typhus, Q fever;
- Viruses – smallpox, influenza, yellow fever, the Ebola, Marbug and Lassa viruses, encephalopathy;
- Toxins – Shiga toxin, botulin toxin, aflatoxin;
- Fungi – coccidioidomycosis.

By comparing conventional weapons, which pose risk to several hundred people over a short period of time, and biological weapons, which may be dangerous for more than 10,000 people, depending on the site and the time of exposure, the immense advantage of the latter type may be demonstrated. Moreover, the effects of exposure to biological agents may be delayed in time and occur even after more than 10 days of exposure.

2. Biological attack detection

Managing victims of a putative or confirmed bioterrorist attack should not be based on ad-hoc plans but has to follow strictly defined procedures.

Coordination of all types of public services responsible for the reaction to bioterrorist attacks, according to the Act of 26 April 2007 on Crisis Management, is a duty of crisis managements centres [3]. Introduction of epidemiological early warning systems is an important element of this duty [2,4].

In every case of a potential terrorist attack, early warning system is the key means of providing protection [5]. On 31 December 2003, the General Sanitary Inspector released an ordinance specifying diseases, syndromes and events, whose occurrence should trigger appropriate early warning systems. The ordinance specified 8 diseases, 3 syndromes and 13 types of events. The list of diseases includes botulism, plague, cholera, smallpox, Q fever, pneumonic and gastrointestinal anthrax, tularaemia and viral haemorrhagic fevers. Among the listed syndromes are:

1) Flaccid symmetric paralyses;
2) Febrile diseases with the signs of respiratory failure, occurring in people travelling from SARS-affected areas within 3 weeks of the return;
3) Febrile diseases with haemorrhagic symptoms with no cause known, especially in people, who returned from abroad during the preceding 3 weeks.

The events listed in the Inspector's ordinance are:

1) Large number of cases of diseases, syndromes and deaths with a similar clinical image occurring at the same time and presenting cutaneous and/or mucosal lesions, as well as symptoms of neurological, respiratory, gastrointestinal or multisystem damage;
2) Rapid, unexpected increase in the incidence and mortality rate of known diseases and syndromes;
3) Occurrence of unidentified diseases and syndromes with a previously unreported clinical image;
4) A single case of a disease caused by a factor usually absent in the local population and occurring in a person, who did not travel abroad in the preceding period;
5) Observed inefficiency of the routine treatment administered in common diseases;
6) Genetically similar etiology of pathogens isolated from sources remote in time and distance;
7) Occurrence of a disease in an unusual period and geographic location;
8) Observation of symptoms atypical for a given pathogen in multiple patients;
9) Occurrence of many foci of food poisoning, expanding beyond one region.
10) Atypical transmission of well-known diseases;
11) Unexplained, epidemic growth of a disease considered endemic;
12) Isolation of an unusual, atypical infection factor, suspected of being genetically modified or obtained from sources considered as inactive;
13) Simultaneous occurrence of foci of similar diseases in nonadjacent areas of the same or different countries.

Several rules may be formed based on the above mentioned guidelines. The main rule presumes that every person exposed to a biological attack should be considered infected. As pathogen transmission needs to be limited, it is necessary to introduce an epidemiological regime at every stage of medical evacuation, transport and care.

3. Procedures in the case of biological attack

As stated above, all actions taken in the case of a putative or confirmed act of terrorism using biological weapons of mass destruction should be based on previously established and exercised procedures. Efficient flow of information between the public services involved in rescue operations is essential for effective crisis management [2,4,6]. To this end, apart from implementing a functional communication system, it is vital to develop a coherent set of procedures for all rescue services [7] and related institutions, defining the range of competence of each unit, ways of communication and actions to be taken on a given type of event (involving different procedures for chemical and biological events and for large-scale accidents in road or rail transport).

Plans of protection against bioterrorist attacks should cover e.g. methods of obtaining vaccines, sera and antibiotics, lists of available medical equipment, means of medical transport and distribution of patients in appropriate medical centres [4,8].

4. Triage of victims of biological attack

Procedures applied on an event of use of biological weapons of mass destruction, either in an isolated incident or a large-scale terrorist operation, cause rescue services to work under pressure and in extremely difficult conditions. Rescuers, often providing the first-line pre-hospital care, should be aware that their approach to work under biological hazard is different from, for example, that performed under chemical hazard [9].

Segregation of victims under biological hazard is different from that conducted in the case of natural disasters or large-scale transport accidents, but also different from the triage performed in catastrophes caused by other than biological factors [8,11]. In the case of biological hazards, medical segregation depends mainly on how much time has passed from the patient's exposure to the biological agent to the moment of occurrence of general symptoms, including those exhibited by the respiratory and nervous system, toxicoinfections with blood clotting disorders or haemorrhagic fevers.

Population exposed to the risk factor may be divided into five groups:

1) people potentially infected (including those unvaccinated);
2) people infected;
3) people with symptoms and asymptomatic carriers;
4) people, who have been subjected to infection and are not carriers;
5) people, who have been vaccinated [8].

Another classification is based on the course of the disease as a result of exposure to the pathogens used in a bioterrorist attack. The method, which divides the population into four grades characterizing the course of infection, is presented in Table 1.

Table 1: Course of a disease induced by a biological agent.

Grade of the disease	Description
Grade I	Mild course, usually in the form of rash or flu-like symptoms, not requiring immediate medical intervention;
Grade II	Moderate course in the form of flu-like symptoms and concurrent problems with specific organs; no immediate life threat, however, there is a risk of disease advance, therefore patients require medical attention and evacuation to hospitals or observational epidemiology units;
Grade III	Severe course; life threat present, poor prognosis of survival if no specialist treatment (intensive care and therapy) in a multi-profile medical facility is undertaken;
Grade IV	Usually poor prognosis due to very severe course; patients require immediate medical rescue to stabilize their vital signs.

5. Disinfection procedures

Disinfection procedures in people exposed to biological warfare agents should be performed as quickly as possible by specialized units (e.g. Biological Defence Battalion of Polish Armed Forces) [10]. All procedures should be performed at level A. According to the rule, that every person present in the area exposed to biological agents is considered potentially infected, every such person has to undergo complete disinfection, while all rescuers providing medical care in that area should be equipped with personal protection measures preventing infection (Figure 1) [11,13,14].

Figure 1: Example of an airway protection method.

6. Medical evacuation

Efficient medical evacuation of the victims helps to prevent pathogen spreading, i.e. reduces the number of potentially infected people. Poland's accession to NATO resulted in the introduction of both military and civilian universal procedures, applied in all member states. According to the procedure of medical evacuation of biological attack victims (STANAG 2068), three levels of evacuation may be distinguished (levels A,B and C) [15]. Within those three levels, there are four types of rescue *Roles* differing in the level of provided medical care.

Pre-medical care provided by the event witnesses or paramedics is characteristic of *Role 1*. *Role 2* involves more complicated interventions, including: evacuation from "dirty" areas (exposed to biological agents) to "clean" areas, preliminary segregation of victims, disinfection procedures, preliminary medical care and preparation of patients for further evacuation. In the case of impairment of vital signs (circulatory or respiratory failure), medical rescue procedures are applied to restore those functions.

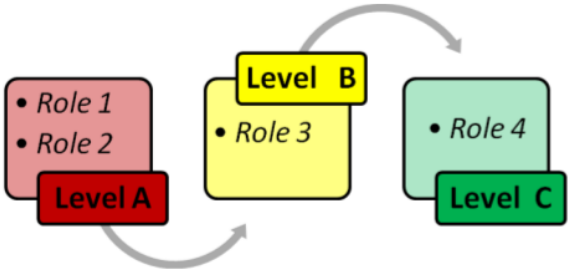

Figure 2: Medical evacuation scheme according to STANAG 2068.

Role 3 comprises observational epidemiology units of stationary hospitals or field hospitals treating infectious diseases. Further patient segregation, application of appropriate therapy and laboratory diagnostics are performed in those units. The Pulawy branch of The General Karol Kaczkowski Military Institute of Hygiene and Epidemiology is an example of a Centre for Diagnostics of Particularly Dangerous Diseases in which specialist tests of potentially infected materials are performed. The facility, satisfying the BSL-3 norm for bacteriological laboratories, was included in the Global Emerging Infections Surveillance and Response System in 2010.Level C (*Role 4*) is characterized by the ability to provide medical care and specialist interventions at the level of both civilian and military clinical hospitals (Figure 2).

7. Patient transport

Potentially infected patients constitute a particular group, therefore require particular conditions during transport assisted by medical personnel [11]. Ideally, every patient suspected of being infected should be transported in full isolation from the surrounding environment, which might be provided by ambulances equipped with isolated compartments with HEPA air filters. However, it is not feasible in that case. Ambulances designated for carrying large numbers of potentially infected attack victims should be clearly marked and considered as "dirty" until complete disinfection of the vehicle's interior. This means a complete suspension of such an ambulance from routine duties, managed by emergency medical dispatcher, until disinfection occurs.

Once transported, the patient should be placed in an isolation ward [4,12]. Ideally, in this case, the ward would be equipped with an autonomous ventilation system, an airlock and a decontamination room. If the hospital does not possess such means, negative pressure isolation chambers (NPCs) may be used.

8. Conclusions

Training is a necessary, if not the most important element of rescue service preparation for the event of a bioterrorist attack. One needs to remember, that such disasters are often completely unpredictable and local population's assumption, that events like those in New York, Madrid, London or Tokyo may never happen to them, is false. What is more, biological agents used by terrorists are often difficult to detect. Symptoms of the disease may occur after some time, which, combined with atypical and misleading clinical signs during incubation period, complicates the localization of the foci of exposure to biological agents.

References:

1. Moran, G. J., D. A. Talan, and F. M. Abrahamian. „Biological terrorism." Infect.Dis.Clin.North Am. 22.1 (2008): 145-87, vii.
2. Fock, R., et al. "[Management of bioterroristic attacks with dangerous infectious agents]." Bundesgesundheitsblatt. Gesundheitsforschung. Gesundheitsschutz. 48.9 (2005): 1028-37.
3. Ustawa z dnia 26 kwietnia 2007 r. o zarządzaniu kryzysowym (Dz.U. nr 89, poz.590).
4. Terhakopian, A. and D. M. Benedek. "Hospital disaster preparedness: mental and behavioral health interventions for infectious disease outbreaks and bioterrorism incidents." Am.J.Disaster.Med. 2.1 (2007): 43-50.
5. Ziemba R. "The establishment and functioning of a enviromental pollution monitoring system." Military Pharmacy and Medicine 4(2011): 77-82.
6. Koenig, K. L., C. A. Kahn, and C. H. Schultz. "Medical strategies to handle mass casualties from the use of biological weapons." Clin.Lab Med. 26.2 (2006): 313-27, viii.
7. Ziemba R. "The cooperation with the units of national rescue system for countering threats in the elimination of the effects of threats." Military Pharmacy and Medicine 4(2011): 7-12.
8. Jenkins, J. L., et al. "Mass-casualty triage: time for an evidence-based approach." Prehosp.Disaster.Med. 23.1 (2008): 3-8.
9. Ziemba R. "First aid, antidotes, treatment and the description of physico-chemical properties of toxic industrial substances on the example of ammonia, chlorine and hydrogen chloridey." Military Pharmacy and Medicine 4(2011): 47-56.
10. Szarpak Ł. "Decontamination of victims in emergency departments." Military Pharmacy and Medicine 4(2011): 65-68.
11. Byers, M., M. Russell, and D. J. Lockey. "Clinical care in the "Hot Zone"." Emerg.Med.J. 25.2 (2008): 108-12.
12. Hope, K. G., et al. "Evaluating the utility of emergency department syndromic surveillance for a regional public health service." Commun.Dis.Intell. 34.3 (2010): 310-18.
13. Houston, M. and R. G. Hendrickson. "Decontamination." Crit Care Clin. 21.4 (2005): 653-72, v.
14. Schumacher, J., et al. "Evaluation of bag-valve-mask ventilation by paramedics in simulated chemical, biological, radiological, or nuclear environments." Prehosp.Disaster.Med. 24.5 (2009): 398-401.
15. Rega, P., K. Burkholder-Allen, and C. Bork. "An algorithm for the evaluation and management of red, yellow, and green zone patients during a botulism mass casualty incident." Am.J.Disaster.Med. 4.4 (2009): 192-98.
16. Zielinski, A. "Enhanced surveillance at mass gatherings." Przegl.Epidemiol. 63.4 (2009): 477-85.

Catastrophe Medicine

Characteristics of potential hazards such as chemical, flood and hydrometeorological to life and health occurring in the area of The Capital City of Warsaw

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Summary:

This paper details the threats to life and health in the area of the capital city of Warsaw, with particular emphasis on existing industrial plants, their production and materials stored therein. It discusses the chemical, transport, flood and hydrometeorological hazards. This paper describes in detail the causes of risks and provides their assessment. The work contains a rich set of factual data related to the characteristics of Warsaw location and threats to its citizens.

Key words: land relief of the capital city of Warsaw, chemical hazards, facilities with hazardous substances, flood and hydrometeorological hazards, risk assessment.

Warsaw is situated on the Vistula river, which involves a section of 27 km within the city. The bed of the Vistula river that runs from the southeast to the northwest divides the city in the left-bank part (Warsaw side), lying on a denudation moraine plain (altitude up to 115 m AMSL) and the right-bank part (Praga side), situated in the valley (altitude up to 90 m AMSL). The bed's width varies from 1 km in the southern part of the city, to 0.6 – 0.7 km in the northern region, where it is more compact.

The lowest natural point is at 78 m AMSL in the valley of the Vistula River at the border of the capital city of Warsaw with Winnica housing estate of Jabłonna municipality; the highest natural point is at 116 m AMSL in the south — west part of the site where the Palace of Culture and Science was build. The highest artificial point is Szczęśliwicka Hill (139 m AMSL). The average level of Warsaw area represents about 100 m AMSL.

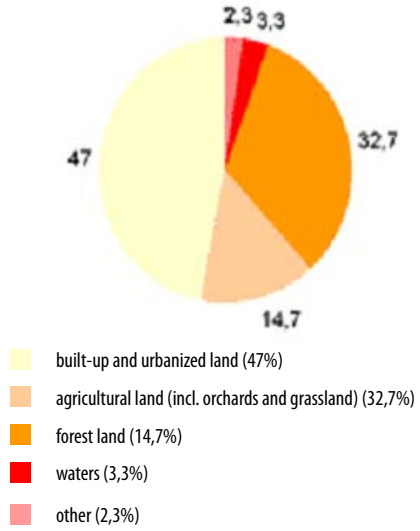

Figure 1: Warsaw area by type of use.

The Capital City of Warsaw covers an area of 518 km^2 and extends over 30 km on the north – south axis and 26 km on the east – west axis.

The Act of March 15, 2002 on the structure of the capital city of Warsaw (Journal of Laws No. 41, item 361, as amended) provides that Warsaw as the capital of the Republic of Poland is a municipality having the status of the city with county rights. It consists of 18 supporting units – the districts.

1. The boundaries of Warsaw's districts:

The boundaries of the district Warsaw-Bemowo: the south side of Kampinoska street, the south side of Ksiezycowa street, an extension of Powazkowska str., the south side of Powazkowska str., the west side of al. Armii Krajowej, the western border of the Kolo grove, the west side of the railway line crossing Górczewska str. and Połczyńska str., than continues on the section of Dzwigowa str., along the south side of the railways to Krancowa str. where it intersects Połczyńska str. by its east side and runs to Podgrodzie str., Batalionow Chlopskich str., then through the fields along Azurowa str. up to Fortowa str., garden plots, Fortowa str., Henryka Hubala Dobrzanskiego str., along its extension to Radiowa str., which intersects, and by the west side of Estrady str. to Kampinoska str.

The boundaries of the district Warsaw-Białołęka: the northern edge of the Gen. Stefan Rowecki bridge at the north along the course of the Vistula river parallel to Przyrzecze str., along Brzozowa str., Szkolna str. up to the railway Warsaw – Legionowo, along the railroad tracks to the Choszczówka station, Chlubna str. up to the edge of Choszczówka forest, the Choszczówka forest edge, a dirt road to the Bródno Canal, Kobia-lka str., Olesin str., Chudoby str., Berenson str., to the west up to a dirt road off Oknicka str., along the dirt road to Torunska Route, along the Torunska Route up to the course of the Vistula river.

The boundaries of the district Warsaw-Bielany: the course of the Vistula river, the northern edge of the Gen. Stefan Rowecki bridge, the north side of al. Armii Krajowej, the south side of Powazkowska str., an extension of Powazkowska str., the south side of Ksiezycowa str., the south side of Kampinoska str., the west side of Estrady str., Rekopis str., the west side of Kampinos National Park, Wyjsciowa str. crosses Trenow str. and along Estrady str., Pancerz str., Pulkowa str. Dziwozony str. to the Vistula river.

The boundaries of the district Warsaw-Mokotów: extension of Batory str., along Batory str., Boy – Zelenski str., the south side of Unii Lubelskiej Square, Klonowa str. Spacerowa str., Gagarin str., Podchorazych str., Czerniakowska str., southern border of MPWiK (Warsaw water supply plant) areas, the course of the Vistula river, the course of Wilanówka river, extension of Zawodzie str., the south side of Zawodzie str., the south side of Augustówka str., the north side of Goplańska str., the east side of Nemirowska str., the south side of Nałęczowska str., the east side of Sobieski str., the south side of Arbuzowa str., the west side of Przy Grobli str., the south side of al. Wilanowska, the north side of Dolina Służewiecka str., the east side of Pulawska str., the south side of al. Wyscigowa, an extension of Bokserska str., the south side of Bokserska str., an extension of Bokserska str., the west side of the railway line Warsaw – Radom, Zwirki i Wigury str.

The boundaries of the district Warsaw-Ochota: the south side of the railway line on the section Warsaw Wlochy – Warsaw West, WKD line, Al. Jerozolimskie, Chałubiński str., al. Niepodleglosci, Batory str., an extension of Batory str., Zwirki i Wigury str., the south – west side of the railway line with stations Warsaw Rakowiec and Warsaw Al. Jerozolimskie.

The boundaries of the district Warsaw-Praga-Południe: the Warsaw cross-city line, Boruty str., an extension of Boruty str., the north side of the railway line Warsaw – Siedlce running along Zabraniecka str. and Gwarkow str., to the south on the eastern side of the prison, the northern, eastern and southern border of the Olszynka Grochowska grove, the west side of Torowa str., the south – east side of Marsa str., the south side Ostrobramska str., the north – east coast of Nowa Ulga Canal, the course of the Vistula river.

The boundaries of the district Warsaw-Praga-Północ: the north side of Gen. Grot – Rowecki bridge, the north side of Toruńska str., the east

side of the railway line Warsaw – Legionowo with a station Warsaw Praga, the north side of the railway line running along the Platynowa and Naczelnikowska streets, an extension of Boruty str., Boruty str., the Warsaw cross-city line, the course of the Vistula river.

The boundaries of the district Warsaw-Rembertów: parallel to Skrajna and Powstancow streets by the northern boundary of garden plots, to Chełmżyńska str. along the northern boundary of the forest to Zolnierska str. (crossing it by the boundaries of Zabki and Zielonka community), from Kadrowa str. along the north side of Paderewski str. to Budnicza str., the west side of Mokry Lug str. to the railroad tracks, the west side of the railway line Warsaw – Tluszcz to Cyrulikow str., the northern boundary of Cyrulikow str. to Okuniewska str., than to the south along the eastern part of the forest to the extension, the north side of Korkowa str., the eastern and northern boundaries of the factory area, an extension of Gozdzikow str., the east side of Rekrucka str., the south-east side of Marsa str., the west side of Torowa str., the southern, eastern and northern boundaries of Olszynka Grochowska grove to prison, to the north (at the east side of the prison) to Gwarkow str., the north side of Gwarkow str., the east side of Scorpiona str., to the north along the western boundary of the grove to the garden plots at Skrajna str.

The boundaries of the district Warsaw-Śródmieście: the north side of the peripheral railway line on the section from the John Paul II str. to the Vistula river, the course of the Vistula river, the south boundaries of MPWiK (Warsaw water supply plant) areas, Czerniakowska str., Kadetow str., Gagarin str., Spacerowa str., Klonowa str., the south side of Unia Lubelska Square, Boy-Zelenski str., Batory str., al. Niepodleglosci, Chałubiński str., John Paul II str.

The boundaries of the district Warsaw-Targówek: the border runs through Radzymińska Mall, crosses Radzymińska str., further through garden plots, Kamrową str., Lodygowa str., Dolna str., through garden plots to Skorpiona str., the east side of Skorpiona str., an extension of Skorpiona str. to the railway line, the north side of the railway line Warsaw-Siedlce running along Gwarkow and Zabraniecka streets, the north side of the railway line running along Naczelnikowska and Plantowa streets, the east side of the railway line Warsaw-Legionowo with a station Warsaw – Praga, the north side of Torunska str. to the mall.

The boundaries of the district Warsaw-Ursus: the western boundary to the north along the railway line, from Warsaw – Skierniewice to Warsaw-Odolany, from the contact between Warsaw-Odolany railway line with Warsaw-Poznan line along the west side of the Warsaw-Poznan line to Warsaw-Skierniewice line, diagonally by the railroad tracks to Zapustna str., along the southwestern border of Zapustna str., the cemetery, Badylarska str., the west side of Badylarska str., the north side of the railway line, the northern edge of Makowa str., Bodycha str., the north side of Bodycha str., to the north from Bodycha str. several meters to the north from Gorna Droga str. Gorna Droga str. is a newly-built residential road providing access to the housing area. This street does not come up to the railway line Warsaw Skierniewice. Further on, the border runs through the fields intersecting Piastowska str., which in Piastow is called Wincenty Witos str.. Then the boundary runs along the south side of railway line (partly along Szarych Szeregow str. in Piastów) up to Noakowski str. in Piastów, further to the north the boundary runs along the western edge of the rail connector of Warsaw-Łowicz and Warsaw-Skierniewice lines. Boundaries of Ursus, Piastow na Ozarow municipality converges at the culvert under Konotopa Canal subgrade. This culvert is south of Bony str. in Ursus.

The boundaries of the district Warsaw-Ursynów: the western boundary of green areas between Karnawal and Czempińska streets, the north side of Czempinska str., the west side of the railway line Warsaw-Radom, an extension of Bokserska str., the south side of Bokserska str., an extension of Bokserska str., the south side of al. Wyscigowa, the east side of Pulawska str., the north side of Dolina Służewiecka str., the south side of al. Wilanowska, the west side of Przy Grobli str., the south side of Arbuzowa str., the top of the Warsaw Escarpment, the northern, western and southern boundaries of the Natolin Reserve Park, the top of the Warsaw Escarpment, the west side of Wczasowa str., Prawdziwka str., along the west side of Osiedlowa str., the south

side of Kuropatwy str. through Pulawska str., along garden plots, up to Gogolińska str., by the railroad tracks, garden plots to Kórnicka str., by extension of Dawidow str., the west side of the railroad tracks to S. Starzynski str., by fields to Kinetyczna str., Czempińska str.

The boundaries of the district Warsaw-Wawer: from the Vistula river along the Nowa Ulga Canal, further the section of Ostrobramska str., Marsa str., Rekrucka str. (to the east above Begonii and Starego Doktora streets), the north side of Korkowa str., the eastern border of the Mazowiecki Landscape Park, up to Letniskowa str. (on the section between Wczasowa and Wiejska streets), Wiejska str., Bruckener str., Ziarnista str., Werbeny str., crossing Wal Miedzyszyński str., to the west – the Vistula river.

The boundaries of the district Warsaw-Wilanów: the course of the Vistula river, the border crosses Wal Zawadowski str., Wloki, Sagi, Wiechy, Waflowa, Luk Drewniany streets, the top of the Warsaw Escarpment, the southern, western and northern boundaries of the Natolin Reserve Park, the top of the Warsaw Escarpment, the south side of Arbuzowa str., the east side of Sobieski str., the south side of Nałęczowska str., the east side of Nemirowska str., the north side of Goplańska str., the south side of Augustówka str., the south side of Zawodzie str., an extension of Zawodzie str., the course of Wilanówka river.

The boundaries of the district Warsaw-Włochy: the south side of the railway line Warsaw-Lowicz, the south-west side of the railway line with stations Warsaw Al. Jerozolimskie and Warsaw Rakowiec, the west side of the railway line Warsaw-Radom, the north side of Czempinska str., the western border of green areas between Karnawal and Czempińska streets, the administrative border of Raszyn municipality (eastern), and Ursus district (eastern).

The boundaries of the district Warsaw–Wola: the south-western boundary of Industrial Zoliborz built-up areas, the north side of the peripheral railway with station Warsaw-Gdanska, John Paul II str., Al. Jerozolimskie, WKD line, the south side of the railway line on the section Warsaw-Wlochy-Warsaw West, the west side of the railway line crossing Połczyńska and Górczewska streets, the west side of the Kolo grove, the north-west side of al. Armii Krajowej.

The boundaries of the Wesoła district: from the north the woodland along Okuniewska str. comprising Pl. Wojska Polskiego housing estate to Cyrulikow str. (in Rembertów district), from the west: Gajowa str., the area adjacent to Bukowa and Sosnowa streets, Wspolna str., Jagiellońska str., the woodland of the Mazowiecki Landscape Park up to Wawerska str., Wawerska str. to Kazita str., to the south-east through a wooded area of the Mazowiecki Landscape Park to the Zielony Lug Reserve, from the south: from the Zielony Lug Reserve to the border with Wiązowna municipality through land of the Mazowiecki Landscape Park to the north-east to Lublin Highway; from the east: Lublin Highway, woodlands along Lakowa str., Stanislawa Wigury str., Orla str., along the border with Wiązowna municipality(from the border with Wawer district, extension of Prabucka str., in the village of Zagorze on the level of the Neuropsychiatric Hospital for Children and Youth, the boundary turns towards Lublin Highway by an arc of 1200 m length, then by the north side of the road in the village of Majdan (Wiązowna municipality). Further on, the border runs by the east side of the Lublin Highway to the intersection with Brzeski Tract.

The boundaries of the district Warsaw-Żoliborz: the north-western boundary of the municipal cemetery, the north-west side of al. Armii Krajowej, the north side of the Gen. Grot-Rowecki bridge, the course of the Vistula river, the north side of the peripheral railway line with a station Warsaw Gdanska, the south-western boundary of Industrial Zoliborz built-up areas, the southern limit of the municipal cemetery.

2. Chemical hazards

The main source of the chemical hazards are hazardous substances occurring in more than 50 enterprises of the capital city of Warsaw.

Dangers may arise during:
- Production,
- Storage,
- Transport,
- Use, or
- Destruction (neutralization) of hazardous materials.

Table 1: Plants with high and increased risk of a serious industrial accident.

	Name and address of facility	Type of dangerous goods	Quantity/ tons/	Main threat
	Plants with a high risk of a serious industrial accident *)			
1.	ORLEN GAZ Sp. z o.o. Rozlewnia Gazu Płynnego w Warszawie – ul. Swojska 47 (LPG bottling plant)	– propane-butane	270.0	fire-explosion
	Plants with an increased risk of a serious industrial accident **)			
2.	Centrum Naukowo-Produkcyjne Elektroniki Profesjonalnej RADWAR. S.A. – ul. Poligonowa 30 (scientific and production center of professional electronics)	– very toxic, – toxic, flammable and oxidizing substances	27.8 110.5	toxic, fire
3.	Chłodnie Warszawskie MORSPOL S.A. – ul. Marywilska 26 (cooling plant)	– ammonia	100.0	toxic, fire
4.	Tarchomińskie Zakłady Farmaceutyczne POLFA – ul. Fleminga 2 (pharmaceutical plant)	– ammonia	19.0	toxic, fire
5.	PETROLOT Sp. z o.o – ul. Gordona Benetta 2	– aviation fuel	6800.0	fire-explosion
6.	Zakład Separacji Powietrza Linde Gaz. Linde Gaz Polska Sp.z.o.o – ul. Pstrowskiego 30 (air separation plant)	– oxygen	1430.0	fire-explosion
7.	Przedsiębiorstwo Handlu Chemikaliami „CHEMIA", Baza magazynowa – ul. Rzeczna 6 (chemicals trade company)	– oxidizing substances	50.0	fire-explosion

*) These plants, due to the amount of hazardous substances used, pose the greatest threat to humans and the environment in Warsaw.
**) Substances collected in the above plants pose a significant fire risk involving chemicals, as well as explosion or environmental contamination risks.

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3. Other plants with dangerous substances

Besides plants included in the group of a high or increased risk, in the city center ornear large housing estates there are plants that use hazardous chemicals in smaller quantities, but because of their location they are also a threat to humans and the environment.

Table 2: Other plants posing a risk of chemical accident.

	Name and address of facility	Type of dangerous goods	Quantity /tons/	Main threat
	Plants posing a high toxic risk			
8.	MPWiK w m.st. Warszawie S.A. Zakład Wodociągu CENTRALNEGO - ul. Koszykowa 81 (central water supply plant)	- chlorine	8.0	toxic
9.	MPWiK w m.st. Warszawie S.A. Stacja Strefowa Wodociągu Północnego - ul. Borecka 1 (water supply plant, station of the northern pipeline zone)	- chlorine	6.0	toxic
10.	MPWiK w m.st. Warszawie S.A. Zakład Wodociągu Praskiego - ul. Brukselska 21 (water supply plant, Praga pipeline)	- chlorine	4.8	toxic
11.	Warszawski Ośrodek Sportu i Rekreacji. Tor Łyżwiarski „Stegny" - ul. Inspektowa 1 (Warsaw sport and recreation center, skating track)	- ammonia	9.5	toxic, fire
12.	Zakłady Przemysłu Tłuszczowego - ul. Radzymińska 122/124 (fat processing plant)	- ammonia	7.0	toxic, fire

	Name and address of facility	Type of dangerous goods	Quantity /tons/	Main threat
13.	DANONE Sp z o.o - ul. Redutowa 9/23	- ammonia	6.0	toxic, fire
14.	Zakłady Mechaniczne PZL-WOLA SA. - ul. Fort Wola 22 (mechanical plant)	- ammonia	4.3	toxic, fire
15.	Chłodnia Przemysłowo-Handlowa „MORS-POLO" - Al. Prymasa 1000-lecia 62 (cooling plant)	- ammonia	3.1	toxic, fire
16.	SERWAR Sp. z o.o. - ul. Hoża 51 (cheese production)	- ammonia	0.8	toxic, fire
	Plants posing a high risk of fire			
17.	PW Hestia - ul. Połczyńska 10	- pyrotechnic materials	80.0	explosion
18.	DAEWOO-FSO MOTOR - ul. Jagiellońska 88	- petrol. oil - paints. varnishes - solvents - acids	~144 ~40 ~20 14.0	high fire-explosion risk
19.	P. Z. Cussons Polska S.A. - ul. Szwedzka 20	- ethanol - abs acid - propane butane - triethylamine	30.0 18.0 20.0 2.5	flammable, corrosive, in case of fire posing a threat to humans and the environment
20.	Warszawska Fabryka Farb Graficznych S.A. - ul. Kawęczyńska 1 (ink factory)	- acetone - ethanol - isopropanol - ethyl acetate	3.4 20.0 23.0 10.0	high fire risk
21.	Fabryka substancji zapachowych POLLENA-AROMA - ul. Klasyków 10 (perfume factory)	- benzyl chloride - chloroform - ethanol - methanol - acetic anhydride	6.0 30.0 40.0 52.0 20.0	high fire risk, toxic compounds may be formed during a fire
22.	The State Mint S.A. - ul. Pereca 21	- ammonia - acids - bases - flammable substances	0.1 7.2 6.5 7.5	high fire and toxic risk
23.	Polish Security Printing Works S.A. - ul. Sanguszki 1	- solvents - sulphuric acid - sodium hydroxide - hydrogen peroxide	~40 7.2 12.0 14.5	high fire risk, corrosive, toxic compounds may be formed during a fire
24.	Warsaw Pharmaceutical Plant "Polfa" S. A. - ul. Karolkowa 22/24	- nitroglycerin on lactose - acetone - propylene glycol - ethanol	1.1 0.6 4.2 3.5	high fire-explosion risk
25.	MPWiK w m.st. Warszawie S.A. Zakład Oczyszczalni Ścieków "CZAJKA" - ul. Czajki 4/6 (wastewater treatment plant)	- biogas - pix (ferric coagulant)	10000m^3 50	high fire and toxic risk
26.	KORAM ZZM POLAND Sp.z o.o. - ul. Annopol 4 (production of plastic components)	- isocyanate	20.0	toxic compounds are formed during a fire (hydrogen cyanide, phosgene)
27.	Gas stations	- petrol - gas		fire-explosion

	Name and address of facility	Type of dangerous goods	Quantity /tons/	Main threat
	Other plants using hazardous chemicals			
28.	Procter Gamble Operations Polska S.A. - ul. Zabraniecka 20	- sodium hypochlorite - sodium hydroxide	49.0 30.0	Different types of chemicals posing a local threat (on site)
29.	Warszawskie Zakłady Przemysłu Nieorganicznego STOCHEM - ul. Strażacka 89 (inorganic industry plant)	- nitric acid - phosphoric acid	20.0 20.0	
30.	Elektrociepłownie Warszawskie S.A. EC Żerań - ul. Modlińska 15 (heat plant)	- sulphuric acid - hydrochloric acid - sodium hydroxide - sodium hypochlorite - sodium chlorite - minced lime	100.0 150.0 50.0 5.0 2.0 25.0	
31.	Huta L.W. Sp. z o.o. - ul. Kasprowicza 132 (steel mill)	- suplhuric acid - nitric acid	100.0 10.0	
32.	Warszawskie Zakłady STOMIL - ul. Grochowska 9 (rubber processing plant)	- sodium fluosilicate - potassium hydroxide	1.6 6.0	
33.	Elektrociepłownia SIEKIERKI S.A. - ul. Augustówka 1 (heat plant)	- hydrochloric acid - sodium hydroxide	350.0 280.0	
34.	Polskie Zakłady Optyczne - ul. Grochowska 316/320 (optical factory)	- acetone - methylated spirits	1.2 1.3	
35.	CEMAT - SILIKON S.A. - ul. Wólczyńska 133 (manufacture of electronic valves, tubes and other electronic components)	- hydrofluoric acid - nitric acid >70%	0.4 1.0	
36.	Centralny Ośrodek Sportu - ul. Łazienkowska 6 a (sport center)	- ethylene glycol - freon	66.0 0.3	
37.	EADS PZL Warszawa Okęcie S.A. - Al. Krakowska 110/114 (aircraft manufacturer)	- acids - cyanides	3.0 0.1	
38.	IMP-BUD FIVE Sp. z o.o. - ul. Duchnicka 3 (steel construction, heat treatment, electroplating, machining, welding)	- acids - cyanides - sodium hydroxide	1.4 0.1 0.5	
39.	Institute of Biochemistry and Biophysics of the Polish Academy of Sciences - ul. Pawińskiego 5 a	- liquid nitrogen - flammable substances	4.0 1.2	
40.	Institute of Organic Chemistry of the Polish Academy of Sciences - ul. Kasprzaka 44/52	- solvents - concentrated acids - concentrated bases - oxidizing materials	2300.0 250.0 150.0 30.0	
41.	Pharmaceutical Institute - ul. Rydygiera 8	- methanol - ethyl acetate - chemical reagents	1.0 0.5 ~0.5	
42.	Institute of Precision Mechanics - ul. Duchnicka 3	- cyanides	~0.1	
43.	Tele and Radio Research Institute - ul. Ratuszowa 11	- chemicals (different)	~1.0	
44.	State Geological Institute - ul. Rakowiecka 4	- acids	0.4	

	Name and address of facility	Type of dangerous goods	Quantity /tons/	Main threat
45.	Pharmaceutical company "ANPHARM" S.A. - ul. Annopol 6	- ethylene glycol - chemical reagents	5.7	Different types of chemicals posing a local threat (on site
46.	Warsaw Welding Equipment Factory "PERUN" - ul. Grochowska 301/305	- acids - chemical reagents	1.3	
47.	Documentary and Feature Film Production Company WFDiF - ul. Chełmska 21	- anhydrous ammonia	0.4	

4. Other sources of chemical hazards

4.1. Road transport

Due to the absence of ring road in Warsaw hazardous substances are transported by the main streets, where there is a heavy traffic and a high risk of failure of the vehicle carrying the hazardous chemicals or other communication accident with its participation.

The substances mostly transported in Warsaw are:
- Chlorine – 446 tons;
- Ethyl alcohol – 82.5 tons;
- Sodium hydroxide – 23 tons;
- Ferrosilicon – 22 tons;
- Potassium nitrate – 20 tons;
- Ammonia – 2.2 tons;
- Dimethylamines – 2.6 tons (data from the Municipal Headquarters of the State Fire Service, annual transport).

4.2. Rail transport

Shipments of hazardous materials, coming into the city of Warsaw in compact drafts of cars, i.e. with one type of goods, are transported directly to the destination station:
- Warszawa Wschodnia (Warsaw East),
- Warszawa Główna Towarowa (Warsaw Main – Commodity),
- Warszawa Okęcie.

From these stations shipments go to adjacent sidings, whose users are usually the recipients of the goods.Shipments of dangerous goods transported in a distributed system (trains with different goods, not only dangerous, for different recipients) come to a transfer station Warsaw Praga, from where they are directed to the shunting stations: Warsaw East, Warsaw Main – Commodity, as well as outside the area serviced by the Freight Department in Warsaw.

5. Flood and hydrometeorological threats

5.1. Flood hazards

The Vistula river creates the greatest risk of flooding for Warsaw, due to its size and number of water borne; and the average degree of risk is created by:
- Dluga river,
- Wilanówka river,
- Służewiecki Potok (Sluzewiec Stream).

5.2. The Vistula River

Characteristics of the river in Warsaw
- mileage in the profile Warsaw Port of Praga: at the 513.3 km of the Vistula river,
- length within the city 32 km (at the 497 – 529 km of the Vistula river).

5.2.1. Characteristics of flood control structures.

In Warsaw, the Vistula is surrounded by levees and road embankments performing the function of the levees. The total length of these structures is about 57 km. Embankments of other courses have a length of about 12 km and they are: the levee of the Jeziorka river – 5.6 km and the levee of Dluga river – 5.5 km.Due to the nature of protected areas all Warsaw embankments belong to the highest 1st class of importance.

The current state of levees does not provide complete flood protection.
On the right bank, a total of 4.3 km of levees require improvement:
- **because of its location on the permeable soil which creates the possible filtration of water flooded into the area protected by levee:**
  - Wał Miedzeszyński (Miedzeszynski Levee), Wawer, area of Cyklamenow str.,

- Wał Miedzeszyński, Wawer, area of Jeziorowa str.,
- Wał Miedzeszyński, Wawer, the middle section of Jeziorowa and Bronowska str.,
- Wał Miedzeszyński, Wawer, area of Kadetow str.
- Wał Miedzeszyński, Wawer, area 250 m south of Kosmatki str.
- Wał Golędzinowski, Praga North, 900 m section of the levee, from Wybrzeze Helskie str. to Batalion Platerówek str.

• **because of the proximity of old river bed, allowing water filtration through the ground:**
- Wał Miedzeszyński, Wawer, 150 m section of the levee, area of Skalnicowa str.,
- Wał Miedzeszyński, Wawer, 100 m section of the levee, between Chodzieska and Jeziorowa str.,
- Wał Miedzeszyński, Wawer, 770 m section of the levee, between Kadetow str. up to 200 m south of Wojsławicka str.

• **because of the insufficient height of the levee:**
- the beginning of Wał Miedzeszyński – at the 501.0 km of the Vistula river,
- Wał Miedzeszyński, the culvert area at the mouth of Nowa Ulga Canal at Kosmatki str.,
- a distance between the Poniatowski Bridge (from Sokola str. – at 512.25 km) and the Gdanski Bridge (up to 200 m north of Ratuszowa str. – at the 515.00 km of the Vistula river), there are: diametral levee and an embankment forming Wybrzeze Helskie str. The lowest ordinate of the crown of diametral levee = 84.80 m AMSL – i.e. 0.9 m too low in relation to the required height of the levee – occurs between Okrzei and Ks. Kłopotowskiego streets at the 513.85 km of the Vistula river.

• **there are also three points posing a potential danger of water entering the area protected by the levee**:
- Wał Miedzeszyński at the 6 675 m, Praga South between Algierska and Sosabowski streets – the bottom of culvert is below the level of the 1000-year flood (exceedance probability Pe = 0.1%), i.e. 959 cm on the water gauge in the Praga Port,
- Wał Miedzeszyński at the 6 950 m, Praga South between Algierska and Sosabowski streets – the bottom of culvert is below the level of the 1000-year flood (Pe = 0.1%),
- Wał Miedzeszyński at the 6 985 m, Praga South between Algierska and Sosabowski streets – the bottom of culvert is below the level of the 1000-year flood(Pe = 0.1%).

On the left bank of the Vistula 5 [km] of levees require modernization.

- Wał Moczydłowski, Wilanów, the levee section with a length of 1800 m, between the 3300 and 5100 meter of the levee, from the level of Pretowa str. To Wloki str. – the area of the Siekierki Heat Plant ash landfill, the slope of the levee from the river at risk of losing stability,
- Wał Moczydłowski, Wilanów, the levee section with a length of 950 m, between the 7750 and 8800 meter of the levee, 450 m south and 500 m north of Glebowa str., the river flows at the distance of 30 – 50 m from the slope of the levee, in case of flood there is risk of slope erosion,
- Wał Moczydłowski, Wilanów, the levee section with a length of 500 m from Syta str. To the north, between the 9100 and 9600 meter of the levee, the levee's slope may lose its stability as a result of soil erosion,
- Wał Moczydłowski, Wilanów, the levee section with a length of 660 m, between the 9100 and 9760 meter of the levee, bad state of the levee's slope protection, there is possible that soil will be washed out from the slope,
- places where the crown of the levee is lower than required:
  - Wał Śródmiejski, opposite the entrance to the Port of Praga, the crown elevation 85.85 m AMSL, 10 [cm] above the water level Pe = 0.1% (a 1000-year level = 959 cm in the Port of Praga), about 20 cm too low,
  - Wał Buraków – Kazuń, at the 525.85 – 528.00 km of the Vistula, the crown elevations 82.40 m AMSL, up to 20 cm below the water level Pe = 0.1% (a 1000-year level = 959 cm in the Port of Praga), i.e. up to 50 cm too low in relation to the requirements.

The above assessment of levees situation was developed by Hydroprojekt Warszawa Sp. z o.o. in 2000 for the Warsaw-Centre municipality contract No. 493/N. The assessment was published in the paper entitled «Computer map of the flood risk coverage in the capital city of Warsaw".

Table 3: Characteristics of the levees at the left bank of the Vistula River in the capital city of Warsaw.

NAME OF THE LEVEE	CLASS	Description (pp – a culvert, pj – overpass, wj – entrance, s – stairs, śl - lock, uw – water intake)	The Vistula mileage [km]	Levee mileage [m]	Description	Crown elevation [m AMSL Cr]	Height [m]	Width of the crown [m]
MOCZYDŁOWSKI	I	beginning; pj	493.8	0 000		90.60	average 4.25	minimum 2.5; maximum 3.6
		s		0 170				
		s		0 420				
		s		0 820				
		pj		0 980				
		s		1 580				
		pj		1 850				
		s		2 360				
		s		2 440				
		The border of Warsaw; pj	497.3	2 900			average 5.0; maximum 7.5	minimum 3.2; maximum 5.0
		s		3 090				
				3 300	Lack of the upstream slope stability at the level of the Siekierki Heat Plant ash landfill			
		pj		3 550				
		pj		5 100				
				7 750	Distance of the River from the foot of the levee 30 – 50 [m]			
		pj		8 150				
		s		8 190				
				8 800				
				9 100	Possible loss of stability through washout; Bad state of protections			
		śl		9 410				
		uw		9 220	Siekierki Heat Plant			
				9 600				
		pj	504.5	9 760	Permeable subsoil			
		End; pj	505.0	9 800				
SIEKIERKOWSKI	I	beginning; pj	505.0	9 800			average 5.0	minimum 3.0; maximum 4.8
		s		11 160				
		s		11 470				
		pj		11 760				
		pj		12 400				
		s		12 890				
		pj		13 110				
		End	509.5	13 750				
CZERNIAKOWSKI	I	beginning	509.5	13 750			average 5.25	minimum 3.0
		pj		13 800				
		uw		14 190	MPWiK			
		pj		14 380				
		End	510.3	14 700				
ŚRÓDMIEJSKI	I	beginning	510.3	14 700				minimum 7.3; maximum 18.0
		s		15 150				
		End	510.9	15 460		86.6		

NAME OF THE LEVEE	MOCZYDŁOWSKI				SIEKIERKOWSKI	CZERNIAKOWSKI	ŚRÓDMIEJSKI
CLASS	I				I	I	I
Width of the foot [m]							
Section number		IM 1	IM 2	IM 3 / IM/S 4			
The amount of materials needed to strengthen the levee w – sandbags [pcs] f – foil [m²] ł – filtration fabric [m²]		w = 27 960 f = 36 000	ł = 3 800; rock filling	IM3;m; w = 12 000 f = 13 200 IM/S4: a) w = 1840 ł = 640; b) w = 3 280 ł = 1 280			
Protected areas	Wlanów, Sadyba, Dolny Mokotów (Siekierki Heat Plant + ash landfill, Central Waterpipe intake						
Area [km²]	65.20						

The detailed description of levees is presented in Tables 3 and 4:

Marked in yellow are levees sections where water may enter the area behind the levee as a result of filtration through a permeable body of levees or through permeable soils in the subsoil.

Marked in blue are levee sections located near the former old river beds where the ground creates favorable conditions for water filtration.

Marked in red are places where the crown of the levee does not meet the high requirements (is too low).

cont. of Table 3

NAME OF THE LEVEE	POTOCKI		MŁOCIŃSKI	
CLASS	I		I	
beginning	end	beginning	end	
The Vistula mileage [km]	515.8	521.4	523.3	524.8
Levee mileage [m]	0.0	5600	0.0	1300
Crown elevation [m] AMSL Cr	86.50	83.91	84.83	83.88
Height [m]	Average 3.5		Average 2.8	
Width of the crown [m]	4.0		3.8	
Protected areas	Żoliborz		Bielany	
Area [km²]	2.60		1.20	

Table 4: Characteristics of the levees at the right bank of the Vistula River in the capital city of Warsaw.

NAME OF THE LEVEE	CLASS	DESCRIPTION pp – a culvert pj – overpass wj – entrance s - stairs	The Vistula mileage [km]	Levee mileage [m]	Description	Crown elevation [m AMSL Cr]	Height [m]	Width of the crown [m]	Width of the foot [m]	Section number
MIEDZESZYŃSKI	I	End	511.8	9 910		87.65	maximum 5.58; average 4.00; minimum 2.50	Levee: high 3.88 – 6.00; low 2.13 – 4.05; section of the paved road 43.78 – 50.16		
		Retaining Wall length 480 [m]		8100 - 8580						
		w		8 020						
		s		7 950						
		w		7 750						
		s		7 310						
		w		7 270						
		w		7 075						
		pp		6 985	bottom below the level of a 1000-year water 0.1%					pM 12
		pp		6 950						
		w		6 750						
		pp		6 675	bottom below the level of a 1000-year water 0.1%					pM 11
		s		6 600						
		pj		6 120	the crown too low					pM 10
				6 095						
		s		5 910						
		w		5 490						
		s		5 470						
		pp Nowa Ulga Canal, Pumping stadion Bluszcze		5 450	the crown too low					pM 9
		s		5 350						pM 8
				5 200	sand in the subsoil					
		s		5 000						
		pj		4 850						
		s		4 650						
				4 570	sand in the subsoil					pM 7
				4 400	the old river bed					
		pj		4 370						
				4 300						
				4 000						
		pj		3 995						
				3 940						
				3 630						
		s		3 620						
				3 520	sand in the subsoil					pM 6
		pp		3 260						
		s		2 970						
		pj		2 860						pM 5
				2 500	sand in the subsoil					
		pj		2 350						
		pp		2 270						
				2 020	sand in the subsoil					pM 4
				1 950	the old river bed					
				1 850						
		pj		1 610						
				1 150	the old river bed					pM 3
				1 000						
		pj		0 860						
				0 065	sand in the subsoil					pM 2
		Beginning	501.0	0 000	the crown too low	88.57				pM 1

The amount of materials needed to strengthen the levee w – sandbags [pcs] f – foil [m²] ł – filtration fabric [m²]	W = 800	a) w = 783; ł = 26; b) w = 1515; ł = 52	a) w = 5658; ł = 1950; b) w = 10940; ł=3900		a) w =6441; ł =1976 b) w =12455; ł=3952		a) w = 783; ł = 26 b) w =1515; ł = 52		a) w = 783; ł = 26 b) w = 1515; ł = 52		a) w = 35 283 ł = 12 220 b) w = 68 215 ł = 24 440		a) w = 783; ł = 26 b) w = 1515; ł = 52		w = 1 000		w = 1 400		w = 16		w = 16	
Protected areas	Saska Kępa, Gocław, Zbytki, Kuligów, Wólka Zerzeńska																					
Area [km²]	18.20																					

cont. of Table 4.

NAME OF THE LEVEE	ŚREDNICOWY					GOLĘDZINOWSKI				RAJSZEWSKI			
	WYBRZEŻE SZCZECIŃSKIE			WYBRZEŻE HELSKIE									
CLASS	I					I				I			
DESCRIPTION	beginning	The railway bridge	end	beginning	end	beginning			end	beginning			end
The Vistula mileage [km]	511.8	512.3		513.9	515.8	515.8	516.0	516.9	518.6	518.6	520.5	522.6	528.9
Levee mileage [m]	0.0	450		2050	3600	0.0			4490	0.0			1102
Description	Poniatowski Bridge	The railway bridge, Pumping station Zieleniecka	Śląsko – Dąbrowski Bridge		Gdański Bridge	Gdański Bridge	Permeable ground in the subsoil		Grot – Rowecki Bridge	Grot – Rowecki Bridge	Lock of Żerań Canal	Adjacent ash landfill of Żerań Heat Plant	
Crown elevation [m AMSL Cr]	86.55	86.30	85.26		85.50	86.30			85.26	84.75			82.20
Height [m]	Average 5.0					Average 4.0				Average 3.5			
Width of the crown [m]	Average 12.0					Average 13.0				Average 4.0 – 5.8			
Width of the foot [m]													
Section number						pM 13							
The amount of materials needed to strengthen the levee w – sandbags [pcs] f – foil [m²] ł – filtration fabric [m²]						a) w = 33 783 ł = 11 700 b) w = 65 315 ł = 23 400							
Protected areas										Housing estates: Żerań, Tarchomin, Nowotwory, Kępa Tarchomińska, Dąbrówka, Henryków			
Area [km²]	24.60									24.5			

cont. of Table 4.

NAME OF THE LEVEE	SITOWIE	
CLASS	III	
DESCRIPTION	beginning	end
The Vistula mileage [km]	499,8	499.5
Levee mileage [m]	0.0	300
Area [km^2]	0.11	

Source of tables 3 and 4: Own calculations on the basis of the levees' characteristics contained the paper entitled «Computer map of the flood risk coverage in the capital city of Warsaw" prepared by HYDROPROJEKT WARSZAWA S. A.

Table 5 summarizes the amount of material needed to protect vulnerable sections of levees color-marked in **Table 3.** (Characteristics of the levees at the left bank of the Vistula river in the capital city of Warsaw) and **Table 4.** (Characteristics of the levees at the right bank of the Vistula river in the capital city of Warsaw)

The colors in this table represent methods of strengthening the individual sections of the levees.

- Strengthening the places that necessarily require it.
- Strengthening the places that necessarily require it + additional strengthening of adjacent space increasing the degree of protection.
- Strengthening the places that necessarily require it, when replacing 65% of andbags by sand coverage.

Table 5: List of materials needed to protect the levees.

Section No.	Name of the levee	Bank	Levee's mileage [m]	Section length [m]	Cause of risk	Protection method	Material:			
							sandbags [pcs]	Filtration fabric [m^2]	foil [m^2]	sand [m^3]
pM 1	Miedzeszyński	right	0 - 20	~ 20	the crown too low ~ 1 [m]	Danish wall 10 layers of 10 [cm] each	~ 800	0	~70	~ 20
pM 2	Miedzeszyński	right	55 - 75	~ 20	sand in the subsoil	a) the area of about 13 [m] width behind the levee covered by filtration fabric loaded with bags	~ 783	~ 260	0	~ 15.7
						b) as in a) + protection of a downstream slope	~ 1515	~ 520	0	~ 30,3
						c) the area of about 13 [m] width behind the levee covered by filtration fabric and soil	0	~ 280	0	~ 78
pM 3	Miedzeszyński	right	1000-1150	150	the old river bed, possible filtration through the subsoil	a) the area of about 13 [m] width behind the levee covered by filtration fabric loaded with bags	~ 5658	~ 1950	0	~113.16

Section No.	Name of the levee	Bank	Levee's mileage [m]	Section length [m]	Cause of risk	Protection method	Material:			
							sandbags [pcs]	Filtration fabric [m²]	foil [m²]	sand [m³]
pM 3	Miedzeszyńsk	right	1000-1150	150	the old river bed, possible filtration through the subsoil	b) as in a) + protection of a downstream slope	~10940	~3900	0	~218.8
						c) the area of about 13 [m] width behind the levee covered by filtration fabric and soil	0	~2100	0	~ 630
pM 4	Miedzeszyński	right	1850-2020	170	the old river bed and sand, possible filtration through the subsoil	a) the area of about 13 [m] width behind the levee covered by filtration fabric loaded with bags	~6441	~2210	0	~128.82
						b) as in a) + protection of a downstream slope	~12455	~3952	0	~249.1
						c) the area of about 13 [m] width behind the levee covered by filtration fabric and soil	0	~2380	0	663
pM 5	Miedzeszyński	right	2490-2510	~ 20	sand in the subsoil	a) the area of about 13 [m] width behind the levee covered by filtration fabric loaded with bags	~783	~260	0	~ 15.7
						b) as in a) + protection of a downstream slope	~1515	~520	0	~ 30,3
						c) the area of about 13 [m] width behind the levee covered by filtration fabric and soil	0	~ 280	0	~ 78
pM 6	Miedzeszyński	right	3510-3530	~ 20	sand in the subsoil	a) the area of about 13 [m] width behind the levee covered by filtration fabric loaded with bags	~783	~260	0	~ 15.7

Section No.	Name of the levee	Bank	Levee's mileage [m]	Section length [m]	Cause of risk	Protection method	Material:			
							sandbags [pcs]	Filtration fabric [m²]	foil [m²]	sand [m³]
pM 6	Miedzeszyńsk	right	3510-3530	~ 20	sand in the subsoil	b) as in a) + protection of a downstream slope	~1515	~520	0	~ 30,3
						c) the area of about 13 [m] width behind the levee covered by filtration fabric and soil	0	~ 280	0	~ 78
pM 7	Miedzeszyński	right	3630-4570	940	the old river bed and sand (4570 m), possible filtration through the subsoil	a) the area of about 13 [m] width behind the levee covered by filtration fabric loaded with bags	~35283	~12220	0	~705.66
						b) as in a) + protection of a downstream slope	~68215	~24440	0	~1364.3
						c) the area of about 13 [m] width behind the levee covered by filtration fabric and soil	0	~13160	0	~3666
pM 8	Miedzeszyński	right	5190-5210	~ 20	sand in the subsoil	a) the area of about 13 [m] width behind the levee covered by filtration fabric loaded with bags	~783	~260	0	~ 15.7
						b) as in a) + protection of a downstream slope	~1515	~520	0	~ 30,3
						c) the area of about 13 [m] width behind the levee covered by filtration fabric and soil	0	~ 280	0	~ 78
pM 9	Miedzeszyński	right	5400-5500	100	the crown too low 0.36 [m]	single wall 4 layers up to 10 [cm]	1000	0	0	20
pM 10	Miedzeszyński	right	6095-6120	35	the crown too low ~ 1 [m]	Danish wall 10 layers of 10 [cm] each	~1400	0	0	~35

Section No.	Name of the levee	Bank	Levee's mileage [m]	Section length [m]	Cause of risk	Protection method	Material:			
							sandbags [pcs]	Filtration fabric [m^2]	foil [m^2]	sand [m^3]
pM 11	Miedzeszyński	right	6675		bottom of the culvert below the water level P_e = 0.1%	blockage of the culvert Ø ~ 1 [m] with the sandbags	~16	0	0	~0.4
pM 12	Miedzeszyński	right	6950		bottom of the culvert below the water level P_e = 0.1%	blockage of the culvert Ø ~ 1 [m] with the sandbags	~16	0	0	~0.4
pM 13	Miedzeszyński	right	6985		bottom of the culvert below the water level P_e = 0.1%	blockage of the culvert Ø ~ 1 [m] with the sandbags	~16	0	0	~0.4
pM 14	Miedzeszyński	right	516-516.9 km of the Vistula	900	permeable grounds in the subsoil	a) the area of about 13 [m] width behind the levee covered by filtration fabric	~33783	~11700	0	~675.66
						b) as in a) + protection of a downstream slope	~65315	~23400	0	~1306.3
						c) the area of about 13 [m] width behind the levee covered by filtration fabric and soil	0	~3780	0	~3510
IM 1	Moczydłowski	left	3300-5100	1800	Lack of stability in the upstream slope	cover the upstream slope with foil and rows of sandbags	~27960	0	~36000	~559.2
IM 2	Moczydłowski	left	7750-8800	950	distance of the river from the levee's foot 30-50 [m]	cover the costal slope with the fleece and stones	0	~3800	0	~
IM 3	Moczydłowski	left	9100-9760	660	Bad protection of the upstream slope	cover the upstream slope with foil and rows of sandbags	~12000	0	~13200	~240

Section No.	Name of the levee	Bank	Levee's mileage [m]	Section length [m]	Cause of risk	Protection method	Material:			
							sandbags [pcs]	Filtration fabric [m²]	foil [m²]	sand [m³]
IM 4	Moczydłowski/ /Siekierkowski	left	9760-9800	40	permeable subsoil	a) the area of about 16 [m] width behind the levee covered by filtration fabric loaded with bags	~1840	~640	0	~36.8
						b) as in a) + protection of a downstream slope	~3280	~1280	0	~65.6
						c) the area of about 16 [m] width behind the levee covered by filtration fabric and soil	0	~680	0	~192
Strengthening the places that necessarily require it						NECESSARY QUANTITY	129345	29760	49270	2598.3
Strengthening the places that necessarily require it, when replacing 65% of sandbags by sand coverage						Necessary quantity – c) method Sand coverage instead of bags	43208	27660	49270	9848.4
Strengthening the places that necessarily require it + additional strengthening of adjacent space increasing the degree of protection						Necessary quantity protection of the base + slopes of levees	209473	63492	49270	4200.7

5.2.2. Causes of hazards

The raise of water level in the Vistula can be caused by:

- Intense rainfall in the basin of the Upper and Middle Vistula. Throughout the plains dangerous rise of water occurs after rainfall of 60 – 80 mm within 2 hours, and 30 mm in the mountains. The threat of flooding as a result of rainfall usually occurs from June to September;
- The rapid melting of snow cover in the basin of the Upper and Middle Vistula.It's favored by rapid warming with a simultaneous rainfall and the frozen ground, which causes rapid surface runoff. This occurs most often from the second half of February to the first decade of April;
- Ice and sludge congestions. Sludge congestions appear usually in December and January during sudden, large temperature drops (up to – 10 ° C), the accumulated mass of sludge under ice cover blocks the river bed in the area of small flow of water.
- Ice congestions occur most often in the second half of February and in March, in places convenient for accumulation of floating ice, i.e. in the narrow places, sandbanks, islands, places of a sudden change in flow direction and on the bridge profiles;
- In Warsaw section of the Vistula the places particularly at risk of congestion are: Wysoczyzn (464 – 465 km), Brzumin (468 – 469 km), Radwanków (473 km), the mouth of Swider river at Dębina (483 – 491 km), the mouth of Jeziorka river at Kepa Zawadowska (493 – 498 km),

Nowy Dwor Mazowiecki – Łomianki – Buchnik (520 – 545 km).

- Swelling of water level at the obstacles. The obstacles in the riverbed, such as compact groups of trees, bushes, bulky waste, can swell the water to a height of up to 1 m. Swellings of water can occur in shallow areas of the river, formed by deposition of material derived from erosion, incl. shore erosion. In these areas the items carried by the stream may wedge (eg, fallen trees, ice float). At the Warsaw section of the Vistula river erosion occurs in the following sections:
  - the left bank: Wolka Dworska, (478 km) – length 60 m, Ciszyca Obórki, (493 km) – 500 m; Kepa Oborska, (495 km) – 1100 m; Kepa Okrzewska, (497 km) – 700 m,
  - the right bank: Tarchomin (527 km) length of 200 [m], distance from the foot of the levee 20 – 30 m, threatening its stability.

Potential time, after which the water starts to percolate through the break.

There was a geotechnical investigation performed and it was determined the course of filtration for the weakest place of Rajszewski Levee, located at the 5 800 meter from the Grot – Rowecki Bridge.

Seepages at the foot of a downstream slope occur after 24 hours of the persistence of flooded water.

5.3. The risk assessment

The entire low situated left-bank part of Warsaw is in the range of a 1000-year flood water (exceedance probability Pe = 0.1%). This covers the area from the so-called Warsaw Escarpment, i.e. the entire Wilanów, the eastern half of Mokotow, the south – east part of Srodmiescie (downtown), the small north-east part of Zoliborz and a narrow strip adjacent to the Vistula river in Bielany district. On the right bank, this range of the flood water covers the western half of Wawer district, the entire Praga North and Praga South, a narrow strip on the west of Rembertow, all Targówek and almost all Białołęka.

In the event of a flood of water and the raise of its level above the edge of the riverbed for the average water the areas located in the inter-levee land will be flooded. The area located behind the levee will be flooded in case of water overflow through the crown of the levee or the entrance of water through the places not protected – the basin of Port of Praga.

Currently, the least protected areas are near the Zoo park and the Port of Praga, as well as some places at the Rajszewski Levee in Białołęka district.

In November 2004, modernization works of the Rajszewski Levee have begun on the section from the Seminary (area of Mehoffer str.) to the northern limits of the City of Warsaw. The works should be completed in 2005, as a result the tightness of the levee's body and its base will be improved.

In 2005, the Provincial Board of Land Melioration and Water Installations in Warsaw will start to prepare the documentation related to the modernization of the Moczydłowski Levee above the Wastewater treatment plant «South».

Potential flooding ranges were developed by Hydroprojekt Warszawa Sp. z o. o. in 2000 for the Warsaw-Centre municipality within the contract No. 493/N. The assessment was published in the paper entitled «Computer map of the flood risk coverage in the capital city of Warsaw".

Table 6: Description of the volume of water.

Theoretically the water will occur	Exceedance probability	Water level at the gage in the Port of Praga [cm]	Elevation of water table [m AMSL]
once in 20 years	Pe = 5%	763	83.71
once in 100 years	Pe = 1%	855	84.63
once in 1000 years	Pe = 0.1%	959	85.67

State of alert and danger point for the capital city of Warsaw have been identified by the indications of the gage in the Port of Praga:
STATE OF ALERT: – 600 [cm], elevation of water table 82.08 m;
DANGER POINT: – 650 [cm], elevation of water table 82.58 m.

Table 7: The population living in flood areas of Warsaw.

Areas within the range of flood with exceedance probability Pe %	Pe = 5% 20-year flood	Pe = 1% 100-year flood	Pe = 0.1% 1000-year flood
	Number of people		
Right-bank districts	**114 249**	**231 996**	**435 111**
Wawer	2 094	3 111	11 822
Praga Południe	104 708	179 843	183 748
Rembertów	-	-	1 739
Praga Północ	1 245	31 854	72 797
Targówek	-	-	123 392
Białołęka	6 202	17 188	41 613
Left-bank districts	**27 646**	**115 961**	**139 838**
Wilanów	1 255	10 980	12 176
Mokotów	20 695	73 419	89 177
Śródmieście	-	19 875	25 739
Żoliborz	3 276	3 742	4 279
Bielany	2 420	7 965	8 467
Total	**141 895**	**347 957**	**574 949**

Source: Own study based on flooding range set by Hydroprojekt Warszawa Sp. z o.o.Dluga river

5.4. Dluga river

Characteristics of the river Location:
Białołęka district and areas to the east of Warsaw.
Basin: the area around the towns of Sulejówek, Wolomin, Rembertów, Marki;
Source area: the areas north of the village of Dębe Wielkie;
Receiver: Żerań Canal;
Major tributaries: Czarna Struga;
Administrator: Provincial Board of Land Melioration and Water Installations, Warsaw branch. Increased rainfall in the basin cause the dynamic growth of the water level and flow.

Characteristics of flood control structures
Along the both sides of the Dluga river there are levees of 5450 m from the dam in the town of Marki to its estuary at Żerański Canal. The levees were performed incorrectly, they have too small spacing, height and width, and inadequate soil compaction. There is a lack of road along the levee that would allow protection activities.

The concept of the Dluga river levees modernization was developed in 2004.

The risk assessment
The Dluga river threatens to flood the one-third of Białołęka district area (10 km2), i.e. housing estates of Kąty Grodziskie, Brzeziny, Mańki Wojdy. The threat may occur only in the event of interruption of the levees, or the overpassing the levee's crown by the flood wave.

5.5. Wilanówka river

Characteristics of the river
Location: District of Wilanów and the area of Konstancin – Jeziorna.
Source area: the areas west of the village of Konstancin – Jeziorna.
Receiver: the Vistula river, estuary through the levee's lock.
Major tributaries: Potok Służewiecki.
Overall length: 16.5 km; within the limits of **Wilanów district:** 9 km.
Width: 4 – 8 m
Depth: 0.5 – 1.5 m
Administrator: Provincial Board of Land Melioration and Water Installations, Warsaw branch. The Wilanówka river flows by siphon under the Jeziorka river.

The risk assessment
In the case of heavy rainfall or rapid snow melting it is possible to raise the water table of the Wilanówka river and the local flooding of adjacent areas.

5.6. Potok Służewiecki

Characteristics of the river
Location: Districts of Usynów and Wilanów-
Source area: the areas of the airport «Okecie».
Receiver: the Wilanówka river.
Major tributaries: Wolnicki Canal, Wolnicki Ditch;

Width of the bottom at the section of Puławska str. – Dolina Służewiecka str.: 1.5 – 2.0 m;
Depth of the section of Puławska str. – Dolina Służewiecka str.: 1.5 – 2.0 m;
Width of the bed at the section of Dolina Służewiecka str. – Wilanowskie;
Lake: 3.0 – 4.5 m;
Depth of the bottom at the section Dolina Służewiecka str. – Wilanowskie;
Lake: 1.5 – 2.0 m;

Flow rate at Wilanowska point: from years 100 – 330 l/s, during the thaw: 115 – 732 l/s. Stream discharges treated rain wastewater from sewage OSD Okecie Airport and untreated rain wastewater from the basin: Służewiec, Służew nad Dolinka, Ursynów and Pasmo Pyrskie.

The risk assessment
Severe rain and quick thaw of snow cause the water surface elevation and the possibility of river flooding.

Areas at risk of flooding are: a crossroads of Dolina Służewiecka str. and Al. Wilanowska, and the area of Arbuzowa str., where 150 families live. NOTE! One of many versions of Potok Służewiecki remodeling was approved. Currently, the Provincial Board of Land Melioration and Water Installations in Warsaw prepares documentation for the next stages of works.

Meteorological hazards
Meteorological hazards are random phenomena, the occurrence of which is difficult to predict in sufficient advance. The Institute of Meteorology and Water Management forecasts these phenomena based on its own observations.
Strong winds
Strong winds are a threat to:
- overhead power lines,
- overhead telecommunication lines,
- radio and telecommunications masts,
- elements of the building.
- trees.

Excessive precipitation (rain, snow)
Excessive rainfall, rapid snow thaw are a threat to: – streets, – underground passages, – road and rail tunnels, – subway, – depressions, – some facilities such as sewage treatment plants, basements.
Icing
The icing and frosting may be a threat to:
- trees,
- power lines,
- telecommunication lines,
- roads (roadways and sidewalks),
- railways: tracks and contact system,
- buildings, gutters (hanging icicles).2

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References:

1. Adams S. C.,Kadivar H.: "Treatment of Chemical and Biological Warfare Injuries: Insights Derived from the 1984 Iraqi Attack on Majnoon Island." Military Medicine 1991:156;
2. Adler J.: "Terrorist Bombing Experiences During 1975-1979 in Jerusalem." Disaster Medicine 1983; 1/3/:351.
3. Ahnefeld W.: „Medycyna stanów nagłych i ratownictwo w Niemczech." Ratownictwo Polskie 1997;(2): 38-47. [Medicine of emergency situations and the rescue in Germany, Polish Rescue].
4. Laws relating to the issues of Civil Defense: Polish Journal of Laws of 1992 No. 4, item 16; of 1993. No. 91, items 420, 421; No. 93, item 429.
5. Aleksjejew G., Iwanow B. P.,Pjerszin W.N.: «Организация медицинской помощи при химических авариях» Журнал Военной Медицины 1990, 87:3. [Organization of medical aid in the event of chemical accidents, Journal of Military Medicine]
6. Alexejev G. I.: "Military – Civilian Collaboration for Disaster Medicine in the USSR." Word Association for Emergency and Disaster Medicine 1998;1: 31.
7. Alloway B., Aures D.: „Chemiczne podstawy zanieczyszczenia środowiska." Warsaw 1999. [Chemical basis for environmental pollution].
8. Andurant R.: "Swift assessment of the consequences of a rather long lasting release Conference Chemical Accidents." Roma – July 1987.
9. Ansoff H.L., Zarządzanie strategiczne, PWE, Warsaw 1985. [Strategical management].
10. Augustyn S.: „Koncepcja nowoczesnego systemu zarządzania kryzysowego." Ratownictwo Polskie ,3/98.; [The concept of a modern system of crisis management, Polish Rescue].
11. Augustyn S.: „Problemy ochrony ludności przed skutkami awarii chemicznych", Przegląd Obrony Cywilnej 1990, 12, 4.; [Problems of protecting the population against the effects of chemical accidents, Civil Defense Revue].
12. Augustyn S.: „Zarządzanie kryzysowe – faza reagowania". Przegląd Obrony Cywilnej 1998, nr 7.; [Crisis management – reaction stage, Civil Defense Revue].

13. Augustyn S.: „Zarządzanie kryzysowe w fazie odbudowy" Przegląd Obrony Cywilnej 1998, nr 12.; [Crisis management at the reconstruction stage, Civil Defense Revue].
14. Augustyn S.: „O zarządzaniu kryzysowym w Polsce." Przegląd Obrony Cywilnej 1999, nr 1. [About the crisis management in Poland, Civil Defense Revue].
15. Barnier M.: „Atlas wielkich zagrożeń. Ekologia, środowisko, przyroda." WNT Warsaw 1995. [Atlas of great dangers. Ecology, environment, nature.]
16. Baumberg I.,Pachucki A.,Grzelak E.: „Ratownictwo medyczne w krajowym systemie ratowniczo-gaśniczym w dobie zmian administracyjnych w kraju." w: „Ratownictwo w systemie organizacyjno-prawnym i ekonomicznym samorządów terytorialnych." Inowrocław 1998r.; ["Emergency medical services in the national fire-extinguishing system in the era of administrative changes in the country" within «Rescue in the organizational, legal and economic system of local governments"].
17. Bogdanik T.: Toksykologia kliniczna. PZWL, Warsaw 1978 [Clinical toxicology].
18. Borysiewicz M. „Modelowanie wypływu i transportu uwolnień w atmosferze niebezpiecznych substancji chemicznych". Instytut Podstawowych Problemów Techniki PAN BUK BT 1996: 12 – 14 [Modeling of flow and transport of hazardous chemicals released in the atmosphere, Institute of Fundamental Technological Issues of the Polish Academy of Sciences].
19. Brzykczy K. „Substancje niebezpieczne – bezpieczeństwo produkcji i stosowania" Wrocław 1999: 6, 8, 11 [Dangerous foods – manufacturing and use safety].
20. Ciećkiewicz J.: „ Medycyna Katastrof – nowa dziedzina wiedzy medycznej". Gazeta Lekarska 1996,7 – 8 (66-67),31.; [Disaster Medicine – a new branch of medical science, Medical Newspaper].
21. NATO Command – ACE Directive 80-64, Defensive Measures Against Toxic Industrial Chemicals Hazards During Military Operations.
22. Dreisbach R. „Wademecum zatruć" PZWL, Warsaw 1982 [Vademecum of poisoning].
23. Drucker P., Zarządzanie w czasach burzliwych i trudnych, Warsaw 1996. [Management in turbulent and difficult times].
24. EC amending Council Directive 96/82/EC of 9 December 1996 on the control of major-accident hazards involving dangerous substances (Seveso II Directive). Presented by the Commission "Draft proposal for a European Parliament and Council Directive".
25. Ellenhorn M.J. "Medical Toxicology". Elsevier, New York, 1988.
26. Geissler E. I van Courtland Moon J.E.(red.)::"Biological and toxic weapons research, development and use from the middle ages to 1945." SIPRI.Press Release 1999, (www.spiri.se).
27. Instytut Medycyny Pracy „Toksykologia Przemysłowa." Łódź 1993. tom I [Institute of Occupational Medicine "Industrial Toxicology, Lodz 1993, vol.1].
28. Jakubaszko J.,Smreka J.,Sehn M.: „Próba oceny przydatności komputerowego programu symulacji działań na miejscu katastrofy „Triage" w nauczaniu studentów medycyny." Materiały Ogólnopolskiego Forum Ratownictwa Medycznego, Inowrocław, 1997r. [An attempt to assess the suitability of a computer program simulating activities at the site of the «Triage» crash in teaching medical students, Materials of the National Medical Rescue Forum].
29. Jakubaszko J.: „Medycyna ratunkowa pilną potrzebą w polskim systemie ochrony zdrowia. Ratownictwo w systemie organizacyjno – prawnym i ekonomicznym samorządów terytorialnych." Inowrocław, 1998: 30-35. [Emergency medicine the urgent need of the Polish health care system. Rescue in the organizational, legal and economic system of local governments].
30. Jakubaszko J.: „Założenia organizacyjne systemu medycyny ratunkowej. Procedury organizacyjno – ratownicze i leczenie w nagłych stanach zagrożenia życia." Inowrocław, 1996:11 – 18.; [Organizational assumptions of the system of emergency medicine. Organizational and rescue procedures and treatment in a sudden life-threatening conditions].
31. Jałoszyński K., Zeszyty Naukowe AON, 2 (39) 2000, 188. [AON Scientific papers].
32. Janikowski R., Wielokrotny model decyzyjny, jako narzędzie oceny oddziaływania projektowanej działalności człowieka na środowisko, Katowice 1993. [Multiple decision model as a tool to assess the impact of proposed human activities on the environment].
33. Material Safety data Sheets, Version 2.2, CIOP, Warsaw 1999.
34. Kitler W., „Wybrane aspekty kierowania państwem w sytuacjach kryzysowych, w obronie narodowej RP, wobec wyzwań i zagrożeń współczesności." AON Warsaw 1999. [Some aspects of statehood in crisis situations, in the national defense of Poland, the challenges and actual threats].
35. Kitler W., Soloch P., Sobejko Z.: „Zeszyt Problemowy – prawno – organizacyjne aspekty ochrony ludności." Zarząd Główny Towarzystwa Wiedzy Obronnej, Warsaw 1/2001, [Issue paper – legal and organizational aspects of civil protection.» Board of the Defense Knowledge Society].
36. Kitler W., Wiśniewski B. , Prońko J.: "Problemy zarządzania kryzysowego w państwie." AON Warsaw 2000. [Problems of crisis management in the state, National Defense Academy].
37. Kitler W., Wiśniewski B. , Prońko J.: „Zarządzanie kryzysowe w obronie narodowej." Informator nr.1(2)/2000,Biuro Spraw Obronnych MSWiA,Warsaw, March 2000. [Crisis management in the national defense», Guide-book No.1 (2) / 2000, Ministry of Internal Affairs and Administration, Office of Defense Affairs].
38. Kocur J., Nowakowski R, Trendak W..: „Środowiskowe uwarunkowania niektórych zaburzeń psychicznych. Nadzwyczajne zagrożenia i ryzyko w środowisku" Arka, Poznań 1994: 146 [Environmental determinants of certain mental disorders. Extraordinary hazards and risks in the environment].
39. Kondracki J.: „ Regionalizacja fizyczno – geograficzna Polski." PWM. Warsaw 1998.[Physical and geographical regionalization of Poland].

40. Kondracki J.: „Geografia fizyczna Polski." PWM, Warsaw 1998. [Physical Geography of Poland]
41. Konieczny J.: „Bezpieczeństwo publiczne w nagłych i nadzwyczajnych zagrożeniach środowiska ." Poznań 1995.; [Public safety in emergencies and extraordinary threats to environment].
42. The Convention on International Carriage by Rail (COTIF), drawn up in Brno on 09.05.1980. Journal of Laws of 1980, No. 34, item 158,
43. The Convention on the Prohibition of Chemical Weapons, Annex to the Polish Journal of Laws No. 63, item 703 of July 30, 1999.
44. Kostecki K.: „Wybrane problemy organizacji ochrony zdrowia w Obronie Cywilnej." Akademia Medyczna Katowice 1993. [Some problems of health care organization in civil defense.» Medical University of Katowice].
45. Kowalczyk M.: „Katastrofa chemiczna – problem, który może zaistnieć." Konferencja Naukowo-Szkoleniowa: „Medycyna Katastrof" Łódź 1997. [Chemical disaster – a problem that may arise.» Scientific and Training Conference «Disaster Medicine»].
46. Krauze M., Nowak I.: „Broń chemiczna." MON, Warsaw 1984. [Chemical Weapons, Ministry of Defense].
47. Kubica W., Tomecki Z., Kowalski Z.,Duszka B.: „Zarys Toksykologii Wojskowej", Ministerstwo Zdrowia i Opieki Społecznej – skrypt dla studentów studiów wojskowych akademii medycznych. PZWL Warsaw 1976.; [Outline of Military Toxicology, Ministry of Health and Welfare – script for students of military medical academy].
48. Kurant A: „Obrona cywilna RP." AON, Warsaw 1993. [Civil defense of Poland, National Defense Academy].
49. Ludwiczak J.,Wilczkowiak S.: „Nadzwyczajne zagrożenia środowiska." AON, MOŚZNiL, Warsaw 1996. [The extraordinary threats to the environment, National Defense Academy, Ministry of Environment]
50. Malak K.: „Bezpieczeństwo obronność państwa."AON, Warsaw 1998. [Safety and national defense, National Defense Academy].
51. Malysev V.: „Ocenka vvozmoznych posledstvii avarii s toksiceskim vybrosom" Voen. med. Z 1993:11,7;
52. Maniscalco C. H..: "The EMS Incident management system". New Jersey 1998.
53. Mazurek M., Terroryzm światowy a broń chemiczna, Ministerstwo Gospodarki, Warsaw 2000, str. 61. [Global terrorism and chemical weapons, the Ministry of Economy].
54. Methods of assessment of the situation after contaminations by industrial toxic chemical agents, Warsaw 1993: 5, 7, 8, 19,11.
55. Michalik J.S. "System przeciwdziałania poważnym awariom przemysłowym w Polsce (1)." Bezpieczeństwo Pracy 11(364) 2001, pp. 14-18 [The prevention of serious industrial accidents in Poland (1), Work Safety]
56. Michalik J.S., Gajek A.: "Zmienione kryteria kwalifikacyjne i odpowiadające im zmiany w bazie danych o substancjach niebezpiecznych." CIOP, Warsaw 2002 [Changed eligibility criteria and the corresponding changes to the database on hazardous substances].
57. Michalik J.S., Kijeńska D.T., Gajek A.: "Wykonywanie procedury zgłoszenia zakładów o zwiększonym oraz o dużym ryzyku poważnej awarii przemysłowej." Poradnik. CIOP, Warsaw 2001 [Implementation of notification procedure relating facilities of increased and high risk of serious industrial accident, Guide].
58. Michalik J.S., Kijeńska D.T.: "Identyfikacja obiektów zagrażających poważną awarią przemysłową. Substancje niebezpieczne i zasady postępowania." Wytyczne. CIOP, Warsaw 2000 [Identification of objects threatening a serious industrial accident. Hazardous substances and rules of conduct, Guidelines].
59. Michalik J.S.: :Przeciwdziałanie poważnym awariom przemysłowym. Nowe polskie przepisy." Bezpieczeństwo Pracy 9(362) 2001: 7-10 [Preventing major industrial accidents. New Polish regulations, Work Safety]
60. Michalik J.S.: "Nowe standardy bezpieczeństwa Unii Europejskiej. Część 1." Bezpieczeństwo Pracy 5(322) 1998: 3-18 [The new European Union safety standards. Part 1, Work Safety]
61. Regulation of the Minister of Economy of April 9, 2002 on the types of quantities of dangerous substances, the presence of which in a plant decides to include it into plants of the increased risk or the high risk of potential serious industrial accident (Journal of Laws No 58, item 535).
62. Own study based on data obtained from the companies, the Municipal State Fire Service, district branches of the Security and Crisis Management Office.
63. The 2000 study of Hydroprojekt Warszawa Sp z o. o. entitled «Computer map of the flood risk coverage in the capital city of Warsaw».

Emergency medicine

Periodic fluctuations in the prevalence of epilepsy in adults

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Summary:

Introduction: Epilepsy is one of the most common diseases of the nervous system. Due to high mortality it is a serious clinical problem from the viewpoint of emergency medicine.
Material and methods: The analysis of the patients over 18 years of age treated for epilepsy in Nicolas Copernicus Provincial Specialist Hospital in Lodz in 2008. The analysis was based on medical records. The following parameters were analyzed: patients' age and gender, time of day and year, type of epilepsy and duration of hospitalization as well as mortality till hospital discharge.
Results: Among 360 treated patients (146 women, 214 men) aged 18 – 97 years (mean age 16.72 ± 48.46 years) an epilepsy incident was the cause of hospitalization.
Conclusions: Epilepsy incidents are observed more frequent in men who suffered from epilepsy at a younger age than women. The mean age of patients with epilepsy is slightly higher than in the studies of foreign authors. Maximum seizures were observed in the morning between 12:00 and 12:59 and in August as well.

Key words: epilepsy, sudden condition, hospitalization, mortality.

Introduction

Epilepsy is defined as a clinical syndrome characterized by the occurrence of recurrent seizures [1]. The term 'attack' refers to an incident of paroxysmal nervous activity, which begins in the gray matter of the brain, interrupting its operation, giving the characteristic symptoms. Attacks may or may not be accompanied by convulsions. Depending on the hyperactive centers location as well as the scope and the speed of discharges spread, seizures may take varied clinical form [2,3].

The diagnosis of epilepsy should be based on an accurate determination of the type of epileptic seizure, with particular emphasis on the elimination of other causes of disorders that cause organic changes that damage the central nervous system including, e.g. the decrease in blood glucose level [3,4].

Prevalence of epilepsy in the world is very diverse. Prevalence rate ranges from 1.5 (Japan) to 37 (Nigeria) in 1000 persons [5,6]. In Poland it is about $^{7}/_{1000}$ inhabitants.

Thesis aim

The aim of the thesis is the trial to assess the incidence of epileptic seizures among adult patients

hospitalized in Nicolas Copernicus Provincial Specialist Hospital in Lodz from 1 January 2008 to 31 December 2008.

Material and methods

The thesis retrospectively analyzed cases of epileptic seizures in patients over 18 years of age based on hospital cards of Nicolas Copernicus Provincial Specialist Hospital in Lodz. The following parameters were analyzed: patients' age and gender, time of day and year, type of epilepsy and duration of hospitalization as well as mortality till hospital discharge.

The analysis covered the period of the year 2008 and was based on medical records. It was carried out in complying with the law on personal data protection.

Normality of distribution of variables were tested using the p significance level of the Shapiro-Wilk test. In the case of normal distribution, the mean differences were tested with the pair test of t-Student. In other cases, non-parametric Wilcoxon test was used, and the obtained results were described and presented graphically with the median.

The test of relationship between the incidence of the tested variables in the analyzed sections were tested with the chi-square independence test with the accepted level of significance p = 0.05. For cross tables the dependence power between variables was additionally tested with V-Cramer factor.

Results

Among 360 patients treated for epilepsy in Nicolas Copernicus Provincial Specialist Hospital in Lodz, men were dominant and they represented 59% of patients.

The average value of age was 48,46 years ± 16,72, while men were average 7 years younger than women (Figure 1). The comparison of the average age of men and women showed a statistically significant difference at p = 0.0001 (Figure 2). In the research material the age range for men was 18-93 years, and for women 19-91 years old. The epilepsy among men were found most frequently in the age group 50-59 years (23%), followed by 30-39 years (22%), the peak incidence for women

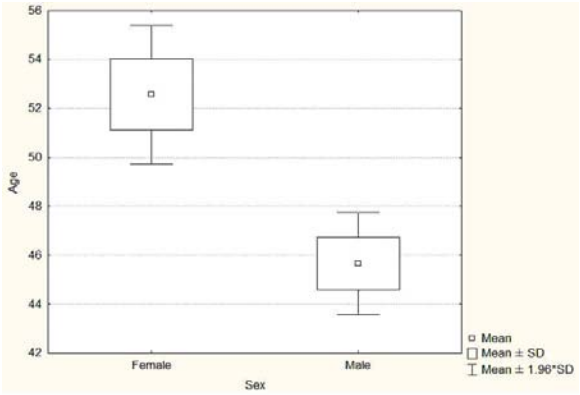

Figure 1: Box-and-whisker diagram – average age of women and men.

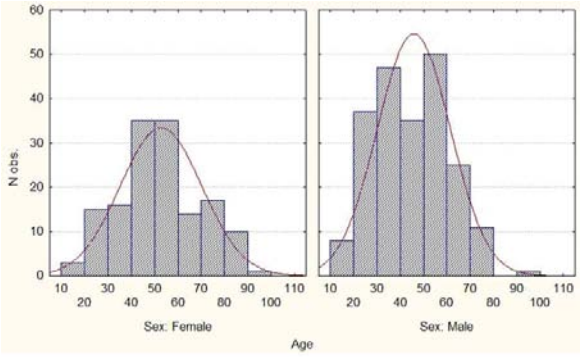

Figure 2: The layout of age of research population.

Table 1: Characteristics of each group of patients with injuries.

Sex	Number of patients [N]	Number of patients [%]	Age [Mean±SD]	P value
Male	214	59	45,66 15,63	0,0007
Female	146	41	52,57 17,46	0,0098
Total	360	100	48,46 ± 16,72	0,00006

equally concerned age range 30-39 years as well as 40-49 years (24% for each interval). The characteristics of patients are summarized in Table1.

The research material was analyzed with regard to the incidence of epilepsy including the circadian cycle. The peak of the observed incidence of epilepsy in the whole research material fell in the period between 12:00 and 12:59 (n = 27, 8%), the decrease in the number of cases concerned the period between 3:00 and

6:59. During this period only 15 cases occurred (p = 0.0000, Figure 3). For the men group peak incidence fell for the period between 12:00-12:59 and 13:00-13:59 (n = 16, 7% – for each period). In the period of 3:00-4:59 there were only two cases of epilepsy in men (p = 0.0000). In the women group the largest number of cases of epilepsy was observed during 8:00-8:59 and 12:00-12:59 (11 cases for each time period). 6:00-6:59 period was characterized by lack of cases (p = 0.0015). Comparison using the

Table 2: The prevalence of epilepsy in treated groups relative to the time of day.

Time of day	Male (n=214)	Female (n=146)	Total (n=360)
0:00 – 5:59	23 (11%)	11 (14%)	44 (12%)
6:00 – 11:59	49 (23%)	38 (26%)	87 (24%)
12:00 – 17:59	71 (33%)	46 (32%)	117 (33%)
18:00 – 23:59	71 (33%)	41 (28%)	112 (31%)
P value	0,0000	0,0000	0,0000

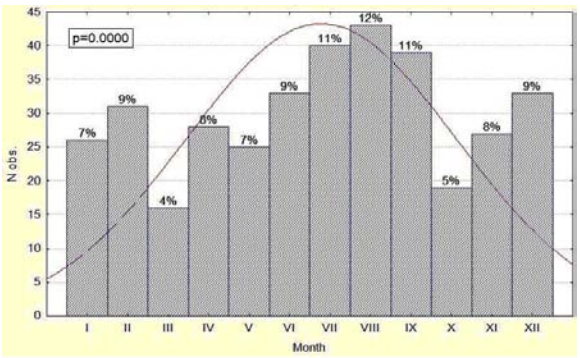

Figure 3: The layout of incidence of epilepsy in the annual cycle.

T test – the men group with the women group for the prevalence of epilepsy in the circadian cycle showed no statistically significant difference (p = 0.1455).

In addition, hours were grouped into four disjoint intervals (0:00-5:59, 6:00-11:59, 12:00-17:59, 18:00-23:59), which allowed to demonstrate differences in the frequency of incidence of epilepsy in relation to the time of day (Table 2).

While analysing the occurrence of epileptic seizures during the year it was observed that in the men group the episodes of epilepsy were seen the most frequent in August (n = 26, and 12%) and least frequent in March (n = 9, 4%, p = 0.0000). In the women group the peak incidence was observed in June and August (17 cases per month), in March, May and October the largest decrease in the number of patients treated for epilepsy was observed (n = 7 for each month, p = 0.00001). The distribution of the incidence of epilepsy in the whole research material is presented in Figure 4. The result of the comparison of the men group with the women group concerning the incidence of epilepsy in the annual cycle was not statistically significant (p = 0.3917).

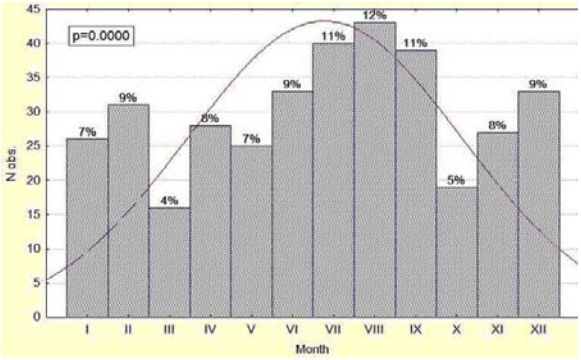

Figure 4: The layout of incidence of epilepsy in the circadian cycle.

Table 3: The prevalence of epilepsy in treated groups relative to the time of year.

Season	Male (n=214)	Female (n=146)	Total (n=360)
spring	46 (21%)	23 (16%)	69 (19%)
summer	66 (31%)	50 (34%)	116 (32%)
autumn	50 (23%)	35 (24%)	85 (24%)
winter	52 (24%)	38 (26%)	90 (25%)
P value	0,0000	0,0000	0,0000

Comparative analysis of the men group with the women group also showed no statistically significant difference in the time of the year in which there was an incidence of epilepsy (p = 0.3917). The results of this analysis are presented in Table 3.

Crucial parameter, namely the length of hospitalization of patients was subjected to the analysis as well. Mean length of hospitalization for the entire research group was 5.6 days on 6.8, with the longest duration of hospitalization for epilepsy in the research material amounted to 46 days. Mean hospital stay of men was 5 days and it was shorter than the duration of hospitalization of women (6.6 days). The comparison of the men group and the women group in time of hospitalization showed a statistically significant difference at p = 0.0364 (Figure 5).

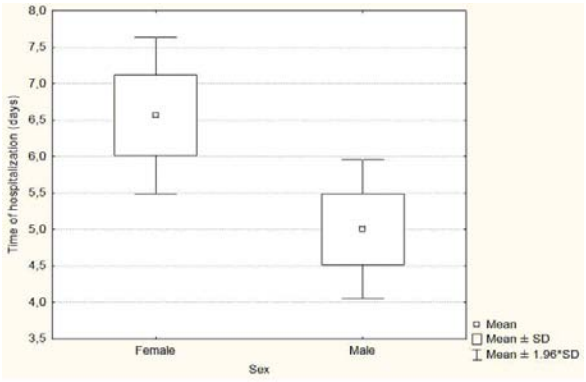

Figure 5: Box-and-whisker diagram of patients' hospitalization time considering sex.

Table 4: Characteristics of mortality in the research material.

Sex	Number of patients [N]	Number of patients [%]	Age [Mean±SD]	P value
Male	7	70	42,57 9,14	0,0833
Female	3	30	7130,41	0,1572
Total	10	100	51,1 21,21	0,00005

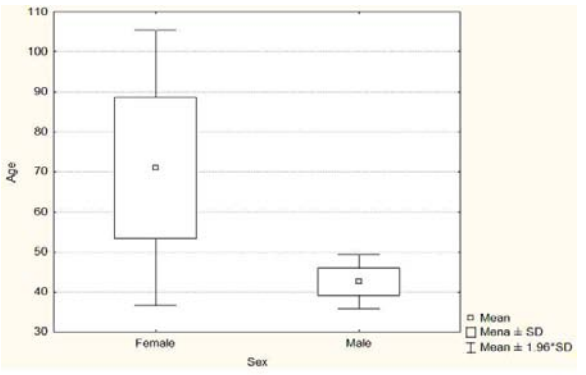

Figure 6: Box-and-whisker diagram of patients' hospitalization time considering sex.

Among 360 patients treated for incidents of epilepsy deaths were found in 10 cases, representing 3.6% of the group. In 350 cases, therapeutic treatment was successful and the patient was discharged home. The characteristic of patients, among whom death was declared is presented in Table 4.

The comparison of age of men and women whose therapeutic process finished with death showed a statistically significant difference (p = 0.0429). The average age of these patients is illustrated in Figure 6. Mean length of hospitalization for patients whose therapeutic process finished with death was 4.8 days ± 10.44, and it was higher by more than three days for men (5.8 ± 12.57) than women (2.6 days ± 2.2).

Discussion

Epilepsy is a syndrome of symptoms, whose an essential feature are clinical seizures as an expression of pathological activity over groups of nerve cells of the brain. It is one of the most common, and the most common as far as children are concerned, disease of the nervous system. The epidemiological data show that epilepsy is a prevalent symptom in the world, statistically estimated 0.5-1.5% of the population. Mortality due to generalized seizures according to various authors ranges from 0.5% to even 12.2%. In the research material mortality was observed in 10 cases, representing 3.6% of the group. Lower mortality rate was reported in the study of Seymoir (0.5%) [7], Ackers (2.4%) [8], and Mu (2.9%) [9]. The higher mortality rate was reported by Terra (5.3%) [10] and Chang (12.2%) [11]. The result closest to the proprietary research was obtained by Geerts (3.6%) [12].

In the proprietary research material the men group was dominant constituting as much as 59%. The result confirms the global study in which foreign authors also demonstrated the predominance of men: Guinhouya 53% [13], Quinones 53% [14], Guekht 59% [15] and Panagariya 66% [16]. The predominance of women was received by Matsuoka 56% [17].

In the foreign literature the average value of the age of patients with epilepsy, respectively in their study was received by: Alemany-Rosales – 36

years [18], Costa – 38.81 years [19], Quinones 40.79 years [14], Crizzle – 44.3 years [20], Hitomi – 46.6 years [21]. These results were slightly lower than the results obtained in the proprietary research, where the average age of the study population was 48.46 years.

National authors such as Janus, Zajewska and Nowak based on their research have observed that many different characteristics and expressions of the life of human body demonstrate variation intensity in both the circadian cycle and an annual one [22-24]. Therefore, one can safely conclude that many features of the human body including the nervous system can be characterized by reproducible changes in the different time cycles. The confirmation of this phenomenon can be observed in the research of Schipel *et al.* [24]. According to the research team a maximum seizures attributed to the night time (22:00-5:59). In the proprietary research, the maximum occurrence of epilepsy attributed to the afternoon hours (12:00-17:59), when there were 33% of all cases. The 22:00-5:59 period was characterized by the presence of only 20% of cases.

Discussed fluctuations in the circadian cycle is just one example of periodically recurring changes of the nervous system functions. The scientific literature also presented an annual seasonal pattern of occurrence of epilepsy – its peak fell in the winter months (December and January) [25]. In our own research, most cases of incidents of epilepsy were observed during the summer (32%). The winter period was characterized by the occurrence of 25% of all cases.

Conclusions

1) Incidents of epilepsy concern men more frequent.

2) The mean age of patients with epilepsy is slightly higher than in the research of foreign authors, and the men suffer from epilepsy at a younger age than women.

3) Maximum seizures were observed in the morning between 12:00 and 12:59 as well as in August.

References:

1. Ziemba R. (red.): Pierwsza pomoc w nagłych wypadkach i zachorowaniach, Warszawa, (2011):55.
2. Banerjee, P. N., D. Filippi, and Hauser W. Allen.: The descriptive epidemiology of epilepsy-a review, Epilepsy Res. 85.1 (2009): 31-45.
3. Wiebe, S., et al.: Epidemiology of epilepsy: prevalence, impact, comorbidity and disparities, Can.J.Neurol.Sci. 36 Suppl 2 (2009): S7-16.
4. Bell, G. S. and J. W. Sander: The epidemiology of epilepsy: the size of the problem, Seizure. 10.4 (2001): 306-14.
5. Foreman, B. and L. J. Hirsch. "Epilepsy emergencies: diagnosis and management." Neurol.Clin. 30.1 (2012): 11-41.
6. Lesser, R.: Epidemiology in Epilepsy, Epilepsy Curr. 1.2 (2001): 57.
7. Seymour, N., et al.: Mortality after temporal lobe epilepsy surgery, Epilepsia 53.2 (2012): 267-71.
8. Ackers, R., et al.: Mortality rates and causes of death in children with epilepsy prescribed antiepileptic drugs: a retrospective cohort study using the UK General Practice Research Database, Drug Saf 34.5 (2011): 403-13.
9. Mu, J., et al.: Causes of death among people with convulsive epilepsy in rural West China: a prospective study, Neurology 77.2 (2011): 132-37.
10. Terra, V. C., et al.: Mortality in children with severe epilepsy: 10 years of follow-up, Arq Neuropsiquiatr. 69.5 (2011): 766-69.
11. Chang, Y. H., et al.: Risk of mortality among patients with epilepsy in southern Taiwan, Seizure. (2012).
12. 12. Geerts, A., et al.: Course and outcome of childhood epilepsy: a 15-year follow-up of the Dutch Study of Epilepsy in Childhood, Epilepsia 51.7 (2010): 1189-97.
13. Guinhouya, K. M., et al.: [The epilepsy treatment gap in six primary care centers in Togo (2007-2009)], Sante 20.2 (2010): 93-97.
14. Quinones, Nunez M. and Mamani D. Lira: Epidemiological profile of epilepsy in a hospital population in Lima, Peru, Rev.Neurol. 38.8 (2004): 712-15.
15. Guekht, A., et al.:The epidemiology of epilepsy in the Russian Federation, Epilepsy Res. 92.2-3 (2010): 209-18.
16. Panagariya, A., et al.: Clinical profile of epilepsy, in a tertiary care centre of North-west India, J.Indian Med. Assoc. 109.1 (2011): 14-18.
17. Matsuoka, H. : A clinical and electroencephalographic study of juvenile myoclonic epilepsy: its pathophysiological considerations based on the findings obtained from neuropsychological EEG activation, Seishin Shinkeigaku Zasshi 91.5 (1989): 318-46.

18. Alemany-Rosales, B. and J. Prieto-Montalvo: Refractory temporal epilepsy. An analysis of 33 cases submitted to surgery, Rev.Neurol. 52.10 (2011): 581-89.
19. Costa, A. L., et al.:Refractory epilepsy is highly associated with severe dentoalveolar and maxillofacial injuries, Epileptic.Disord. 13.1 (2011): 61-64.
20. Crizzle, A. M., et al.: Associations between clinical tests and simulated driving performance in persons with epilepsy, Epilepsy Behav. (2012).
21. Hitomi, T., et al.: Clinical anticipation in Japanese families of benign adult familial myoclonus epilepsy, Epilepsia 53.2 (2012): e33-e36.
22. Janus, D.:The influence of weather on human health, Military Doctor. 81 (2005): 46-49.
23. Zalewska, J. B., Nowak, J. Z.: Circadian rhythm and biological clock, Sleep. 2 (2002): 127-36.
24. Schapel, G.J., Beran, R. G., Kennaway D. L., et al.: Melatonin response in active epilepsy, Epilepsia, 36 (1995): 75-78.
25. Cortez, M. A., Burnham W. M., Hwang P. A.: Infantile spasms: seasonal onset differences and zeitgebers, Pediatr. Neurol. 6 (1991): 355-64.

Catastrophe medicine

Population and environmental risk posed by hazardous chemical substances (HCS) in Warsaw City Centre

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Summary:

No country, region, or township may be considered completely protected against catastrophes. Proper preparation, ability of risk assessment, as well as swift and thorough information on the occurrence of a natural or industrial disaster all add to the reduction of risks and minimization of consequences.
Not only state services governed by ministries, such as State Fire Service, Medical and Technical Services, and the Army, should be prepared to cope with the hazards, but also state and local administration, as well as business management. It is their duty to establish strategies of risk minimization, satisfy basic needs of the population and efficiently manage the squads and the equipment dedicated to life saving, prevention and damage reparation.
It is also important to prepare the population for possible disasters by systematic training and education in the most significant issues.

Key words: chemical hazard, toxic industrial chemicals, chemical terrorism.

Introduction

Providing protection against potential threats for the state, the citizens and the environment is one of the key duties of state administration. This obligation has been included in Article 5 of the Constitution of the Republic of Poland, enacted on 2nd April 1997.

Until recently, the term "contamination with chemical, radioactive or biological agents" was commonly associated only with warfare and weapons of mass destruction. To date, terms related to contamination during the time of peace, in conjunction with mass education of the population in potential consequences, means of protection and damage repair, have been uncommon.

At present, after the 11th September 2001 terrorist attacks on the World Trade Center, a different view needs to taken on our everyday hazards, such as acts of terrorism, emerging despite the time of peace. Although it is possible to define many types of potential threats with high probability, terrorist attacks are not that predictable.

Industrial development from its very beginning was connected with increased risk posed by toxic agents and substances, as well as transported, processed and stored waste.

Industrial contamination, constituting a serious danger to human life and health may occur at any time due to:

- malfunctions,
- railway, road, air and sea catastrophes,
- explosions of containers, tanks, etc., which may be the effect of external factors, such as natural disasters.

However, the most common cause of catastrophes are human errors, comprising: carelessness, haste, insufficient knowledge or inability to predict consequences, nonconformance with production technologies or transport regulations, erroneous design of construction elements and technological processes, low work discipline, insufficient supervision and lack of proper equipment for control and measurements.

Every malfunction is a result of a combination of different causes and adverse situations, and its outcome depends on the type, range, character and circumstances of the above factors.

Toxic industrial chemicals (TICs) comprise all chemical compounds (both organic and inorganic), flammable and explosive materials, biologically active substances, radioactive substances, waste and other compounds, which may produce substances directly or indirectly poisoning human environment through heat-induced or environment-induced decomposition.

In every case, propagation of TICs leads to the contamination of earth, air and water, posing threat for living organisms and inducing rapid changes within natural environmental processes. The most dangerous catastrophes, being the most common, are those related to the release of high amounts of chemical compounds, whose quantity and range of occurrence expand with industrial development.

From 450 selected chemical substances, approx. 170 have been deemed to cause toxic industrial contaminations. The most hazardous chemical substances are: nitric, sulfuric, and hydrocyanic acids, cyanogen chloride and phosgene, due to the corrosive and poisonous effect not only of their liquid forms, but also their vapours.

Long-range hazards, due to characteristic properties and effects, are posed by: ammonia, chlorine, concentrated hydrochloric acid, hydrogen cyanide, carbon disulfide, hydrogen fluoride, hydrogen sulfide, ethylene oxide, and many more, whose toxicity is described further in this paper.

Clouds of vapour or gas forming above a damaged chemical tank or container move with the wind, constituting danger even to areas located very far from the damage site.

The range of spreading of toxic substances and their air concentration largely depend on their: quantity and level of toxicity, wind velocity, vertical atmospheric stability, ambient temperature and land relief.

Many industrial facilities accumulate high quantities of liquid, solid and gaseous toxic products, as well as flammable and explosive materials.

Damage to a technological line or tanks, in which the materials are stored or transported, poses an immediate threat to both the staff and local residents. HCSs are usually transported by rail, road or inland waters.

As stated by the National Headquarters of the State Fire Service, ⅓ of the Polish territory lies within the contamination zones of 80 largest chemical plants.

The results of rail transport analysis indicate that almost all railway routes are considered as particularly dangerous. This also regards public roads, even though road transport seems less exposed to hazard due to, for example, lower capacity of road tankers.

Carelessness of the transport service providers, lack of essential information on the toxicity of transported materials, necessary security measures and procedures to be applied in case of collision, but also lack of means of protection and appropriate equipment, improper load placement, often bad technical condition of the vehicles and the cisterns, as well as higher incidence of road accidents all add up to the fact that areas located near transport routes are high risk zones. In practice, the level of knowledge regarding the risks is low, especially in the areas where the risks seem minimal.

No country, region, or township may be considered completely protected against catastrophes. Proper preparation, ability of risk assessment, as well as swift and thorough

information on the occurrence of a natural or industrial disaster all facilitate the reduction of risks and minimization of consequences.

Not only state services governed by ministries, such as State Fire Service, Medical and Technical Services, and the Army, should be prepared to cope with the hazards, but also state and local administration, as well as business management. It is their duty to establish strategies of risk minimization, satisfy basic needs of the population and efficiently manage the squads and the equipment dedicated to life saving, prevention and damage reparation. It is also important to prepare the population for possible disasters by systematic training and education in the most significant issues.

Malfunctions in production plants

Depending on the character of malfunction, HCSs may be liberated to the atmosphere in a single event (e.g. an explosion) or over a certain period of time.

The quantity of toxic compounds which may be liberated in a defined time period depends, among other factors, on the construction properties of the installation, tank capacity, type of chemical compound, scale and character of the sustained damage, physical properties of the compound, as well as the type and elapsed time of actions undertaken to localize the source of the malfunction.

In every case, the amount of liberated substance may vary and span from several kilograms to hundreds of tons (Table 1).

The size of toxic leakage from damaged installations is significantly dependent on the meteorological conditions present in the disaster area.

Table 1: Names of production plants and their location in Warsaw city centre.

No.	Name and address of production plant	TIC type and amount [t]
1	Warsaw Sport and Recreation Centre. Speed Skating Rink ***"STEGNY"*** ul. Inspektorowa 1	Ammonia 9.5
2	***"KRÓLEWSKIE"*** SA Brewery ul. Grzybowska 58	Ammonia 8.5
3	***"DANONE"*** Sp. z o.o. ul. Redutowa 9/23	Ammonia 6.0
4	PZL – WOLA SA Mechanical Engineering Facility ul. Fort Wola 22	Ammonia 5.5
5	Water Supply Local Station ul. Borecka 1	Chlorine 7.0
6	Municipal Water Supply and Sewage Company. Central Pipe Waterworks. Ul. Koszykowa 81	Chlorine 6.0
7	Municipal Water Supply and Sewage Company. Praga Pipe Waterworks. ul. Brukselska 21	Chlorine 4.0
8	Elektrociepłownie Warszawskie SA. ***"SIEKIERKI"*** Power Station ul. Augustówka 1	Hydrochloric acid 350.0
9	***"KRÓLEWSKIE"*** SA Brewery ul. Grzybowska 58	Hydrochloric acid 10.0
10	Warsaw Radio Centre ***"RAWAR"*** ul. Poligonowa 30	Hydrochloric acid 9.3

Nevertheless, the scale of threat posed by every malfunction is assessed not only by the amount of the liberated substance, but also by its toxicity.

Historically, in large-scale industrial catastrophes accompanied by leakage of toxic substances the greatest danger was posed by the quantity of the liberated poisonous compounds.

A TIC contamination zone encompasses the site of malfunction (leakage) and the area in which contaminated air disperses the toxin at concentrations inducing different grades of toxic effect: lethal, moderate, mild and threshold.

Contamination zones may form circles, ellipses or irregular shapes. Surface area of these zones in adverse conditions may cover from several to more than a dozen hectares, or even several square kilometres in particular meteorological conditions.
The area damaged by the malfunction is characterized by the highest TIC toxicity. Area size (radius) depends on the type of TIC, its storage conditions and the severity of sustained

damage (malfunction). The size does not exceed 1 km for most chemical agents.

Fire expands the damaged area by 1.5 to 2 times, which may be caused by a larger TIC leak size in such case, as well as TIC dispersal as a result of explosions.

Spreading zone of contaminated air (both primary and secondary) is formed as a result of toxic substance evaporation from the malfunction site. The zone is circle slice-shaped with the centre of the circle located in the malfunction site (Figure 1).

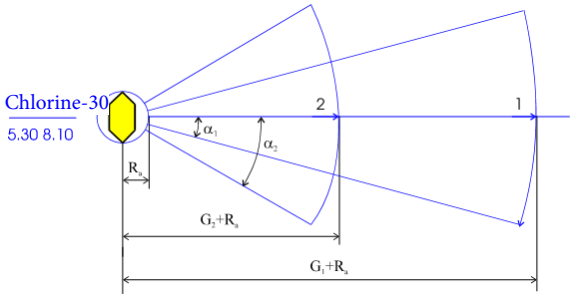

Figure 1: Schematic of predicted contamination zones after a production plant malfunction involving TICs

G1,G2 – spreading range of the primary and secondary clouds;
Ra – damaged area radius (due to malfunction)
α1,α2 – angle between the contamination zone lateral borders

Reference: Metodyka oceny sytuacji chemicznej po skażeniach toksycznymi środkami przemysłowymi, Warsaw 1993, p. 19.

The depth and angle between the contamination zone lateral borders depend on many factors, including the type and amount of the liberated TIC, topography, season of the year and meteorological conditions in lower strata of the atmosphere: wind velocity and direction, kategorii atmosfery, precipitations. A considerable amount of these factors has an effect on the range of spreading of contaminated air in different conditions.

In the case of chlorine, a substance consumed in large quantities by the chemical industry, the radius of the contamination zone may reach even several dozen kilometres.

In the rail network managed by Polish State Railways, approx. 24,000 Polish and 6,000 foreign cisterns are used every year providing approx. 350,000 transport services of hazardous materials. Annual turnover of hazardous materials is approx. 14 million tons, 700,000 of which are particularly hazardous substances.

Road transport

Approx. 6,000 road tankers designed to carry hazardous liquid materials are registered in Poland. It is estimated that every year approx. 1 million tons of such materials are transported. Several hundred road accidents take place every year and vehicles transporting hazardous materials participate in these events. The greatest potential threat is posed by toxic gaseous substances transported in urban areas, as well as by accidents involving contamination of rivers near water intake sites.

Definition and characteristics of chemical terrorism

There are over 100 contemporary definitions of terrorism. Most of them define terrorism as planned and organized activities of an individual of a group of individuals, which violate the existing legal order and are undertaken to force governments and social leaders to perform certain acts or provide certain means.

In the case of chemical terrorism, such activities are ruthlessly conducted by using highly toxic chemical substances, as well as biological and radioactive agents or nuclear weapons. Many terrorist groups are naturally difficult to identify, which reduces the chance of providing a terrorist attack alert early enough or preventing the attack.

The interest of terrorists in using chemical or biological weapons increased significantly after the successful attack in the Tokyo subway. Since then, the governments of the most seriously threatened states, especially the United States and Canada, have been conducting large-scales programmes of tracking potential terrorists and preventing the attacks.

National Defence Strategy of the Republic of Poland

Chemical terrorism is prevented on the basis of state acts of criminal law and special antiterrorism laws. On 23rd May 2000 the Council of Ministers of the Republic of Poland enacted the "National

Defence Strategy of the Republic of Poland" [3], Section 9 of which reads:

"We have also seen increasing threats related to the spread of weapons of mass destruction and its delivery means. The number group of countries, including rogue states, which is close to gaining possession of WMD is increasing. Also, a variety of extremist political, religious and terrorist organizations have been making attempts to gain access to this kind of weapon. If successful, this kind of weapon might be used for terrorist purposes both in and around Poland. We should also be aware of the attempts to transport these weapons through the territory of Poland with all related risks."

With the aim of preventing terrorism the Republic of Poland has ratified international conventions brought forth by such organizations as:

- International Civil Aviation Organization (ICAO),
- United Nations (Chemical Weapons Convention, CWC) [4].

The declarations have been supported by regularly increased funds for antiterrorism activities.

Chemical terrorism threat in the Republic of Poland

As a result of the successful terrorist attack employing a chemical warfare agent, ***sarin***, in the Tokyo subway (20 March 1995), as well as at least 12 other acts performed recently, governments and the public keep carefully analysing potential threats stemming from the possibility that terrorist groups may come into possession of chemical, biological and nuclear warfare agents, considered as weapons of mass destruction (WMD).

In the professional literature, this type of terrorism is frequently termed WMD terrorism (**1, 2**). Terrorism experts are trying to assess whether an individual or a group of individuals may really produce or come into possession of such weapons.

Perhaps it is more important to know how easy it would be to disperse appropriate chemical agents in the environment and what its final outcome would be. In order to illustrate thus defined terrorism, a schematic representation of an act of chemical terrorism is presented in Figure 2.

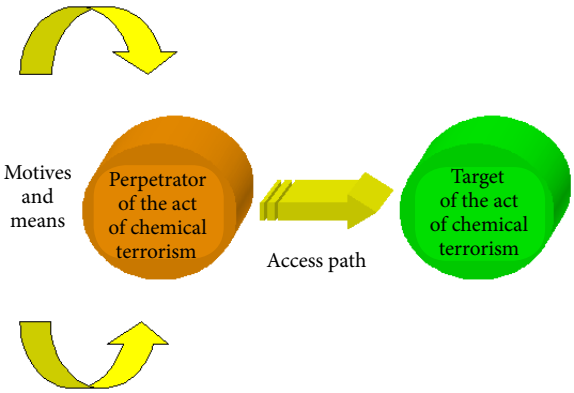

Figure 2: Schematic: perpetrator of an act of chemical terrorism – access path – chemical attack target (victims).

Perpetrators and motives of chemical terrorism

Until early 1980s, terrorists very rarely used chemical or biological agents as weapons. In the 1980s, extreme left-wing activists in Europe threatened to use those agents against civilian or military targets, but no such acts occurred in practice. Until recently, the aims of terrorist attacks were successfully reached through the use of conventional weapons, such as explosives and automatic firearms. (5)

Analyses of the changing situation indicate that, despite poor knowledge of such weapons of mass destruction as highly toxic chemical substances or biological agents, the probability of their application in terrorist attacks is currently significant and rising. (6)

Growing disproportion between the economic situation in rich and technologically advanced countries and poor, underdeveloped countries leads extremist terrorist groups to become more radical and increases their interest in causing multiple deaths and large-scale destruction.

Some examples of this phenomenon are:

- the New York World Trade Centre bombing;
- the Oklahoma City Federal Building bombing;
- the US Embassy bombings in East Africa;
- proliferation of weapons of mass destruction, including both active materials for WMD production and production technologies, along with the know-how acquired in WMD development programmes currently or formerly conducted by some states;
- radicalization of ethnic and religious conflicts in various parts of the world.

Particularly high threat is posed by the activities of apocalyptic religious cults, right-wing extremists or *ad-hoc* islamist groups, whose aim is not gaining political influence or reputation among the population, but rather causing as much destruction and as many victims as possible in the states which are considered particularly hostile by those groups.

Many of those terrorist organizations are naturally difficult to identify, which reduces the chance of providing a terrorist attack alert early enough or preventing the attack. The interest of terrorists in using chemical or biological weapons increased significantly after the successful attack in the Tokyo subway.

Intelligence agencies are aware of the interest of those groups in chemical or biological agents. Among the suspects may be found such organizations as:

- Islamic Jihad Organization and Hamas,
- Armed Islamic Group (GIA) in Algeria,
- Egyptian islamists, Sikh and Chechen terrorists,
- Kurdistan Workers' Party (PKK),
- Khmer Rouge,
- Liberation Tigers of Tamil Eelam (LTTE) and other.

What has to be mentioned is that intelligence agency reports are not always unambiguous and not all of them are verified, although a clearly increasing trend may be seen in the interest in chemical or biological terrorism.

Some of the above mentioned organizations do not exclude potential use of WMD in their acts of terrorism.

Highly toxic chemical substances

Highly toxic chemical substances, from the point of view of terrorists, have certain advantages over conventional means. It is assumed that those substances are relatively cheap and easy to use. Some of them may act immediately, other act after a latency period. This aspect depends of the type of toxic agent and its concentration.

Chemical agents with the potential of being used in terrorist attacks are both those from the military arsenal of chemical weapons and the toxic substances commonly used in industry.

Table 2: Characteristics of chemical substances potentially usable in chemical terrorism [7].

Compound name	LD_{50} [mg/kg]	NDS [mg/m^3]
acrylonitrile	78	2
ammonia	350	20
arsenic and its inorganic compounds	763	0.01
arsine	no data	0.2
arsenic trioxide	14.6	0.01
benzene	930	10
benzo[a]pyrene	no data	0.002
chlorine	n/a	1.5
zinc chloride	350	1
hydrogen chloride	n/a	5
hydrogen cyanide	no data	0.3
carbon disulfide	3188	18
phenol	384	10
formaldehyde	800	0.5
phosgene	no data	0.5
nitric acid	no data	5
picric acid	200	0.1
sulfuric acid	2140	1
methanol	5628	100
nitroglycerin	105	0.5
lead and its inorganic compounds	no data	0.05
vanadium pentoxide	10	0.05
pyridine	891	5
mercury and its inorganic compounds	1	0.05
hydrogen sulfide	n/a	10
zinc oxide	no data	5
antimony trichloride	525	0.5

Table 3: Routes of transport of HCSs to selected production plants in Warsaw city centre.

No.	Name and address of production plant receiving HCS	HCS Name ADR Code	Route of transport
1	"KRÓLEWSKIE" SA Brewery ul. Grzybowska 58	1005 AMMONIA anhydrous	Włocławek – Sochaczew – Pruszków Al. Jerozolimskie, ul.Towarowa, ul.Grzybowska
		1789 HYDROCHLORIC ACID	ul.Rzeczna, ul.Radzymińska ul.Targowa, ul.Grochowska ul.Poligonowa
2	"DANONE" Sp. z o.o. ul. Redutowa 9/23	1005 AMMONIA anhydrous	Włocławek – Sochaczew – Warszawa ul. Połczyńska
3	Elektrociepłownie Warszawskie SA. "SIEKIERKI" Power Station ul. Augustówka 1	1789 HYDROCHLORIC ACID	PKP Warszawa Okęcie – Konstancin
4	* Municipal Water Supply and Sewage Company. Praga Pipe Waterworks. ul. Brukselska 21	1017 CHLORINE	Legionowo – ul. Jagiellońska Wał Międzeszyński –ul.Brukselska
5	* Municipal Water Supply and Sewage Company. Northern Pipe Waterworks ul. Borecka 1	1017 CHLORINE	Wodociąg Północny (Wieliszew) Legionowo – ul. Modlińska ul. Płochocińska, ul. Borecka
6	*Municipal Water Supply and Sewage Company. Central Pipe Waterworks ul. Koszykowa 81	1017 CHLORINE	Wodociąg Północny (Wieliszew) Legionowo – Jabłonna – Most Grota Wybrzeże Gdyńskie, Wybrzeże Gdańskie, Trasa Łazienkowska, ul. Krzywickiego, ul. Koszykowa
7	Warsaw Sport and Recreation Centre. Speed Skating Rink "STEGNY".ul. Inspektowa 1	1005 AMMONIA anhydrous	Włocławek – Sochaczew – Warszawa ul. Pułkowa, Wybrzeże Gdyńskie, Wybrzeże Gdańskie, ul. Czerniakowska, ul. Inspektowa
8	PZL – WOLA SA Mechanical Engineering Facility ul. Fort Wola 22	1005 AMMONIA anhydrous	Włocławek – Sochaczew – Warszawa ul. Połczyńska, ul. Fort Wola
		1789 HYDROCHLORIC ACID	Łódź – Sochaczew – Warszawa ul. Połczyńska, ul. Fort Wola

The following parameters may characterize the agents potentially used in terrorist attacks:

- toxicity, defined using the LD_{50}, or LD_{100} parameters;
- availability;
- mechanism of toxicity;
- physicochemical properties (volatility, solubility, stability);
- special properties suitable for the type of terrorist attack.

Municipal Water Supply and Sewage Company: transport of chlorine to local subsidiaries is organized with attention to the safety of HCS transport following the ADR agreement (which precisely determines the entities transporting HCSs, conditions of transport, requirements for transporting vehicles, container types and quantity of transported substance, vehicle labelling, driver training, etc.). Each chlorine transport is reported to regional authorities, City

Table 4: Risks related to toxic chemical agents.

Characteristics of chemical substance		First aid	
Formula Name	Risks	Premedical aid	Medical aid
NH_3 AMMONIA	Flammable, toxic. Toxic in the case of respiratory exposure.	Evacuate the subject from hazardous area, place the subject in a semi-lying or sitting position, protect from cold. Administer oxygen using mask. In case of breathing difficulties, administer Atrovent inhalation. Seek medical aid.	If laryngeal contraction symptoms persist, introduce secure intravenous access, administer hydrocortisone IV. No improvement is an indication for intubation and emergency medical transport to hospital.
Cl_2 CHLORINE	Toxic and irritant. Toxic in the case of respiratory exposure. Irritant to eyes, respiratory system and skin.	Evacuate the subject from hazardous area. Secure the subject in a semi-lying or sitting position, protect from cold. Administer oxygen using mask. In case of breathing difficulties, administer Atrovent inhalation. Seek medical aid.	If laryngeal contraction symptoms persist, introduce secure intravenous access, administer hydrocortisone IV. No improvement is an indication for intubation and emergency medical transport to hospital.
HCl HYDROGEN CHLORIDE	Corrosive and irritant. Induces serious burns, irritant to respiratory system.	Evacuate the subject from hazardous area, place the subject in a comfortable semi-lying or sitting position, allow no movement, protect from cold. In case of glottal contraction, administer Atrovent inhalation. Administer breathing oxygen. Seek medical aid immediately.	If laryngeal contraction symptoms persist, introduce secure intravenous access, administer hydrocortisone IV. No improvement is an indication for intubation and emergency medical transport to hospital.

Engineer and the police. Convoy staff comprises the "Company Chlorine Emergency Squad".

"**Company Chlorine Emergency Squad**" is a group trained for any case of chlorine liberation from its containers, working for Municipal Water Supply and Sewage Company as chemical security staff. Company Chlorine Emergency Department is equipped with respiratory aids and protective clothes allowing them to minimize the damage caused by any malfunction (chlorine leakage) during the transport. The chlorine convoy is escorted by police cars.

The other production plants use services provided by independent companies, authorized to transport HCSs and equipped with appropriate vehicles, trained drivers, proper authorization documents for HCS transport, etc.

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References:

1. Anon.:Biological weapons;malignant biology.1999. NBC-MED.Microbiology 101 Internet Text. Chapter XV.
2. Anonim.:Biological and chemical terrorism:Strategic plan for prepardnes and response.Recomendations of the CDC Strategic Planning Workgroup. MMWR.2000:49,1.
3. Ashraf H.:european dioxin-contaminated food crisis grows and grows (news).Lancet 1999,353,2049.
4. Inglesby T.,Grosman R., O'Toole T.: A plague on your city: observations from TOPOFF.Biodefens Qarterly.2000.
5. Jancin B.:Primare care physitians on frontline of bioterrorist attack.Pediatric News 1999:33,25
6. Kaufmann A.F.,Meltzer M.J, Shmidt G.P.:The economic impact of bioterroristic attack: are prevention and posattack interventionprograms justifiable?Emerging Infectious Diseases 1997:3,83.
7. Kortepeter M.G.,Parker G.W.:Potential biological weapons threats.Emerging Infectious Diseases 1999,5,1.
8. O'Toole T.:Smallpox: an attack scenario.Emerging Inf. Disease.1999, 5,1.
9. Porter V.:Smallpox:disease eradicated, but virus not eliminated.Infect. Med.,2000:17,131.
10. Stern J.:The prospect of domestic bioterrorism. Emerging Inf Disease,1999.5.14.
11. Torok T J., Tauxe R.V.et al.:Large community outbreak of salmonellosis caused by international contamination of restaurant salad bars.JAMA,1997:278,389.
12. Anonim.Reported cases of Escherichia coli outbreaks. Merdian Diagnostics,Inc.(http://www.me).
13. Bilecki Ś.,Gall W., Grzybowski A.,Kubica J., Reiss J.:Epidemiologaia wojskowa.Podręcznik MON, Warszawa 1992.
14. Chemical and Biological Terrorism.National Akademy Press, Washington D.C. 1999. Tekst dosepny tez na stronie internetu http://www.nap.edu.
15. Christofer G.W.,Cieslak T.J.,PavlinJ.a.,Eitzen E.M.:Biological Warfare.A historical perspective.JAMA 1997:278,412
16. Eichoff T.C.:Airborn disease. Am.J.Epidemiol.1996:144,S39.
17. Ferguson J.R.:Biological Weapons and US Law.JAMA 1997:278,357.
18. Finke E.J.,Loscher J.,Koch H.:"Planning of medical support for a treatened or actual biological environment.Principles, policies and procedures."W:"NBC Risks", Sohns T.,Voicu V.A.,(red.).NATO Science Series,Kluwer Acad. Publ.,Dordrecht 1999: 69.
19. Franz R.D.,Jahrling P.B.,Friedlander A.M.,McClain D.J..Hoover D.L.,Bryne W.R.,,Pavlin J.A.,Christopher G.W.,Eitzen E.M.:Clinical recognition and management of patients exposed to biological warfare agents .JAMA 1997:278,399.
20. Geissler E. I van Courtland Moon J.E.(red.):Biological and toxic weapons research, development and use from the middle ages to 1945.SIPRI.Press Release 1999,(www.spiri.se).
21. George L.T.C. i wsp.:Biological warfare.A historical perspective,JAMA 1997:278,4120.
22. Henderson D.A.:The looming threat of bioterrorism. Science 1999:283,1279.
23. Krzemiński Z.,Majda-Stanisławska E.:Hantawirusy. Post.Mikrrobiol.1998:37,199.
24. Magdzik W.(red.):Choroby zakaźne i pasożytnicze. Zapobieganie i zwalczanie."Vesalius". Uniwersyteckie Wydawnictwo Medyczne,Kraków 1993.
25. Mierzejewski J.:Konsekwencje doświadczeń nad wykorzystaniem Bacillus anthracis jako broni biologicznej.Post.Mikrobiol.1995:34,385.
26. Mierzejewski J.:Terroryzm biologiczny.Życie Weteryn.1999:74,204.
27. Noah D.L.,Sobel A.L.,Ostroff S.M., Kildew J.A.:Biological warfare training.Infectious disease outbreak differentiation criteria.Milit. Med.1998:163.
28. Perry i Fetherson.Clin.Microbiol.Rev.1997,10,35.
29. Simon J.S.:Biological Terrorism.Preparing to Meet the Threat.JAMA 1997:278,428.
30. Virella G.:Mikrobiologia i choroby zakaźne.Urban & Partner,Wrocław 2000.
31. Geisslered E.(red.):Współczesna broń biologiczna i toksyny.SIPRI, Oxford,University Press,1986 (www.sipri.se).
32. Zaremba M.L.,Borowski J.:Mikrobiologia lekarska. PZWL, Warszawa, 1997.
33. Barnaby W.:the BMA report on biological and genetic weapons. Medicine,Conflict Survival 1999:15,286.
34. Biological and chemical terrorism:strategic plan for preparedness and response.Morbidity and Mortality Weekly Report.US Dpt. Of Health and Human Services,CDC 2000:49.
35. Haghighi L.:Bacillus antrcis:an old weapon in the future.Ixth International Congress of Bacteriology & Applied Microbiology.Sydney.Australia 1999.
36. Hurlbert R.E.:Microbiology 101 Internet text. Ch. XV, Addendum: Biological weapons:malignant biology.1999 (http://www.wsu.edu).
37. Jaljaszewski J.:Nowe, ponownie pojawiające się zakażenia: globalne zagrożenie.Nauka 1999, Nr. 2, 17.
38. Pomerantsev A.P.,Staritsin N.A.,Mockov Y.V.,Marinin L.I.:Expression of cereolysine AB genes in Bacillus Anthracis vaccine strain ensures protection against experimental hemolytic anthrax infection Vaccine 1997:15, 1846.
39. Philip R.:Environmental health training within public health medicine.Public Health 1990:104,465.
40. Rothschild J.R.:Tomorrows weapons: chemical and biological.New York 1964.
41. The problem of Chemical and Biological warfare. Tom I:The rise of CB Weapons.Sztokholm 1971.
42. Toksykologia Przemysłowa , tom I,Instytut Medycyny Pracy,Łódź 1993.

43. Szajewski J.,Feldman R.,Glińska-Serwin M.:Leksykon ostrych zatruć.PZWL, Warszawa 2000.
44. Jaśtak Z.: Skażenia promieniotwórcze, chemiczne i biologiczne.Warszawa 1969.
45. Calabrese E.J., Baldwin L.A.: Hormesis as a biological hypothesis. Environ. Health Perspect. 1998:106 (supl.l): 357-362.
46. Cerveny T. J. i wsp.: Acute Radiation Syndrome in Humans, w: Medical Conse-quences of Nuclear Warfare, Walker R.I. i Cerveny T.J. (Wyd.), Armed Forces, Radiobiology Research Institute, Bethesda, MD 1996:15-36.
47. Diamandis E.P.: Clinical applications oftumor suppressor genes and oncogenes, in cancer. Clin. Chim. Acta 1997:257,157-180.
48. Doerffer K., Unrau P.: Cancer genes and risk assessment. Health Phys. 1998:74,173-180.
49. Doli R.: Hazards of ionising radiation: 100 years of observations **on** mań. Br., J. Cancer 1995:72,1339-1349.
50. Doli R.: Effects of smali doses of ionising radiation. J. Radiat. **Prot.** 1998: 18, 163-174.
51. Donos R.F., Cerveny T.J.: Triage and treatment of radiation-injured mass casualties. w: Medical Consequences of Nuclear Warfare, Walker R.I., Cerveny T.J.
52. (Wyd.), Armed Forces Radiobiology Research Institute, Bethesda, MD 1996:37-54.
53. Fry R.J.M., Fry S.A.: Health effects of ionizing radiation. Med. Clin. North Am., 1990: 74, 475-488.
54. Kiecolt-Glaser J.K., Glaser R.: Psychoneuroimmunology and Cancer: Fact or Fiction? Eur. J. Cancer 1999:35,1603-1607.
55. Luckey T.D.: Nurture with ionizing radiation: A provocative hypothesis. Nutr. Cancer 1999: 34,1-11.
56. Mickley G.A. i wsp.: Behayioral and neurophysiological changes with exposure to ionizing radiation, in: Medical Consequences of Nuclear Warfare, Walker, R.I. & Cerveny T.J. (Wyd.), Armed Forces Radiobiology Research Institute, Bethesda, MD 1996:105-151.
57. Mickey G.A.: Psychological factors in nuclear warfare, **w:** Medical Consequences of Nuclear Warfare, Walker R.I., Cerveny T.J. (Wyd.), Armed Forces Radiobiology Research Institute, Bethesda, MD 1996:153-169.
58. Miller R.W.: Delayed effects of extemal radiation exposure: A brief history. Radiat. Res. 1995:144,160-169.
59. Muller H.J.: Artificial transmutation ofthe gene. Science 1927:66,84-87.
60. Nias A.H.W.: Ań Introduction to Radiobiology, John Wiley & Sons, Chichester,1990.

Military Medicine

Tactical Combat Casualty Care: problem outline,application, rules of proceeding

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Summary:

Tactical Combat Casualty Care (TCCC) is strictly connected with battlefield medicine and assault tactics. It covers a broad scope of procedures, techniques and combined actions aimed at providing effective aid to one's own casualties at the time of military operations and their evacuation from the field of battle. The paper presents the rules of proceeding and the range of actions taken under TCCC.

Key words: Combat Casualty Care, TCCC, application, rules of proceeding.

Ninety per cent of casualties during military operations die before they are provided medical aid [1,2]. This fact is the main reason for the ongoing introduction of improvements in casualty care in the field of battle. The answer to this problem is Tactical Combat Casualty Care (TCCC) whose aim is to treat potentially reversible causes of cardiac arrest during combat, along with providing tactical security of the site [4,5]. Studies on the topic indicate that among the most common causes of death in the field of battle are limb haemorrhages (60 %), respiratory problems (33 %) and obturation of respiratory ways (13 %), therefore all actions under TCCC are aimed at coping with the above life-threatening conditions [4,1,2,6,3,7]. Actions introduced according to the TCCC algorithm are meant to keep the subject alive until the final treatment is available and encompass pre-hospital procedures, such as application of tourniquet to manage massive limb haemorrhages, needle decompression in the cases of tension pneumothorax, and tracheotomy in the cases of impaired air flow through respiratory ways due to facial trauma [4,5,8,9,10,11,12,13,3,7].

TCCC: attempted definition and rules of proceeding

There are many incorrect interpretations and abuses of the term Tactical Combat Casualty Care, thus it is crucial to identify the actions it covers. TCCC may be defined as a component of special tactics realized by military units, subunits and other tactical groups. This type of tactics is strictly connected with battlefield medicine and assault tactics. It covers a broad scope of procedures, techniques and combined actions aimed at providing effective aid to one's own casualties at the time of military operations and their evacuation from the field of battle. Its main goal is to save the lives of casualties through relocation (in search of a short-term shelter from danger), counterattack and providing first aid. The main principles of Tactical Combat Casualty Care are gathered in the TCCC guidelines [2,11,12,3].

Noteworthy is the fact that one of the most significant features of TCCC is a changed nature of life saver's actions and procedures, which are different to those in civilian environment. According to the TCCC procedures, the first casualties to be provided with aid are those less severely wounded, so that they may return as quickly as possible to the military operation and support their unit. Life saver's own safety is a very important aspect. TCCC concerns a given unit or subunit in a hazardous location which is forced to use its own means to provide first aid to its wounded members [2,11,12,3].

TCCC: zones of care

Considering the level of threat posed by the enemy, TCCC distinguishes three zones: hot (also known as ground zero or hot spot), warm (relatively safe) and cool (safe) [14].

The hot zone refers to a location occupied by enemy forces, in which constant risk to health and life occurs. Actions taken in that zone are named Care Under Fire, since they are executed under direct enemy gunfire and involve counteractions leading to stopping the enemy attack, relocating the casualty to a covered site and treating any external haemorrhages using a tourniquet or haemostatic bandage [2,11,12,3,7].

The warm zone is in close proximity to the hot zone and enemy actions may still reach people in that zone. The warm zone is also called the Tactical Field Care zone. It is usually located at the back of the main operation zone. Most actions taken under TCCC are performed there, such as preliminary casualty segregation and first aid. Other unit members who do not participate in providing aid are in combat readiness. The first casualties to be provided with aid are those with the least severe wounds and the greatest chance of survival, so that they may return as quickly as possible to their duties and support their unit in the military operation. Once treated, the wounded need to be moved away from that zone to a safe place, as the warm zone may become a hot zone at any time. At this stage, the CABDE examination is also performed, i.e. the assessment of circulatory functions, air flow through the respiratory tract, respiratory functions, neurological state and entire body examination for possible traumas [3,7].

The third and last zone distinguished by TCCC is the cool zone. It is an area in which no threat from the enemy is present, while it is possible to pass the casualties to civilian paramedics. It is indicated that a field hospital be located in that zone. Medical aid is provided to all casualties, particularly those most severely wounded. Action taken at this stage are named Tactical Evacuation and cover evacuation both from the field of battle (Casualty Evacuation, CASEVAC) and medical evacuation conducted by air from the site where the wounded may be taken to a field hospital (Medical Evacuation, MEDEVAC) [11,12].

Actions taken under TCCC

Providing Care Under Fire is based on stopping the enemy attack, protecting one's own safety and relocation along with the casualty to a covered site where all life-threatening external haemorrhages may be stopped using a tourniquet over the uniform in limb haemorrhage cases or compression/haemostatic bandage for wounds in other body parts. Clearing the respiratory tract is best postponed until relocation into a relatively safe place. It is vital to talk to the wounded, reassure them and explain the actions involved in the first aid [2,11,12,3,7].

When providing Tactical Field Care to unconscious casualties, their respiratory tract should be cleared either manually using the head-tilt/chin-lift manoeuvre or a nasopharyngeal tube, and if the above methods fail, performing tracheotomy is suggested [14,11,12,3,7]. In order to assure clear airways the wounded should be placed in the recovery position. Casualties with altered state of consciousness should be disarmed immediately, as the may pose danger. In subjects with penetrating traumas cervical immobilization is not required [6,11,12,3,7], while it should be considered in the victims of mine explosions [5,15]. Casualties with chest trauma and breathing difficulties are to be suspected of tension pneumothorax. It is indicated to relieve tension pneumothorax by puncturing the damaged chest using a 14-gauge needle. Puncture site should be located in the 2nd intercostal space in the midclavicular line [4,11,12,3,7]. Open or sucking chest wounds should be dressed with a tight bandage [11,12]. The casualty should then be observed for possible development of tension pneumothorax [11,12,3,7]. At this stage, previously applied

bandages are checked and previously unidentified haemorrhages are sought and secured with bandages. Additionally, the possibility of removing tourniquets is assessed once the wound is dressed using compression or haemostatic bandages. If it has not been done before, massive haemorrhages from extremities are blocked with tourniquets applied directly onto the skin, 5–8 centimetres above the wound [9,11,12]. If, despite tourniquet application, pulse is present in the distal parts of the limb, tightening the tourniquet or applying another one above should be considered [8,9,11,12,13,3,7]. Haemostatic bandages are applied over haemorrhages from other body parts [11,12,3,7]. If needed, an 18-gauge intravenous line or, when that is not feasible, intramedullary line should be applied [11,12,14,15]. In casualties presenting signs of hypovolaemic shock, such as altered state of consciousness with no recent head injury and faint or absent peripheral pulse, it is recommended to administer 500 ml Hextend I.V. (6 % HES with physiological crystalloid other than 0.9 % NaCl as carrier). If no improvement is evidenced after 30 minutes, the dose may be repeated once. In conscious casualties with no signs of shock liquids may be administered orally [11,12,3,7]. In subjects requiring blood transfusion administration of tranexamic acid (TXA, AXACYL) is recommended to decelerate fibrinolysis by inhibiting plasminogen activation to plasmin. The subject is administered I.V. 1 g TXA dissolved in 100 ml 0.9 % NaCl or lactated Ringer's solution.

Another dose is administered after Hextend or other infusion [12]. The decision to continue resuscitation should be made taking into account the logistic and tactical conditions, as well as the risk of arrival of further casualties [11,12,3]. In unconscious casualties with traumatic brain damage and no peripheral pulse, fluid resuscitation is recommended until the pulse of the radial artery becomes detectable [11,12,3,7]. It is also important to protect the casualty from heat loss by minimizing the time of exposure, drying the subject or changing the subject's clothes, placing the subject on an isolated surface and covering with a thermal blanket [11,12]. To prevent hypothermia, warmed fluids are used for fluid resuscitation [11,12]. In the case of eye injury, a quick field-of-view examination should be conducted and a protective bandage should be applied over the injured eye [11,12,4,7]. Pain management in subjects with a retained ability to fight involves 15 mg Meloxicam administered orally once a day and 650 mg Paracetamol every 8 h. Casualties who are unable to fight receive 5 mg morphine intravenously or intramedullarily with the dose repeated every 10 minutes, if necessary. Constant observation of the subject for possible development of hypoventilation is necessary. If needed, naloxone should be administered.

Alternatively, 800 µg fentanyl may be used buccally. To prevent vomiting and enhance the action of analgesics, 25 mg promethazine may be administered I.V./I.O./I.M. every 6 h [11,13,3,7]. Use of antibiotics is indicated with all open wounds, including ocular wounds. In subjects who can swallow, 400 mg moxifloxacin is used orally once a day. Unconscious casualties receive I.V./I.M. 2 g cefotetan or I.V./I.M. 1 g ertapenem every 12 h [11,13,3,7]. At this stage, bone fractures are immobilized and the pulse of the injured limbs is controlled. Resuscitation of unconscious casualties with blunt or penetrating traumas, no pulse, not breathing or presenting any signs of life will not succeed and should not be undertaken in the field of battle [11,12,3,7]. However, in casualties with chest injuries or polytrauma who have no pulse or breath, bilateral chest puncture should be performed to exclude tension pneumothorax before abandoning resuscitation [12]. In the case of inhalational airway burns, surgical airway clearance is required [12]. Burns covering approx. 10 % total body surface area (TBSA) are dressed with dry aseptic bandages. Burns covering >20 % TBSA should be dressed with thermal blanket both to protect the wounds and to prevent heat loss [12]. What is more, in the case of such large burns it is indicated to perform fluid resuscitation based on the Rule of Ten established by the U.S. Army Institute of Surgical Research (USAISR). According to the rule, fluid volume to be infused to the casualty is calculate using the formula % TBSA × 10 ml/h in adults weighing 40–80 kg. Another 100 ml/h are added per each 10 kg weight exceeding 80 kg. Fluid resuscitation in burn treatment involves the use of lactated Ringer's solution, 0.9 % NaCl or Hextend (up to 1000 ml) [12].

During tactical evacuation, the casualty is subjected to procedures indicated in earlier phases with an optional application of laryngeal mask, the Combitube airway and tracheal intubation.

If the chest puncture to relieve tension pneumothorax has been unsuccessful or a long transport time is expected, application of a chest drain should be considered. Using oxygen therapy is indicated in casualties with a low saturation level indicated by pulse oximeter or injuries involving poor ventilation, unconscious subjects or subjects with traumatic brain damage (maintain $SpO_2 > 90\,\%$)[11,12,3,7].

If signs of shock occur, apart from the actions taken during the previous stage, continuing fluid resuscitation using crystalloids or Hextend should be considered until a systolic pressure of 80–90 mmHg is obtained [6,11,12,3,7]. When shock is present, blood substitutes may be used, if available. Two plasma units and RBC concentrate may be administered at a ratio of 1:1. If those preparations are not available, full blood may be used [11,12]. In unconscious subjects with traumatic brain damage and no peripheral pulse, fluid resuscitation is conducted until a systolic pressure of ≥ 90 mmHg is obtained [11,12,3,7]. Use of Pneumatic Antishock Garment (PASG) should be taken into consideration in casualties requiring stabilization of pelvic fractures and to control pelvic and abdominal haemorrhages. The method is contraindicated in subjects with craniocerebral or chest injuries [11,12,3,7]. At this stage, the subject's condition is monitored using pulse oximeter. Other vital signs are assessed as well. In casualties with no apparent lethal injuries, who experienced respiratory and cardiac arrest, cardiopulmonary resuscitation is acceptable at this stage, but only if the subject may soon reach a place where surgical intervention may be performed and mission objectives will not be compromised [12].

The range of competences of the personnel providing first aid to casualties is presented in Table 1.

Table 1: The range of competences under TCCC [3].

Skills		Soldier	Combat Life Saver	Combat Medic
Principles of tactical medicine		x	x	x
Dressing haemorrhages	Tourniquet	x	x	x
	Compression bandage	x	x	x
	HemCon® haemostatic bandage	x	x	x
	Military anti-shock trousers (MAST)			x
Casualty transport techniques		x	x	x
Respiratory ways	Head-tilt/chin-lift manoeuvre	x	x	x
	Nasopharyngeal tube	x	x	x
	Tracheal puncture/tracheotomy			x
	Laryngeal mask			x
	Tracheal intubation			x
	Combitube airway			x
Ventilation	Relieving tension pneumothorax via needle chest puncture		x	x
	Securing open pneumothorax	x	x	x
	Chest drainage			x
	Oxygen supply			x
Intravenous line / therapy	Assessment of shock signs	x	x	x
	Intravenous line application		x	x
	Intramedullary line application			x
	I.V. Fluid resuscitation		x	x
	I.V. Analgesics administration			x
	I.V. Antibiotic therapy			x
	I.V. Blood and blood substitute administration			x
Intramuscular (I.M.) therapy	I.M. Morphine	x	x	x
	I.M. Antibiotic therapy			x
Oral (P.O.) medications	P.O. Analgesics	x	x	x
	P.O. Antibiotic therapy	x	x	x

Skills		Soldier	Combat Life Saver	Combat Medic
Fractures	Immobilization using splint	x	x	x
	Immobilization using skeletal traction splint		x	x
Electronic monitoring				x

Conclusions

First aid in the field of battle is very limited due to high risk to the life saver's health and life. Involved actions are meant to prevent potentially reversible causes of cardiac arrest, such as hypovolaemia, hypoxia and tension pneumothorax by stopping haemorrhages using tourniquets or haemostatic bandages, chest puncture using needle, oxygen and fluid therapy. Providing Care Under Fire is limited to stopping life-threatening haemorrhages, while further relocations to safer places permit more methods of vital sign stabilization to be applied, including blood and blood substitute transfusion during Tactical Evacuation. This paper refers to the standards set by TCCC and used mainly by the American and Canadian armed forces, however, the authors are aware that not all countries allow the use of the aforementioned methods by soldiers, combat life savers and combat medics under the prehospital care. Nonetheless, the effectiveness and safety of the procedures described in this paper has been widely studied and described in medical literature. Therefore the authors presumed that all recommendations were worth mentioning without their adaptation to the regulations of Polish Armed Forces.

References:

1. Bellamy RF. The causes of death in conventional land warfare: implications for combat casualty care research. Milit Med 1984; 149: 55-62.
2. Butler FK, Hagmann J, Butler EG. Tactical Combat Casualty Care in Special Operations. Milit Med 1996, 161(3 Suppl):1-15. 3.The Committee on Tactical Combat Casualty Care: Tactical Combat Casualty Care. Prehospital Care in the Tactical Environment. 21 Feb 2003 Draft.
3. Beckett A, Savage E, Pannell D. i wsp. Needle decomperssion for tension pneumotorax in Tactical Cambat Casualty Care: do catheters placed in midaxillary line kink more often than those in the midclavicular line? J Trauma 2011; 71: 408-412.
4. Comstock S, Pannell D, Talbot M i wsp. Spinal injuries after improvised explosive device incidents: implications for tactical combat casualty care. J Trauma 2011; 71: 413-417.
5. Dubic M A: Current concepts in fluid resuscitation for prehospital care of combat casualities. US Army Med Dep J 2011, April-June:18-24.
6. US Army Special Operations Command: Ranger Medic Handbook 2007, Edition 75th Ranger Regiment.
7. Kragh JF, Baer DG, Walters TJ. Extended (16-Hour) tourniquet application after combat wounds: a case report and review of the current literature. J Orthop Trauma 2007; 21(4): 274-278.
8. Kragh JF, Walters T J, Baer DG i wsp. Practical use of emergency tourniquets to stop bleeding in major limb trauma. J Trauma 2008; 64: 38-50.
9. Kragh J F, Walters T J, Baer D G i wsp. Survival with emergency tourniquet use to stop bleeding in major limb trauma. Ann Surg 2009;249(1): 1-7.
10. Tactical Combat Casualty Care Guidelines. February 2009. Źródło: www.itstactical.com.
11. Tactical Combat Casualty Care Guidelines. 8 August 2011. Źródło: www.itstactical.com.
12. Taylor DM, Vater G M, Paker P. J. An evaluation of two tourniquet systems for the control of prehospital lover limb hemorrhage. J Trauma 2011; 71:591-595.
13. Bennet BL, Cailteux-Zevallos B, Kotora J.: Cricothyroidotomy bottom-up training review: battlefield lessons learned. Milit Med 2011;176:1311-1319.
14. Pannell D, Brisebois R, Talbot M. i wsp. Causes of death in Canadian Forces members deployed to Afganistan and implication on tactical combat casualty care provision. J Trauma 2011; 71: 401-407.

Epidemiology

Estimation of protein-energy and mineral nutritional status of flight engineers and navigators serving in the Polish Air Force

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Summary:

Introduction: The aim of the study was to assess the protein-energy and mineral nutritional status of flight engineers and navigators of military aircraft.
Material and Methods: Measurements of body weight and body height were performed in all examined subjects. The obtained results made a basis to calculate the Body Mass Index - BMI. The study also included thickness measurements of selected skin folds. Examinations of bone mineral density were also carried out using the densitometric method.
Results/Conclusion: Normal body weight was found in 24.3 % of navigators and 31.0 % of flight engineers. Overweight was found in 54.1 % of navigators and 44.9 % of flight engineers. Obese persons were also present among the examined subjects. In the group of navigators obese persons constituted 21.6 % and in the group of flight engineers – 24.1 % of the examined subjects. Normal bone calcification was found in 91.9 % of navigators and 69% of flight engineers. Among navigators, 8.1 % reported osteopaenia, while among flight engineers – 31 %. No changes indicating the occurrence of osteoporosis were found in either group. Overweight and obesity were found in both navigators and flight engineers which is not favourable from the health point of view. Correct bone calcification found among over 90 % of the examined navigators is a very positive factor.

Key words: mineral nutritional status, overweight, obesity, densitometric method.

Introduction

Nutritional status of an organism is a result of nutrition manner, absorption and utilization of nutrients, as well as the activity of many different adverse environmental factors. Both the deficiency and the excess of nutrients in a daily diet affect nutritional status, creating a risk of many diet-related diseases (Szponar *et al.* 2002). Factors such as abundance and widespread availability of food, its aggressive advertising, as well as a lifestyle restricting physical activity, are the main causes of overweight and obesity spread (Respondek 2008). Both of those phenomena originate from a prolonged state of positive energy balance (Jarosz and Respondek 2008). Currently, in 19 European Union member states the percentage of people indicating overweight and obesity in the population of adult women varies from 36.9 to 56.7 %, whereas in men those values vary from 51 to 69.3 % (http//webcache.googleusercontent.com/search 2012). Good nutritional status is not only consistent with the accepted standards of body

weight, muscle or fat content, but also with good condition of bone mineralization that limits the occurrence of fractures, especially upon the exposure to adverse environmental factors affecting the skeletal system.

Service in the Polish Air Force is highly stressful. Strong emotions associated with the responsibility for the tasks performed in the air are often reduced by excessive consumption of food, especially during standbys. Such a way of mental stress reduction leads to increased body weight (Kobos *et al.* 2003).

The aim of the study was to assess the protein-energy and mineral nutritional status of flight engineers and navigators serving in the Polish Air Force.

Material and methods

A total of 66 men performing military service in various units of the Polish Air Force and flying different aircraft types underwent the examination of protein-energy and mineral nutritional status. Nutritional status of 37 navigators and 29 flight engineers was assessed.

Measurements of body weight and body height were conducted among all examined subjects and the obtained results made a basis to calculate the Body Mass Index—BMI. In accordance with the Ferro-Luzzi classification (Ferro-luzzi et al 1992), the BMI value was the basis for the qualification of the examined subjects to the following groups: normal weight [BMI 18.5 kg/m^2 – 24.9 kg/m^2], overweight [BMI 25.0 kg/m^2 – 29.9 kg/m^2] and obesity [BMI 30.0 kg/m^2 – 39.9 kg/m^2]. Based on the thickness measurements of 4 selected skin folds (on biceps, triceps, under scapula and over iliac crest), fat content in the body was determined using the Durnin and Womersley method (Durnin and Womersley 1974). The measurements of skin fold thickness were conducted using the Holtain caliper with constant pressure of 10 g/mm^2.

The examination of bone mineral density was carried out using the DEXA densitometric method (dual energy-X-ray absorptiometry) on the nonprevailing upper limb forearm bone, using the EXA 3000 apparatus. The degree of bone mineralization was assessed based on the T-score value. The T-score value of >-1 was adopted as a normal value. T-score values between – 1 and – 2.5 are characteristic of osteopaenia, while values lower than – 2.5 are typical of osteoporosis (Blade and Fogelman 2000).

Results and discussion

The average age of the examined group of navigators was 35.2 ± 7.5, while for flight engineers it was 38.4 ± 7 years (Table 1). The group of flight engineers was taller by 1.4 cm compared to the navigators and the weight of navigators was higher by 0.8 kg. In comparison with the flight engineers, the group of navigators had approx. 1.5 cm longer arm circumference, skin fold thickness under scapula and over iliac crest greater by 2.81 mm and 0.7 mm, respectively, as well as lean body weight greater by 0.5 kg. Normal body weight was found in 24.3% of navigators and 31.0 % of flight engineers, while overweight was found in 54.1% of navigators and 44.9 % of flight engineers. In the group of navigators, 21.6% were obese, whereas in the group of flight engineers obesity occurred in 24.1% (Table 2).

Table 1: Average values of the examined parameters in the groups of navigators and flight engineers.

	Navigators	Fight Engineers
Age [years]	35.2±7.5	38.4±7.2
Body height [cm]	175.8±6.2	177.2±7.8
Body weight [kg]	85.8±10.9	85.0±11.53
Arm circumference [cm]	34.6±3.12	33.1±3.23
Skin fold on biceps [mm]	2.85±0.52	2.83±0.52
On triceps [mm]	3.05±0.51	3.07±0.50
Under scapula [mm]	23.00±6.78	20.19±6.56
Over iliac crest [mm]	28.43±8.29	27.70±6.74
Body Mass Index [kg/m^2]	27.80±3.71	27.1±3.48
% of fat content	22.9±4.51	22.87±3.33
Lean body mass [kg]	65.9±7.55	65.4±.8.42

The results of previous studies performed in 402 male aircraft crew members of the Polish Air Force revealed the percentage of

overweight and obese men increasing with age. Overweight occurred in each of the examined age groups, at the same time the percentage of subjects reporting overweight ranged from 50% in men aged up to 30 to 59.6 % in the group of men aged 41-50. Similarly, the number of obese subjects increased with age. In the group of men aged up to 30, obesity was found in 10.5%, while in the group aged 41-50 obesity was found in 20.2 % of the examined subjects (Kłos and Bertrandt 2000).

Table 2: Overweight and obesity occurrence in the examined groups (%).

BMI [kg/m²]	Navigators	Flight engineers
Normal values 18.5-24.9	24.3	31.0
Overweight 25.0 – 29.9	54.1	44.9
Obesity 30.0 – 39.9	21.6	24.1

of overweight and obesity concerned 33 % of world population. It is estimated that in 2030 up to 58 % of the inhabitants of our planet will have abnormal body weight (IDCZAK http//www.yaacool-uroda.pl 2012).

Adequate supply of calcium is very important for proper formation and functioning of the human skeletal system. Normal bone calcification was found in 91.9 % of the examined navigators and 69% of flight engineers. In both examined groups, changes in skeleton calcification characteristic of osteopaenia were found and concerned 8.1% of navigators and 31 % of flight engineers.

Changes in skeleton calcification characteristic of osteoporosis were not found in the examined groups.

Conclusions

1) Excessive body weight found in over 75 % of navigators and 69 % of flight engineers testifies to an unfavourable, from the health point of view, and unbalanced, in terms of energy, nutrition model.

2) Changes in bone calcification characteristic of osteopaenia, found in more than 39 % of the examined subjects indicate a calcium shortage in the diet or disorders in calcium absorption and assimilation.

3) It is necessary to take extensive educative actions among the Polish military aircraft crews in correct nutrition, as well as permanent training of Air Force officers responsible for planning and implementing nutrition in the field of nutritional prophylaxis of metabolic civilization diseases.

Table 3: Bone calcification status in the groups of navigators and flight engineers compared to other groups of men (%).

T-score	Navigators	Flight engineers	Medical aircraft crew (Kłos and Bertrandt 2011)	Pilots altogether (Bertrandt et al 2005)	Inhabitants of Warsaw (Bertrandt and Kłos 2008)
Normal bone calcification up to -1	91.9	69	86.2	64.3	36.3
Osteopaenia -1 – -2.5	8.1	31	10.5	33.3	42.5
Osteoporosis ≤-2.5	-	-	3.3	2.4	21.2

Studies of nutrition in men serving as military medical aircraft crew in the Polish Air Force revealed the occurrence of overweight in 53.3 % of the examined physicians and 61.9 % of the examined medical rescuers. Obesity was found in 20 % of physicians and 16.7 % of medical rescuers (Kłos and Bertrandt 2011).

The results of another study indicated that every third Pole is overweight and 14 % of Polish citizens are obese. The authors concluded that overweight occurred more often in men than in women. (JANIK and ZATOŃSKI 2004). Studies carried out in 2006 at the University School of Public Health and Tropical Medicine in New Orleans demonstrated that in 2005 the problem

References:

1. Blade G., Fogelman I.: Diagnostyka radiologiczna osteoporozy. W Arden N.K., Spector T. D. (2000): Osteoporoza – aktualny stan wiedzy, Warszawa, Borgis,: 50-56.
2. Bertrandt J., Kłos A., Bieniek R.(2005): Bones calcification degree and nutritive status of Polish aircraft personnel stasing in the military training camp. Ann. Nutr. Metab. **49**, (S1): 337.
3. Bertrandt J., Kłos A. (2008): Densytometryczna ocean uwapnienia kości kobiet I mężczyzn zamieszkujących okolice Warszawy. Lek. Wojsk. **86:** 81-84.
4. Durnin J.V., Womersley J. (1974): Body Fat assessed from total body density and its Estimation from skinfold thickness: measurements on 481 men and women aged 16 to 72 years. Br. J. Nutr. **32**: 77-97.
5. Ferro-Luzzi A., Sette S., Franklin S., James W. P.T.(1992): A simplified approach of assessing adult chronic energy deficiency. Eur. J. Clin. Nutr. **46,** 173-186.
6. Idczak K. Nadwaga słabością Polaków. Odżywianie: (2012) http//www.yaacool-uroda.pl 2012).
7. Jarosz M., Respondek W(2008): Rola żywienia i aktywności fizycznej w zapobieganiu nadwadze i otyłości oraz przewlekłym chorobom niezakaźnym. w Jarosz M., Bułhak-Jachymczyk B. Normy żywienia człowieka. Podstawy prewencji otyłości i chorób niezakaźnych. PZWL, Warszawa: 353-358.
8. Janik K., Zatoński W.(2004): Rozkład masy ciała w Polsce w 2002 roku. W Brzozowska A., Gutkowska K.: Wybrane problemy nauki o żywieniu człowieka u progu XXI wieku. SGGW, Warszawa: 134-138.
9. Kłos A., Bertrandt J.(2008): Występowanie nadwagi i otyłości wśród wojskowego personelu latającego. Pol. Przegląd Medyc. Lotniczej **4:** 337-343.
10. Kłos A., Bertrandt J.(2011): Występowanie nadwagi i otyłości oraz ocena stanu odżywienia mineralnego wojskowego medycznego personelu latającego. Lek. Wojsk.. **89**: 93-97.
11. Kobos Z., Bednarski W., Bertrandt J., Kłos A., Bieniek R(2003).: Psychologiczne uwarunkowania otyłości wśród personelu lotnictwa. Żyw. Człow. Metab. **30**:237-239.
12. Respondek W.(2008): Strategia populacyjna prewencji otyłości. – wyzwanie dla obywatela. Otyłość – wyzwanie dla państwa i obywatela IŻŻ: 13-16.
13. Rosnące Europejskie BMI http://webcache. googleusercontent.com/search 2012.
14. Szponar L, Rychlik E, Ołtarzewski M : Stan odżywienia wybranych grup ludności w Polsce. Żyw.Człow. Metab, 2002; 29: 268-82.

Toxicology

Preliminary applications of Ultra High Pressure (UHP) in deactivation of microflora contaminating cosmetics

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Summary:

Introduction. The aim of the study was a preliminary assessment of potential UHP application in deactivating environmental bacterial and fungal microflora, as well as bacteria commonly inhabiting human skin in contaminated aqueous extracts of mint and camomile.
Material and methods. The assays were conducted using *Pseudomonas aeruginosa*, S*taphylococcus aureus* and *Staphylococcus epidermidis* at 10^6 CFU/ml, as well as environmental bacterial and fungal microflora contaminating the examined herbal extracts. Microbial samples were exposed to the pressure of 500 MPa for 30 min at 20°C and 600 MPa for 30 min at 50°C. The effect of pressure ranging from 200 to 400 MPa at 50°C was also assessed using a 15-minute exposure of aqueous mint extracts contaminated with *P. aeruginosa* and *S. epidermidis*.
Results. The obtained results indicate that a complete deactivation of mesophilic aerobic spore-forming bacteria, both in mint and camomile extracts, occurs under the pressure of 600 MPa at 50°C after a 30-minute exposure. Complete deactivation of the *P. aeruginosa* and *S. epidermidis* strains, whose suspensions were added to the herbal extracts, was observed after a 15-minute exposure to the pressure of approx. 400 MPa. Lower pressure (approx. 300 MPa) applied for the same amount of time caused a radical but not complete decrease in the number of live bacterial cells. The lowest pressure applied in our study (200MPa) had no effect on the survival of the examined bacterial strains.
Conclusion. Based on the obtained results we may presume that the UHP method of liberating cosmetic herbal extracts from bacterial contamination may be the method of choice in the production of cosmetics.

Key words: cosmetic products, microbiological contamination, UHP.

Introduction

Chemical agents used for conservation of cosmetics have bacteriostatic and fungistatic, or even bactericidal and fungicidal effect. Due to those properties, the agents may not be neutral for the skin of the user. This is one of the reasons for searching other nonchemical methods of preserving the microbiological durability of cosmetic products. In recent years, much attention has been given to the microbiological purification of alimentary products by

subjecting them to Ultra High Pressure (UHP). UHP destroys opportunistic microflora and, according to current knowledge, remains neutral for the physicochemical structure and sensoric properties of exposed products [1-5].

Therefore it seems interesting to elucidate the potential of UHP application in the liberation of cosmetic raw materials and intermediate products from unwanted microflora. No reports on that topic have been found in the available literature.

The aim of the study was a preliminary assessment of potential UHP application in deactivating environmental bacterial and fungal flora, as well as bacteria commonly inhabiting human skin in the simplest but representative cosmetic products.

1. Material and methods

1.1. Examined cosmetic products

The simplest, but at the same time the most popular cosmetic products were used in the assays, namely aqueous extracts of mint and camomile.

To prepare them, 100 g of each of the commercially available herbs were weighed and poured over with 1 L of distilled water boiled shortly beforehand and cooled down to 60°C. The mixtures were then left for 3 h at room temperature. Subsequently, the extracts were filtered and subjected to UHP.

The study was conducted using unidentified strains of *Pseudomonas aeruginosa* and *Staphylococcus aureus* isolated from bacteriological study samples[1]. The bacteria, cultured for 24 h in nutritive broth, were used to quantitatively inoculate the prepared herbal extracts, previously subjected to autoclave sterilization at 120°C for ½ h to deactivate the contaminating environmental microflora. Once UHP treatment was applied, the number of live bacteria cells was determined.

1.2. Examination of the effect of UHP treatment on environmental bacterial and fungal microflora contaminating mint and camomile extracts

High-pressure assays were conducted on the U11 Compressor device at the Institute of High Pressure Physics, Polish Academy of Sciences in Warsaw, Poland.

Procedure

The examined extract samples were transferred into dedicated 3 ml polypropylene ampoules, placed in welded plastic wraps from which air was removed, and then subjected to high pressure. A 1:1 mix of polypropylene glycol and distilled water was used as the medium for direct pressure transfer.

Pressure methods

1) Application of 50 MPa for 10 min at 20°C.
2) Double reiteration of the above treatment after 10 – and 40-minute pauses. Steps 1 and 2 were aimed to stimulate the vegetation of bacteria and fungi (including mould) contaminating the hoods.
3) Application of 500 MPa for 30 min.
4) Application of 600 MPa for 30 min.

Immediately after the exposure, quantitative cultures were plated on nutritive agar and Sabouraud agar (Biomed). Determination of live bacterial and fungal cells, not deactivated by high pressure, was performed according to the PN-ISO 4833:2004 [6] and PN-ISO 7954:1999 [7] standards[2].

1.3. Examination of the effect of UHP treatment on the *S. epidermidis* and *P. aeruginosa* suspensions in mint and camomile extracts

The studied bacterial strains were cultured in nutritive broth for 24 hours at 37°C. Fully grown cultures were centrifuged for 30 min at 6000 rpm. Thus created cell pellet was washed three times with distilled water with subsequent centrifugation as above. The washed pellet was then resuspended in water and cell density of the suspension was determined by counting colonies grown from plated serial logarithmic dilutions. A working suspension of 10^6 CFU/ml was then prepared from the initial suspension and 0.1 ml of the former was added to the previously prepared samples of mint and camomile extracts. Thus created suspensions were treated as in the aforementioned quantitative analysis of environmental

1. The strains were kindly granted by the Bacteriological Analyses Laboratory of the Military Institute of Hygiene and Epidemiology in Pulawy, Poland.

2. Quantitative analyses of microflora survival were conducted at Department of Food and Consumer Articles Research, National Institute of Hygiene in Warsaw, Poland.

microflora contamination. Immediately after the exposure to high pressure, the samples were quantitatively plated on nutritive agar for subsequent colony count.

2. Results

Table 1 presents the results of the survival studies of the environmental bacteria contaminating aqueous extracts of mint and camomile exposed to the pressure of 500 MPa for 30 min at 20°C.

Table 1: Survival of environmental bacterial flora in mint and camomile extracts exposed to the pressure of 500 MPa for 30 min at 20°C.

Sample type	Type of isolated bacteria	Pre-exposure cell count [CFU/ml]	Post-exposure cell count [CFU/ml]	% deactivation
Mint extract	Mesophilic aerobic	4.4 x l04	4.2 x 102	>99
Camomile extract	Mesophilic aerobic	2.4 x 105	2.9 x 102	>95
Mint extract	Bacillus cereus	1.2 x l02	0	100
Camomile extract	Bacillus cereus	2.2 x 102	0	100
Mint extract	Other mesophilic spore-forming	1.1 x 103	4.0 x l01	>99
Camomile extract	Other mesophilic spore-forming	2.3 x 103	4.0 x 101	>99

Data presented in Table 1 indicate that in the conditions applied during UHP exposure of mint and camomile extracts, under the pressure of 500 MPa, a radical decrease in the number of live mesophilic aerobic bacteria was obtained in both extracts with a complete deactivation of *B. cereus* and almost complete deactivation of other spore-forming bacteria. Since in the applied conditions we did not obtain a complete deactivation of all examined mesophilic aerobic bacteria and spore-forming bacteria (apart from *B. cereus*), in the second step of the study the applied pressure was increased to 600 MPa and the temperature was increased to 50°C, while the 30-minute exposure time was retained (Tab. 2). Samples subjected to this assay were only examined for the presence of aerobic spore-forming bacterial flora, as it was presumed a priori that the non-spore-forming microflora would be completely deactivated.

Table 2: Effect of the exposure to the pressure of 600 MPa for 30 min at 50°C on the survival of mesophilic aerobic spore-forming bacteria in mint and camomile extracts.

Sample type	Pre-exposure cell count [CFU/ml]	Post-exposure cell count [CFU/ml]	% deactivation
Mint extract	6×10^2	0	100
Camomile extract	8.8×10^3	0	100

Data presented in Table 2 indicate that under pressure increased to 600 MPa all mesophilic aerobic spore-forming bacteria were completely deactivated, both in mint and camomile extracts. Table 3 presents the results of the survival studies of the microscopic fungi in aqueous extracts of mint and camomile, exposed to the pressure of 600 MPa at 50°C for 30 min, i.e. the conditions in which all bacteria were deactivated in both extracts.

Table 3: Effect of the exposure to the pressure of 600 MPa for 30 min at 50°C on the survival of microscopic fungi in mint and camomile extracts.

Sample type	Pre-exposure cell count [CFU/ml]	Post-exposure cell count [CFU/ml]	% deactivation
Mint extract	5.l x l0²	0	100
Camomile extract	1.4×10^2	0	100

Data presented in Table 3 indicate that the exposure to the pressure of 600 MPa for 30 minutes led to a complete deactivation of the microscopic fungi contaminating the examined mint and camomile extracts. Table 4 presents the results of the second part of the UHP effect study on *P. aeruginosa* and *S. epidermidis* suspensions. Since no difference in the results obtained with the mint and camomile

extracts was observed, this part of the study was conducted using only the former extract.

Table 4: Results of the P. aeruginosa and S. epidermidis suspension deactivation in mint extract exposed to various UHP values at 50°C during a 15-minute exposure.

Sample type	Pressure (MPa)	Pre-exposure cell count [CFU/ml]	Post-exposure cell count [CFU/ml]	% deactivation
Suspension of *P. aeruginosa* in mint extract	200	1.0 x l0^5	1.0 x 10^5	0
Suspension of *P. aeruginosa* in mint extract	300	1.0 x 10^5	1.3 x l0^2	>97
Suspension of *P. aeruginosa* in mint extract	400	1.0 x 10^5	0	100
Suspension of *S. epidermidis* in mint extract	200	1.0 x 10^5	1.0 x 10^5	0
Suspension of *S. epidermidis* in mint extract	300	1.0 x 10^5	1.9 x 10^2	>98
Suspension of *S. epidermidis* in mint extract	400	1.0 x 10^5	0	100

Data presented in Table 4 indicate that a complete deactivation of the *P. aeruginosa* and *S. epidermidis* strain suspensions was obtained after a 15-minute exposure to the pressure of 400 MPa at 50°C. On the other hand, the applied pressure of 300 MPa at the same exposure time resulted only in a decrease in the number of live bacteria cells, while the lowest applied pressure of 200 MPa did not reduce the populations of the examined bacterial strains.

3. Discussion

To search nonchemical methods of preserving the microbiological durability of cosmetic products, a preliminary assessment of potential high pressure application for that purpose was conducted. The obtained results indicate that some bacteria may be resistant to the deactivating action of a pressure as high as 500 MPa. However, the combination of 600 MPa and the temperature increased to 50°C with appropriate duration of the exposure to both of these factors resulted in a complete deactivation of the entire environmental microflora occurring in mint and camomile extracts. Encouraging may be the relatively high sensitivity to UHP observed for the *Aeromonas hydrophila* strain related to the aqueous environment, whose reduction in cheese may already be obtained by applying the pressure of 300 MPa for 14.58 min (8). This information may be interesting if we consider that many cosmetics have ingredients derived from algae and other aquatic organisms.

By examining the effect of UHP on the most common bacteria, which are *S. aureus* and *P. aeruginosa*, we obtained results which justify further studies, as both bacterial strains were found to be relatively sensitive to UHP. It is a significant finding, since those species constitute both environmental microflora and potential pathogens.

The *Pseudomonas* group may be found in soil, water, sewage and air. The bacteria usually colonize new locations as the first organisms, as long as minerals and organic acids or saccharides are available. Similarly to the examined *S. aureus*, the *Pseudomonas* group contains pathogenic strains producing toxins. They are the cause of abscess formation. *Pseudomonas* also produce endotoxins during their growth on improperly stored food (9). Considering fungal contamination, the obtained results provided a significant finding that this type of eukaryotic microflora is more sensitive to UHP that bacteria.

4. Conclusions

1) Exposing cosmetic herbal extracts to the UHP of 500 MPa for 30 minutes at 20°C causes a radical decrease in the number of live cells of mesophilic aerobic bacteria, complete deactivation of *B. cereus* and almost complete deactivation of other spore-forming bacteria.

2) Complete deactivation of mesophilic aerobic spore-forming bacteria and microscopic fungi, both in the mint and camomile extracts, occurs under pressure increased to 600 MPa and the temperature of 50°C during a 30-minute exposure.

3) Complete deactivation of the *P. aeruginosa* and *S. epidermidis* strains, inoculated into herbal extracts from a 10^6 CFU/ml bacterial suspension, occurs after a 15-minute exposure to the pressure of 400 MPa. A lower pressure of 300 MPa with the same exposure time results in a radical but incomplete decrease in the number of live bacterial cells. The lowest applied pressure of 200 MPa does not reduce the populations of both examined bacterial strains.

4) Based on the obtained results we may presume that this method of liberating cosmetic herbal extracts from bacterial contamination may be the method of choice in the production of cosmetics.

References:

1. Malinowska-Pańczyk E., Kołodziejska I., Dunajski E., Rompa M., Cwalina S.: Effect of high pressure and sub-zero temperature on some gram-negative bacteria. Polish J. Food Nutr. Sci., 2004;13/54: 279-283.
2. Malinowska-Pańczyk E., Kołodziejska I.: Wpływ wysokiego ciśnienia na mikroorganizmy. Medycyna Wet., 2005; 61: 150-1523.
3. Malinowska-Pańczyk E., Kołodziejska I.: Wpływ połączonego działania wysokiego ciśnienia i innych czynników na mikroorganizmy. Medycyna Wet. 2007; 63: 515-518.
4. Malinowska-Pańczyk E., Kołodziejska I.: Zmiany zachodzące w komórkach mikroorganizmów pod wpływem podwyższonego ciśnienia. Medycyna Wet., 2007; 63: 1285-1290.
5. Malinowska-Pańczyk E., Kołodziejska I i in.: Protective effect of mono and disaccharides on *Escherichia coli* cells against high pressure and sub-zero temperature. Jont 20th AJRAPT-43rd EHPRG International Conference on High Pressure Science and Technology, Karlsruhe, 2005 Proceedings, T9-P023, 7 (CDEOM ISBN 3-923704-49-6.
6. PN-ISO 4833:2004. Ogólna liczba bakterii tlenowych mezofilnych. Eurocontrol.
7. PN-ISO 7954:1999. Pleśnie. Mikrobiologia. Ogólne zasady oznaczania drożdży i pleśni. Metoda płytkowa w 25 stopniach C.
8. Szczawiński J., Stańczak B., Pęconek J: Wpływ wysokiego ciśnienia hydrostatycznego na przeżywalność *Aeromonas hydriophila* w serze podpuszczkowym dojrzewającym. Medycyna Wet., 2004; 60(3): 314-316.
9. Schlegel H.G.: Mikrobiologia ogólna. Wydawnictwo Naukowe PWN Warszawa, 2003:136-140.

Toxicology

Biological weapons—uncertainty, frustrations, worries

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Summary:

This paper describes putative tactic and aims of bioterrorism. Examples of proper reactions to acts of bioterrorism are demonstrated, based on hypothetical threats. Characteristics of signs useful in biological attack identification, as well as practical preventive measures, including the need of establishing new vaccine production technologies, are also presented. Apart from preventive measures, the importance of technically difficult damage reparation endeavours was discussed. Finally, main risks of bioterrorism are assessed, including factors potentially used as weapons, especially smallpox and anthrax. In conclusions, the need of effective prevention of terrorist attacks is emphasized. One of the priorities is improving the capabilities of intelligence agencies in predicting and preventing acts of terrorism, which nowadays are considered as a threat as serious as nuclear weapons were in the past.

Key words: bioterrorism, frustrations, ignorance, worries, prognoses, prevention, reparation, tasks.

Introduction

The nature of modern civilization contributed to broadening of the concept of war as a small group of people may destroy any living force with great effectiveness. Naturally, it applies to terrorism which nowadays assumed a global level and became the most important problem of the modern world and humanity. [1]

Global community knows little on the nature of biological terrorism. For today, there are virtually no records of a significant event related to this type of terrorism, terrorist groups, their tactic, particular motives and aims of their activity. All those data are necessary for the analyses which may then be used as a base for establishing strategies of combating that threat [1]. Some agents have been used sporadically in acts of individual terrorism during military conflicts [2] and in the only specific, yet limited in range, act performed after the World Trade Center attacks in the USA in 2001, when several letters containing pulverized anthrax spores were sent by post [3]. However, terrorist groups in the future will be more interested

in mass killing using such weapons. The most probable tactic of bioterrorists will be releasing pathogenic agents in the form of aerosol, i.e. air suspension of droplets or microscopic particles shaped as a stable cloud. Thus dispersed agents will be invisible and odourless, and nobody will be aware, that an act of bioterrorism has been committed. As there is no system for a quick detection of aerosols containing biological weapons, terrorists will be able to use them in their attacks against any target.

Limited possibilities in reacting to bioterrorism

The most important task during the preparation of preventive measures is conducting studies of possible methods of reaction to terrorist attacks, particularly major ones. The results of analyses performed to date are far from being encouraging. The lack of preparation is a result of several factors [4]:

1) Difficulties in preventing events which have never occurred before.
2) In the case of biological terrorism, the size of human loss may be shockingly vast and many officials keep the blind faith that such acts may somehow be prevented by the combined efforts of the police, security services and intelligence agencies. It is therefore required to improve training methods and coordinate actions taken by different services responsible for appropriate reactions to terrorist threat.

As for the reactions to biological terrorism, there is a need of, for example, equipping hospitals with appropriate devices, as well as antibiotic and anatoxin reserve. It is also necessary to improve the competences of medical personnel in the identification of various symptoms characteristic of diseases caused by biological weapons, so that the victims may quickly receive appropriate therapy. Most physicians in their practice have never seen, for example, clinical cases of anthrax, not to mention smallpox or haemorrhagic fevers [5].

An important aspect of the reaction to biological terrorism will also be controlling the psychological reactions of people employed in damage reparation services [2,6]. Particular emotional problems may be generated by handling bodies of the victims of mass destruction attacks [2].

Hypothetical examples of bioterrorism threats

Even in the 1950s, American scientists alerted that the USA is not protected strategically or tactically against biological weapons. An example of a hypothetical threat was an enemy submarine attack from several miles off the coast, involving the dispersion of the Q fever microbes in the area spanning from Norfolk to Portland and covering 700 nautical miles. Constant winds occur there which blow several miles into the land before they are dispersed by land air masses. It is one of the most populated areas with approx. 80 million inhabitants. It has been estimated that approx. 30% population may become infected and approx. 30 million may become disabled for 7–10 days even if properly treated with antibiotics. Another example of hypothetical strategic attack is an air strike on Washington, involving the dissemination of tularaemia bacteria of anthrax spores. Putatively, within 4–7 days the attack would cause morbidity in hundreds of thousands of people and 20% of cases would result in death without an appropriate antibiotic therapy [5,6].

Aspects of epidemiological identification of a bioterrorist attack

A bioterrorist attack will be identifiable based on the following signs:

1) Presence of a main epidemic focus with a large number of affected and dead patients over a short period of time, e.g. within 12–46 hours.
2) Very high effectiveness of the attack, e.g. 60–80% morbidity in the attacked population.
3) Frequent incidence of pulmonary complications indicating aerosol as the carrier of the pathogens causing such diseases as plague, tularaemia, anthrax, or Q fever.
4) Unprecedented territorial range of the epidemic, e.g. Crimean–Congo haemorrhagic fever occurring in Alaska or New York, or Venezuelan equine encephalitis in England.
5) High mortality rate due to much higher exposure to microorganisms than in the case of natural epidemics.

6) Localization of the sites of incidence. Outbreak occurrence following wind direction from the site where the attack was conducted.
7) Infections (even single ones) caused by microorganisms never reported in a given area.
8) High mortality of many animal species.
9) Effective protection against infection in people staying in places in which the air is filtered or even in closed rooms.
10) Almost simultaneous occurrence of similar outbreaks in different places.
11) Finding direct evidence of an attack, e.g. pieces of contaminated ammunition; supposition that biological weapons have been used by the enemy forces or terrorists; confirmation of an attack; information from intelligence agencies stating that biological weapons have been used by enemy's agents orcollaborating parties.

As it has already been emphasized, currently there is no detection system which would indicate approaching biological threats. Within the next few years, unusual cases of disease and death in humans and animals will be the only threat identification methods [5].

Civilian population is not immunized against most diseases caused by biological weapons or equipped with appropriate protective means, such as filtered ventilators and efficient gas masks.

The most effective defence method against biological agents is immunoprophylaxis. Yet, vaccine production involves certain difficulties [7,8]. Most of all, in the case of a biological attack, most of the pathogens are exotic. This creates some technological difficulties in undertaking preventive endeavours. The difficulties stem from poor knowledge of microorganisms and the need of having well-equipped laboratories along with sets of bacterial and viral strains necessary for vaccine production. A good command of production technology is of great importance as well.

Another problem is the effectiveness of vaccines in the case of atypical route of infection. The most probable method of attack is aerosol dispersion. People and animals, even if vaccinated parenterally, may not be sufficiently protected against infections originating in system [8].

Another issue is the availability of vaccines. Nowadays vaccines are produced in small quantities sufficient only to prophylactically immunize laboratory personnel and other selected groups within medical services or military medical personnel serving in locations endemic for particular diseases. On a rapid increase in the demand for those vaccines low production rates would be encountered along with the inability to conduct clinical studies of vaccines and their safety. Logistic aspects also play an important role in this regard. Even the widely available vaccines might not be administrable on a fully mass scale. Alternatively, conventional vaccine administration using needles should be substituted with jet injectors using high pressure and capable of performing 600-1000 immunizations per hour [8].

The US government is still interested in vaccine distribution through aerosol. This route, similarly to vaccination employing drinking water, would be very useful for mass vaccinations. However, the aerosol method has three key disadvantages:
1) Requires much larger quantities of vaccines than conventional methods.
2) Extremely complicates individual dosage control.
3) Requires mass transport of the immunized population to immunization facilities, where appropriate stationary vaccination equipment is based.

Another commodity in performing mass immunizations may be the use of polyvalent vaccines, which reduce the number of required injections. Likewise, adjuvants and other vaccine enhancers are successfully used. Passive immunoprophylaxis might be effective as well, however, it would be of limited significance in mass operations due to large quantities of immune sera required for immunizations [8].

Damage repair endeavours

When numerous cases of an unidentified disease occur it may be assumed a priori that a bioterrorist attack using bacteria or Rickettsiae is involved and that prophylactic antibiotic administration will "moderate" the infective process until a proper determination of the infective factor and its susceptibility is conducted [5].

If more cases of infection occur, 4–5 groups for test treatment may be created without waiting for pathogen isolation and determination of its drug resistance profile. By using only one antibiotic per group, therapeutic effect of each of them may be assessed [2,5].

Immunization undertaken immediately after the occurrence of bioterrorist attack is inefficient as most diseases may have short incubation period. Specific therapy employing monoclonal antibodies is still not refined enough to become the method of choice within the next few years [4,5].

One of efficient methods of biological agent deactivation is disinfection. However, practical execution of mass-scale disinfection operations would exceed the technical capabilities of any attacked population. When used to a limited extent, successful disinfection methods are those employing formaldehyde or ethylene oxide, although they are toxic for the operative personnel and may damage precision instrumentation and other equipment [4,6].

In the light of a multitude of potentially used biological agents, the simplest means of disinfection are soap and water for body hygiene and boiling or soaking in chlorine solution for garments.

Other endeavours involving environment-related actions include the protection against insects as vectors of many infective diseases, which requires creating appropriate insecticide reserve. In extreme situations, like the aforementioned hypothetical aerosol-based attack using tularaemia bacteria or anthrax spores, it may be expected that appropriate medical aid may not be provided to the entire group of victims of such an event, exactly as in the case of other weapons of mass destruction. Medicine reserve would rapidly deplete, hospital would quickly become overcrowded and other public (school, churches) and private buildings would have to be adopted for medical purposes. Coordination of all medical endeavours would be extremely difficult if, thinking optimistically, medical services were still sufficiently operative to be able to fulfil their duties. Mass-media would be flooded with telephone calls which might lead to service suspension. The lack of one main information centre or its complete block would add to a potentially rising public disorder.

After a mass-scale attack, additional problem potentially constituting another source of infection would be mass gathering of unburied human and animal bodies. What appears to be a secondary problem, may actually force public services to undertake unconventional actions [3,5,6].

Assessment of main risks related to bioterrorism

Until 1980s in the USA, not to mention other countries, there was a general feeling of self-confidence about the immunity to bioterrorism, the funds for defensive measures were reduced, most of the serious research programmes were closed, and the participating research groups were disbanded. This self-confidence was ruined by the Soviet dissidents' reports on the size of the Russian offensive biological weapons programme [9] and by the fact that at least 10 states have biological weapons currently at their disposal. The signing of the Biological Weapons Convention in 1972 was an opportunity for the Soviet Union to gain advantage over Western countries. For example, the considered eradication of smallpox along with the cease in immunizations in 1980 was regarded as such an opportunity. Large-scale production of the smallpox virus as a biological weapon was initiated. In 1989 a total annual productivity of 12 metric tons was reached.

By 1992, the Soviet and then Russian research and application programme of biological weapons development was taken over and continued by at least two different organizations: "Biopreparat" subordinated to the Ministry of Medical and Microbiological Industry and a special, unidentified enterprise subordinated to the Ministry of Defence. Well-known is a still operative part of the multi-laboratory "Biopreparat" complex composed of 9 facilities and formerly employing 60,000 people. One of those facilities is the State Research Center of Virology and Biotechnology located in Koltsovo, Novosibirsk Oblast. It has been licensed by WHO to store the smallpox virus (another deposit is located in the CDC headquarters

in Atlanta, USA). The Koltsovo centre has a Biohazard Level 4 (BL-4) laboratory permitting studies of the most virulent pathogens, such as smallpox and haemorrhagic fevers. Currently, like other laboratories in Russia, the institution is experiencing financial problems. A substantial number of researchers have left their positions and their current employment is not known. What is dangerous, countries such as Iran, Syria, and North Korea keenly enrol such specialists. A mix of rogue states and generously financed religious cults with researchers desperately seeking fund sources creates an unclear and dangerous political situation which may potentially evoke serious consequences [3].

Factors potentially used in bioterrorism

Although many biological agents capable of inducing infection may be considered as potential biological weapons, only few of them may actually constitute a serious threat. Few of them may be cultured and dispersed efficiently to cause morbidity and deaths in quantities which might put the functioning of the attacked population at risk. The characteristics which qualify pathogens as potential biological weapons are: specificity, potential to transmit from human to human, environmental stability, the size of infective dose and the availability of preventive and therapeutic measures.

The regulations by the Centers for Disease Control and Prevention (CDC) introduced in 1997 list 24 microorganisms and 12 toxins, whose possession requires registration and special permission for transfers.

The WHO guide (1) lists the following pathogen-related diseases: anthrax, brucellosis, glanders, melioidosis, plague, Q fever, typhus, coccidioidomycosis, Venezuelan equine encephalitis, smallpox.

The listed toxins are: botulinum toxin, staphylococcal enterotoxins, aflatoxins and other fungal, algal, and plant toxins. The smallpox and anthrax pathogens are characterized by high infectivity when dispersed in the form of aerosol and have mortality rates of 30 and 80%, respectively. These two pathogens have other advantages as potential biological weapons. They may be easily cultured in large quantities and are resistant to environmental factors. Therefore they are suitable for disseminating by aerosol dispersion over large areas and populations. The plague bacterium and botulinum toxin are less likely to be used. The results of the former US offensive biological weapons programme indicate that the production and dispersion of large quantities of the plague bacteria and botulinum toxin poses problems impossible to solve. Thus the microorganisms exposed at the top of the list are the smallpox [1,7] and anthrax [1,3] pathogens.

Smallpox and anthrax constitute the greatest threat also due to their different clinical and epidemiological properties. The outbreaks of smallpox in Yugoslavia (1972) and anthrax in the Soviet Union (1979) permit us to imagine the size and nature of the problem.

Analysis of risks related to smallpox

Smallpox constitutes an extremely serious threat due to a significant susceptibility to the virus in humans and the cease in mass immunizations ordered many years ago as a consequence of virus eradication. Since the immunity among the population diminishes, many people are probably not immune to smallpox anymore. Among the nonimmune, mortality rate after smallpox contraction might reach 30% and there is no effective therapy. Virus dispersed in the form of aerosol might retain its virulence for over 24 hours and remain highly infective even in small doses. A disease outburst in which only 100 people contract the disease might already pose a serious challenge for healthcare services. Due to the risk of large-scale spreading of the virus in aerosol, the patients would have to be kept in negative pressure isolation rooms, whose air ducts would have to be equipped with special filters. Even in the USA few hospitals have such rooms. A protective immunization programme would also have to be introduced among the people who were in direct contact with the patients. A vaccine administered after 3–4 days of exposure might protect most of them from developing an infection. However, it is unlikely that smallpox would be diagnosed early enough and the vaccination programme

would be introduced rapidly enough to prevent infections in people exposed to the pathogens on the occurrence of first cases. Few physicians have ever seen the signs of smallpox and even fewer, if any, have been trained in diagnosing this disease. A second wave of smallpox cases would be almost inevitable.

The initial vaccinations would be necessary for medical personnel in contact with the patients. With the increasing number of cases, contacts and involved areas, mass immunization would quickly become the only practically applicable way of combating the epidemic. Nonetheless, mass immunization would also be impossible, as current vaccine reserve is limited to 5–7 million doses. In comparison, 6 million New York residents were vaccinated in 1947 after the occurrence of just 8 cases of smallpox. Moreover, smallpox vaccine is currently not in production. Reliable assessments indicate that major supplies might be provided no earlier than 36 months after the first outburst of the disease [7].

Analysis of risks related to anthrax

A scenario of inhalational anthrax epidemic is by no means a lesser problem [10]. Anthrax aerosol might be liberated stealthily and drift in the environment, as it happened in 2001 [1]. After 2–3 days patients with various aspecific symptoms, such as fever, cough, or headache, would appear in emergency departments and doctors' offices. Within 1–2 days those patients would become critically ill and after further -3 days deaths would occur. It is dubious that antibiotic therapy might be helpful once the symptoms of the disease have developed.

As has been mentioned before, the mortality rate would reach 80%. Even though anthrax is not transmitted from human to human, it has other properties which pose threat. People exposed to anthrax pathogens may become ill even after 8 weeks of the first exposure [8]. In this type of cases preventive measures in the form of antibiotics may be employed, but such therapy should be continued for at least 60 days [4].

The above period may be shortened by a proper vaccine administration. Experimental studies indicate that 2 vaccine doses administered separately during 15 days may immunize the subject after 30 days of the first dose administration. Yet, the vaccine is currently not available to the civilian population [3]. Even in the USA, magazines holding antibiotic reserve are still only planned and no city has a plan of antibiotic distribution allowing their administration for more than 60 days.

The history of studies of the anthrax pathogens as biological weapons has alarming and so far unexplained holes which increase the worries related to potential terrorist attacks. These are: 1. The undefined content of the anthrax aerosol from Sverdlovsk [11]. The possibility of obtaining anthrax strains with confusing characteristics leading to misidentification and incorrect treatment [12]. Varying condition of pulverized spores in the anthrax-containing letters from 2001 [13] and the results of the unexposed investigation aimed at determining the perpetrators [14].

Conclusions

Biologists, mainly in the field of medicine and public health, present as critical views on confronting the problems posed by biological weapons as physicists and chemists do on the nuclear and chemical threats, respectively.

There is a need of training physicians in the early recognition of most of dangerous diseases. Likewise, laboratory and public health employees along with epidemiologists need to be trained in combating dangerous infective diseases.

The inability to develop endeavours considered as solutions in the case of a bioterrorist attack might lead to a biological disaster with unimaginable consequences.

In the 20th century, the humanity experienced the results of chemical and thermonuclear warfare but, fortunately, managed to avoid disasters expected to occur after a biological attack. Lessons from remote past seems to teach us very well in this regard. Considering the world population and the death-to-case ratio, it may be assumed that the greatest human loss in our history was caused in Europe by the plague pandemic ("black death") in the 14th century. The estimated number of deaths was 23,840,000 which constituted one fourth of the entire European population at that time.

Despite the passing of 6 centuries, this lesson is a terrifying illustration to a horror story which nowadays may be represented by a large-scale use of biological weapons. Currently the threat is emphasized by the means allowing a large-scale production of toxins and pathogens with genetically enhanced infective properties.

We need a new and broad perspective on the real threat of biological weapons, and a system to prevent the use of such weapons, as well as the most effective procedures for eliminating the consequences of their use. The emergency services and health services should have well-developed and tested procedures of action in circumstances of a threat. Moreover, what is also necessary, is the rapid recognition and accurate identification of risk factors, as well as developed and tested procedures to eliminate the consequences of the use of biological weapons. These actions are related to individual and collective inactivation, and inactivation of the environment, organization of first aid to victims, organization of the system of segregation and transport of patients. It is necessary to keep ready a certain number of beds in well-equipped departments of infectious diseases, which would enable hospitalization of patients with especially dangerousinfectious diseases. [16]

Problems related to biological disaster management are so complex that they are impossible to solve by people of one profession. They require combined knowledge from many different disciplines at different administration levels. As much support as possible is necessary for any actions leading to increasing the importance of the Biological Weapons Convention. One of the priorities is improving the capabilities of intelligence agencies in predicting and preventing acts of terrorism. Inspiring international research programmes in that field encourages openness and constructive dialogue.

References:

1. Ziemba R.: Catastrophe medicine as domain of scientific system, Military Pharmacy and Medicine, 2012, V(1):28.
2. Reagowanie systemu zdrowia publicznego na broń biologiczną i chemiczną: Przewodnik WHO (tłumaczenie z j. angielskiego: Public Health Response to Biological and Chemical Weapons: WHO Guidance) Wydanie II, WHO, Genewa 2004:357
3. J.Mierzejewski; Franz D. R., Zajtchuck R.; Rodzaje patogenów, które mogą być użyte w ataku bioterrorystycznym. Przegląd Epidem. 2001, Suplement 2:159-7167.
4. Mierzejewski J., Reiss J.: Doświadczenia i wnioski z ataków wąglikowych w USA. Medycyna Mikrobiologia2004, 4(41):34-43.
5. Mierzejewski J., Franz D., Zajtchuck R.: Bioterroryzm (zarys zagrożeń i przeciwdziałania.) Skalpel 2001, 109(4):41-85.
6. Mierzejewski J., Reiss J.: Specyfika i postępowanie w różnych rodzajach zagrożeń. Wojskowa Farmacja a i Medycyna, 2008; 1(1): 44-47.
7. Boscarino JA. Adams RE. Figley CR. Galea S. Foa EB. Fear of terrorism and preparedness in New York City 2 years after the attacks: implications for disaster planning and research. Journal ofPublic Health Management & Practice, 2006, 12(6):505-13.
8. Artenstein AW. Grabenstein JD.: Smallpox vaccines for biodefense: need and feasibility. Expert Review of Vaccines. 2008, 7(8):1225-37.
9. Mierzejewski J., Reiss J., Gall W.: Kontrowersje wokół szczepień przeciw wąglikowi. Skalpel 2004:4, 5 – 10.
10. Knoph Jan T., Westerdahl Kristina S.: Re-Evaluation Russia's Biological Weapons Policy, as Reflected in the Criminal Codę and Official Admisions: Insubordination Leading to a President's Subordination. Critical Reviews in Microbiology, 2006: 32, 1-13.
11. Raffin T. A., Shafazand S., Doyle R.: Inhalational Anthrax* : Epidemiology, Diagnosis, and Management. Chest 1999;116;1369-1376.
12. Jackson P., Hugh-Jones M.E., Adair D.M. et al.: PCR analisis of tissue samples from the 1979 Sverdlovsk anthrax victims: The presence of multiple Bacillus anthracis strains in different victims. Proc. Natl. Acad. Sci. USA 1998, 95, (2):1224-1229.
13. Pomeransev A.P., Staritsin N.A., Mockov Yu.V. at al: Expression of cereolysine AB genes in bacillus anthracis vaccine strain ensures protection against experimental hemolytic anthrax infection. Vaccine 1997: 5, 1846-50.
14. Matsumoto G.: Anthrax Power: State of Art Science 2007:3,1492-7.
15. Kęcik K. "Kto wysyłał wąglika? Przegląd 2010:34-35.
16. Buczyński A., Ziemba R, Ziemba E.:Current health threats connected with the use of biological weapons, Military Pharmacy and Medicine, 2012, V(1):28.

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