© Med Sci Monit, 2012; 18(1): SR1-8
PMID: 22207129

www.MedSciMonit.com
Special Report

Received: 2011.11.10
Accepted: 2011.11.30
Published: 2012.01.01

Use of individual auto-injector kits 'IZAS-05' on the contemporary battlefield

Radosław Ziemba

Military Centre for Pharmacy and Medical Technology, Celestynow, Poland

Source of support: Self financing

SR

Summary

In crisis situations, such as transportation catastrophes, terrorist attacks or contamination with chemical warfare agents, it is crucial to properly organize and sensibly conduct rescue operations. Among chemical warfare agents, the most toxic ones are the derivatives of organophosphorus compounds.

An individual auto-injector kit 'IZAS-05' contains auto-injectors, which are devices designed for intramuscular administration of drugs in self-aid or buddy-aid on the battlefield.

This paper describes in detail the components of the 'IZAS-05' kit, as well as its mode of use and possible contraindications.

key words: **chemical warfare agents • antidote • individual auto-injector kits**

Full-text PDF: http://www.medscimonit.com/fulltxt.php?ICID=882188

Word count: 2739
Tables: 1
Figures: 10
References: 17

Author's address: Radosław Ziemba, Military Centre for Pharmacy and Medical Technology, Wojska Polskiego 57 St., 05-430 Celestynow, Poland, e-mail: zx11@op.pl

BACKGROUND

Nowadays, the most likely use of chemical warfare agents (CWAs) can take place during a terrorist attack. Depending on their effect on the human body, there are mainly **nerve** toxic agents, such as: sarin, soman and VX, and **blister** toxic agents, such as yperite and lewisite. It seems that terrorists rarely make use of **incapacitating** toxic agents, which cause only short, transient disturbances in human psyche and motor activity [1–3]. They can be exemplified by psychogases, such as LSD-25 and BZ, as well as irritants (tear gasses), such as CS, CN and CR, employed by the police to incapacitate and harass for a short time [1,4,5].

The most toxic among chemical warfare agents are the derivatives of organophosphorus compounds. Even small doses of these substances cause clinical poisoning accompanied by the syndrome of muscarinic-like and nicotinic-like symptoms, as well as central nervous system symptoms. Poisoning symptoms develop instantly, thus necessitating application of adequate treatment, frequently including intensive care.

The Table 1 below shows human toxicity of some chemical warfare agents [1,6].

The importance of immediate administration of an antidote is proved by the fact that the half-life of 'aging' of the enzyme-organophosphorus compound complex is very short, e.g.: for AChE (acetylcholinesterase)-soman complex it is only 3.5 minutes, while for AChE-sarin – about 18 minutes. This means that after this time only 50% of the blocked enzyme can be reactivated. What is extremely important is also the knowledge that most CWAs show good or very good sorptive properties and ability to penetrate various materials (wood, rubber, fabric, skin and the like). Thus, materials contaminated with chemical warfare agents are a serious source of poisoning, even more so in shelters or isolated rooms [1–7,10].

In crisis situations, most frequently during transportation catastrophes or terrorist attacks, the most important thing is to organize and conduct rescue operations (in case of hazard to a larger number of people).

However, in many situations, particularly during warfare, the foundation of life protection is self-aid or buddy-aid (e.g.: in the event of loss of consciousness).

Due to the specific effect of chemical warfare agents on the human body, the above-mentioned treatment must be multidirectional, i.e. combined.

That is why individual auto-injector kits IZAS-05 [11], which have been included in the equipment of the Polish soldier for several years, contain [12,13]:

- atropine – a natural antagonist of acetylcholine, which – following the inhibition of the AChE activity by CWAs – excessively accumulates on neuromuscular junctions and synapses of the nervous system, which results in characteristic muscarinic-like and nicotinic-like symptoms,
- pralidoxime – a reactivator of the CWA-blocked enzyme AChE (acetylcholinesterase),
- diazepam – which has sedative and anticonvulsant effect.

Observation of warfare in Iraq and Afghanistan, as well as talks with soldiers, and in particular with medical aids, prove that especially in the case of **mass poisoning** with CWAs, where – as has already been said – the most vital role is played by the time of antidote administration [14], it becomes necessary to equip medical rescuers with so-called **masks with active filters.** They allow free performance of the activities connected with organizing and conducting rescue operations for 30–60 minutes, depending on which CWA has been used. This seems to be the minimum time needed to leave the contaminated zone.

1. INDIVIDUAL AUTO-INJECTOR KIT IZAS-05

An individual auto-injector kit IZAS-05 contains auto-injectors designed for intramuscular administration of drugs for self-aid or buddy-aid on the battlefield [4].

Administration of drugs (antidotes) by means of auto-injectors saves the lives and health of soldiers before they receive specialist medical care (e.g. in hospital). Auto-injectors contain:

1. drugs (antidotes) for treating poisoning with nerve chemical warfare agents, i.e. sarin, soman, tabun and VX, or,
2. an analgesic for fighting very severe post-traumatic pain.

An auto-injector is an easy-to-use device, and it can be used by every soldier on the battlefield, if necessary. To ensure proper use of auto-injectors and the drugs (antidotes) contained therein, every soldier should undergo theoretical and practical training (with the use of training auto-injectors), under the supervision of a doctor.

1.1. Components of IZAS-05

An individual auto-injector kit IZAS-05 comprises the following auto-injectors:

a. brown (large), with a yellow cap, containing 2 mg of atropine sulphate and 600 mg of pralidoxime chloride,
b. yellow (small), containing 2 mg of atropine sulphate,
c. grey (small), containing 10 mg of diazepam, contained in a collective packaging (in the shape of an eyeglasses case), which is to be carried in a special canvas pouch that can be fit in the MOLLE system;
d. red (small), containing 20 mg of morphine sulphate in a separate tube – a transparent cylinder-shaped container, which is to be carried in a special canvas pouch that can be fit in the MOLLE system.

2. GENERAL PRINCIPLES CONCERNING AUTO-INJECTORS

An auto-injector is fit with a self-firing mechanism (spring) and a needle. Failure to follow directions for use may cause an injury. Auto-injectors must not be disassembled or pointed at the face.

Auto-injectors have been loaded with drugs (antidotes), which can be used only in accordance with the principles specified in chapters 4 and 5. Incorrect use of drugs can cause loss of battle ability and adversely affect the soldier's health.

Auto-injectors dispensed to soldiers during warfare should be protected from unfavourable environment (excessive

Table 1. Toxicity of selected chemical warfare agents.

CWA	Poisoning via inhalation			Poisoning via skin exposure
	Threshold concentration (mg/min/m³)	Lethal concentration (mg/min/m³)	Onset of poisoning symptoms	Lethal dose (mg/kg BW)
Sarin	3	100	Seconds, minutes	20
Soman	1	70	Seconds, minutes	5
VX	0.04	40	Seconds, minutes	0.12
Yperite	30	1500	Minutes, hours	100
Lewisite	30	1500	Minutes	50
BZ	110	200,000	Minutes, hours	–

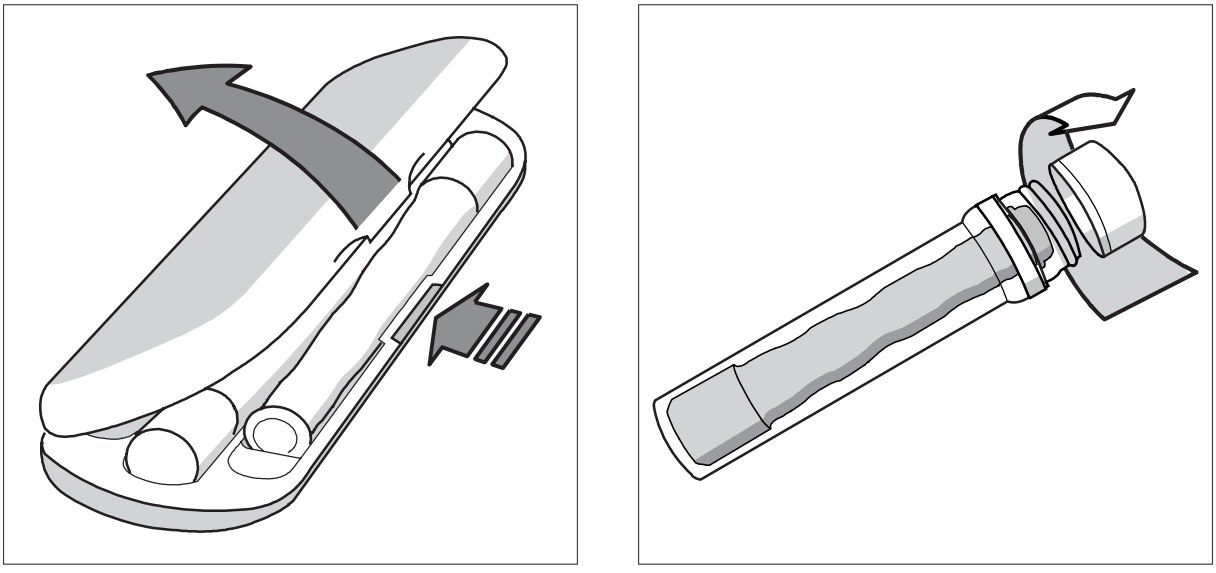

Figure 1. Unpacking an auto-injector.

sunlight, high and low environmental temperature, dirt). The above factors can cause loss of beneficial properties of the drugs (antidotes) contained therein and significantly reduce their efficacy.

2.1. Principle of operation of auto-injectors

An auto-injector has a container with drugs (antidotes). Once the triggering mechanism is released, the needle comes out automatically and is inserted into the body (into the muscles, at the site where an auto-injector is positioned) [3].

The drugs are injected into the body via the needle introduced into the muscles. Drug administration, that is complete emptying of the drug container, takes up to 10 seconds at the most.

Insertion of the needle is usually accompanied by slight pain, comparable to the one experienced when given an intramuscular injection in hospital to administer a drug, or during the blood drawing procedure.

3. Usage of auto-injectors

3.1. Preparing an auto-injector for use

Remove the auto-injector from the outer protecting packaging directly before use – Figure 1 (by pressing the case safety catch or unscrewing the tube cap).

Hold the auto-injector in the hand that is used for most activities – Figure 2 (right hand if you are a right-handed person). If the dominant hand is injured, use the auto-injector with the healthy (fit) hand.

3.2. Positioning the auto-injector for injection

The needle end of the auto-injector should be positioned against the injection site and pressed hard enough for the skin to dent slightly at the site where the auto-injector is positioned.

Position the auto-injector perpendicularly (at the angle of 90 degrees) against the body surface. Incorrect positioning of the auto-injector while administering the drug can result

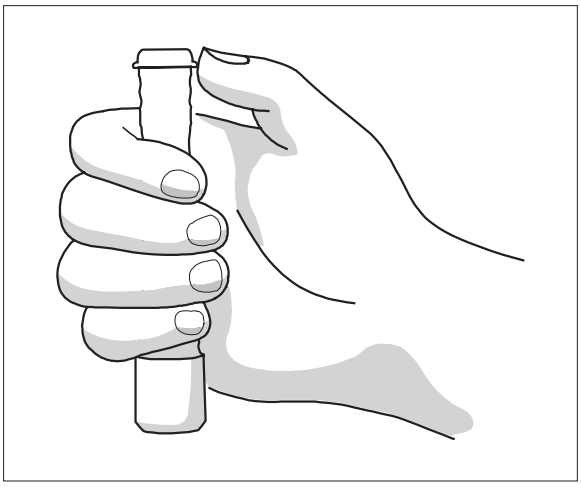

Figure 2. Grip the auto-injector (as shown in the Figure) and place your thumb on the mushroom safety catch.

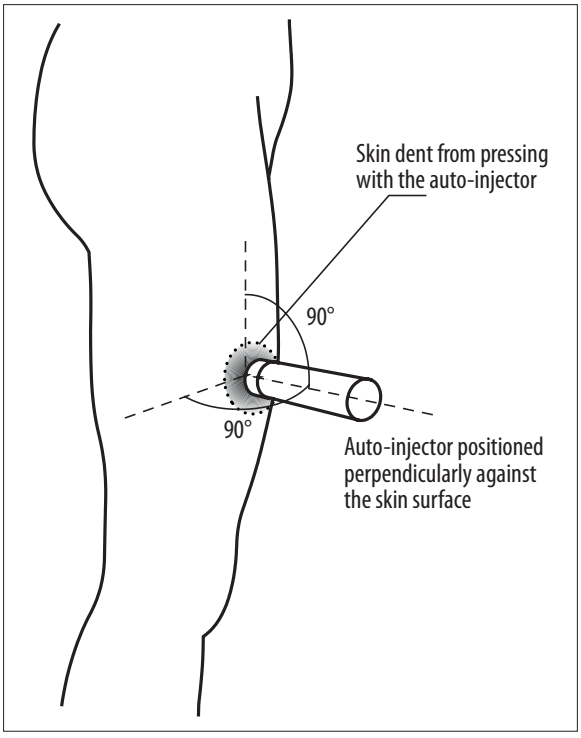

Figure 3. Press against injection site.

in its damage or failure to administer the dose. Correct positioning of the auto-injector is shown in Figure 3.

While injecting, the auto-injector must not be detached from the body surface.

3.3. Injection site

An auto-injector is designed for administering drugs both directly through bare skin (without clothing), and indirectly – through the field gear. In the event of poisoning with nerve CWAs, due to – among others – the necessity to administer antidotes immediately, the clothing should not be removed to uncover the skin at the injection site.

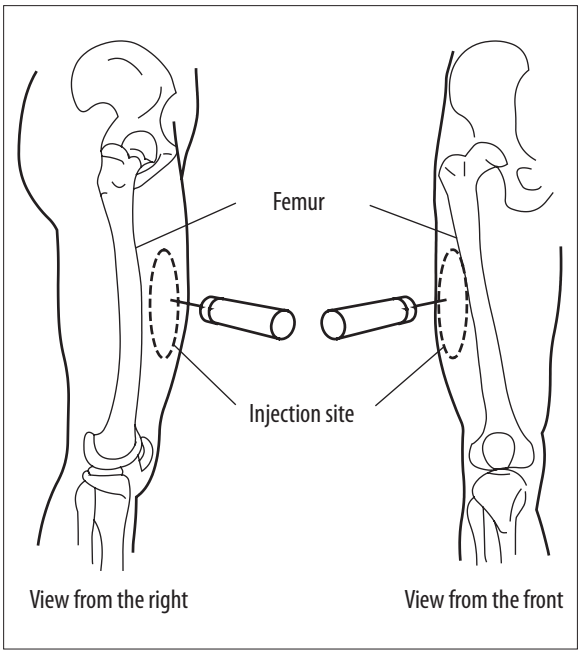

Figure 4. Injection into the thigh.

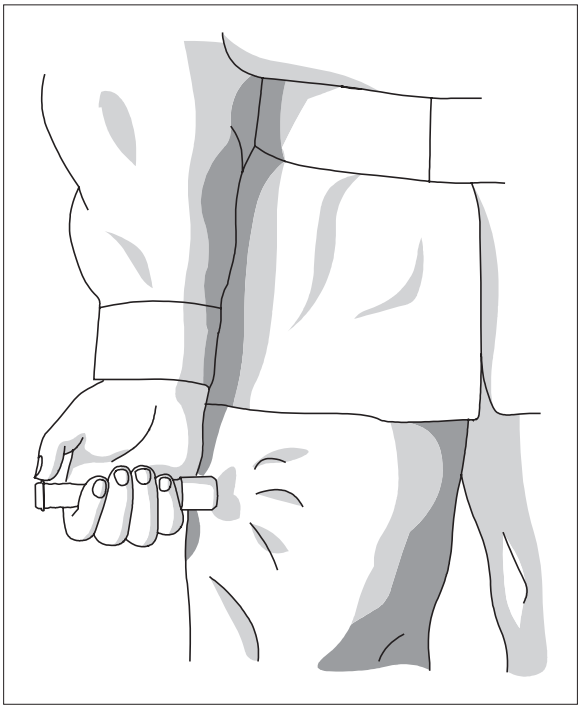

Figure 5. Use of the auto-injector for self-aid – injection into the thigh.

While administering drugs (antidotes), it is crucial that the auto-injector needle be inserted into a large muscle. There are two basic sites where drugs can be injected safely with the use of auto-injectors: the thigh and the buttock.

Injection into the thigh – Figures 4–6: position the auto-injector at midpoint of the thigh, against its antero-lateral surface. Injection at the specified site will not result in damage to the nearby bone.

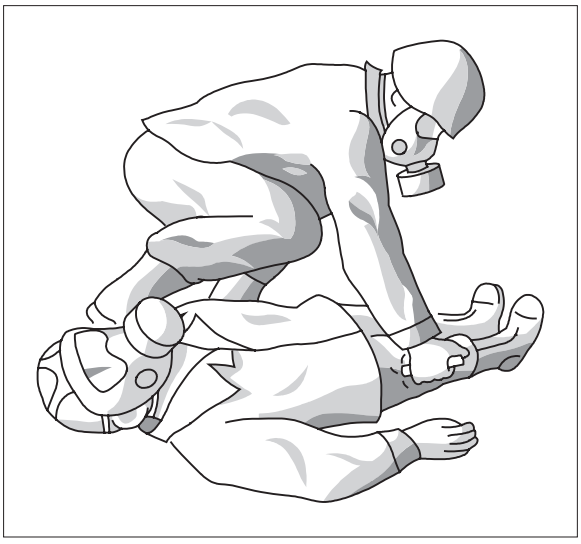

Figure 6. Use of the auto-injector for buddy-aid – injection into the thigh.

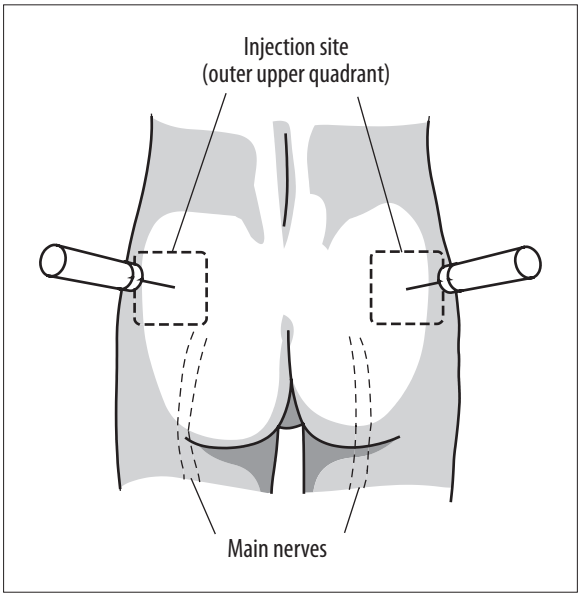

Figure 7. Injection into the buttock.

Injection into the buttock – Figure 7: position the auto-injector at the outer upper quadrant of the buttock. Injection at the specified site will not result in damage to the nearby nerve – Figures 8 and 9.

3.4. Drug administration

After positioning the auto-injector against the thigh or the buttock, release the triggering mechanism (by levering up the red safety catch with your thumb) in such a way so as not to detach the auto-injector from the body surface [4].

The drug is administered automatically, once the triggering mechanism is released. You should wait for about 10 seconds for the auto-injector to be emptied – Figure 10. While administering the drugs, the auto-injector must not be detached from the body surface or redirected.

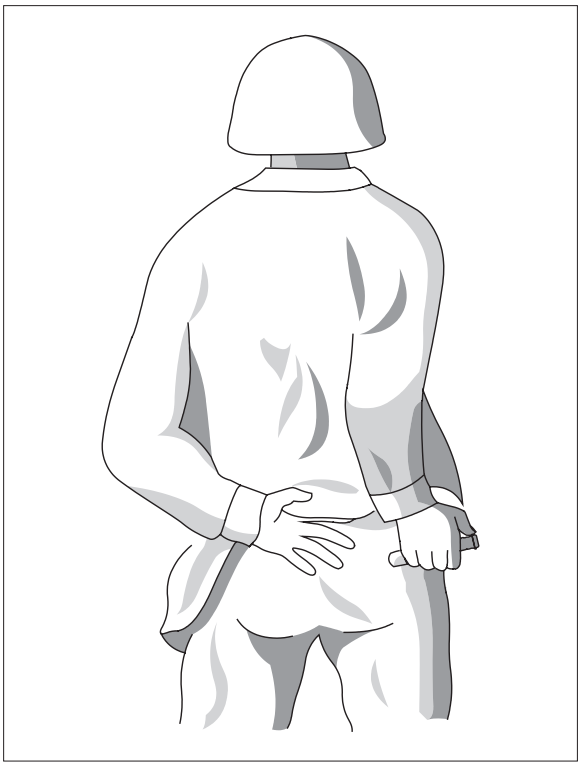

Figure 8. Use of the auto-injector in self-aid – injection into the buttock.

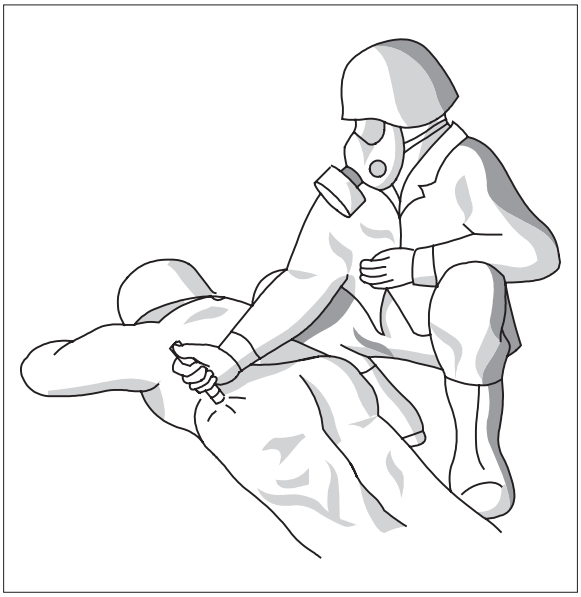

Figure 9. Use of the auto-injector in buddy-aid – injection into the buttock.

After 10 seconds from release of the triggering mechanism, remove the auto-injector with a rapid movement, and put it aside safely, avoiding wounding with the needle.

4. Auto-injectors in CWAs poisoning

Treatment of poisoning with nerve CWAs should be provided immediately once the poisoning symptoms occur.

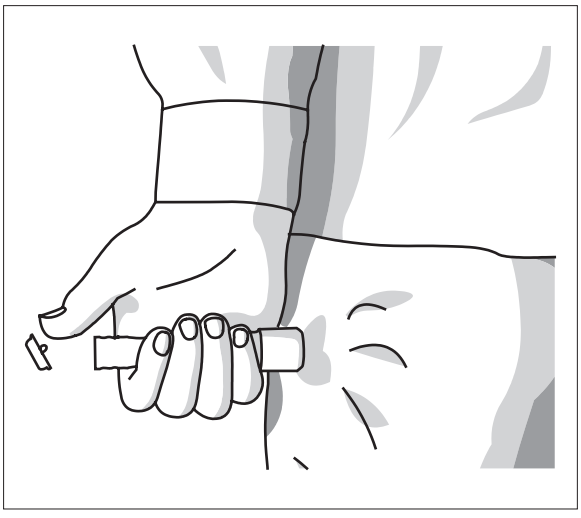

Figure 10. Drug administration.

Auto-injectors for self-aid or buddy-aid allow immediate injection of necessary drugs (antidotes).

Treatment on the battlefield with the use of auto-injectors with antidotes is an indispensable, life-saving stage of treating CWA poisoning, which will be continued by medical staff at the next stages of medical evacuation.

Auto-injectors must not be used if there are no symptoms of poisoning with nerve CWAs. Unjustified use of auto-injectors can entail unfavourable effects on health and reduce combat abilities of soldiers [3,15,16].

4.1. Sequence of use of auto-injectors

In the event of poisoning with nerve CWAs, the brown auto-injector with a yellow cap (containing atropine and pralidoxime) should be used first (see subchapters 4.4.1 and 4.5.2); then, additional doses of atropine should be given with the use of yellow auto-injectors (in accordance with the principles specified in subchapters 4.4.2 and 4.5.3), followed, if need be, by an anticonvulsant with the use of a grey auto-injector (in accordance with the principles specified in subchapters 4.4.3 and 4.5.4).

4.2. Classification of poisoning with nerve CWAs

In order to simplify the principles for medical proceeding on the battlefield, a classification of poisoning has been introduced, whereby two main types have been identified according to severity: moderate poisoning, in the event of which the drugs can be self-administered by the injured (self-aid), and severe poisoning – where treatment must be provided by the buddy (buddy-aid) or medical staff [17].

Poisoning presenting with symptoms of moderate intensity (moderate poisoning)

Symptoms:
- watery nasal discharge,
- sudden salivation,
- vision disturbances (dim, hazy vision),
- chest tightness or difficulty breathing,
- noticeably clammy skin and muscle twitching at some spots,
- abdominal pain resembling colic,
- nausea.

Severe course poisoning (severe poisoning)

Symptoms:
- symptoms described above, plus:
- strange behaviour of the injured or difficulty in establishing contact with him/her (disorientation),
- wheezing and crowing, difficulty breathing, cough,
- significant constriction of pupils (pupils are the size of pinheads),
- eye redness and tearing (if direct eye contamination),
- vomiting,
- intensified muscle tremor and generalized weakness,
- involuntary urination and defecation,
- convulsions,
- loss of consciousness,
- respiratory arrest.

4.3. Principles for use of auto-injectors for self-aid

4.3.1. Green auto-injector (two drugs: atropine and pralidoxime)

In case of symptoms of poisoning with nerve CWAs (symptoms listed above), use the green auto-injector (atropine and pralidoxime).

If the poisoning symptoms are greatly intensified (severe poisoning – as described in 4007), the poisoned person is not able to self-inject the drugs. In such a situation, it is necessary that they be administered by another soldier who is around (buddy-aid).

4.3.2. Yellow auto-injector (atropine)

The yellow auto-injector contains an additional dose of atropine. An additional dose of atropine should be administered if the symptoms of poisoning with nerve CWAs (described in 4006 and 4007) occur after 10–15 minutes from administration of the previous dose of atropine with the use of the brown or yellow auto-injector (self-assessment and/or buddy-assessment).

Additional dose of atropine should not be administered if after 5–10 minutes from administration of the previous dose of atropine there occurs a significant increase in the heart rate (rapid heartbeat) and significant dryness in the mouth.

4.3.3. Grey auto-injector (diazepam)

Diazepam (an anticonvulsant) is administered only in buddy-aid. A contaminated person with only moderately intensified symptoms of poisoning does not need an anticonvulsive drug, whereas a heavily poisoned person generally will not be able to self-administer the drug.

4.4. Principles for use of auto-injectors in buddy-aid

First, one should rescue oneself, then one can start rescuing others. Auto-injectors can be used for rescuing other

soldiers (buddy-aid), who are not able to self-administer the drugs due to sustained injuries or intensified symptoms of poisoning.

In buddy-aid, auto-injectors from the rescued person's kit are to be used as first, then, from the rescuer's own kit or the kit belonging to a casualty or a person who has not been poisoned. Prior to using the auto-injector, the injured person should have a gas mask put on.

4.4.1. Brown auto-injector with a yellow cap (two drugs: atropine and pralidoxime)

In case of symptoms of poisoning with nerve CWAs (symptoms listed above), use the brown auto-injector with a yellow cap (atropine and pralidoxime).

4.4.3. Yellow auto-injector (atropine)

A yellow auto-injector with an additional dose of atropine should be administered if:
- symptoms of poisoning with nerve CWAs (described in 4003 or 4004) occur after 10–15 minutes from administration of the previous dose of atropine with the use of the green or yellow auto-injector.

An additional dose of atropine should not be administered if after 5–10 minutes from administration of the previous dose of atropine the poisoned person experiences significant increase in the heart rate (rapid heartbeat) and mouth dryness [3].

4.4.3. Grey auto-injector (diazepam)

An auto-injector with diazepam is to be used if:
- convulsions have not occurred yet, but the poisoned person has already received three doses of atropine (including the green auto-injector) or
- convulsions occur in the poisoned person.

5. Auto-injector with an analgesic

An auto-injector with an analgesic is designed for immediate treatment of very severe pain accompanying major injuries. An auto-injector can be used for self-aid, buddy-aid or by medical staff.

Colour marking of the auto-injector: Outer housing of the auto-injector containing an analgesic is of red colour.

5.1. Principles for use of the auto-injector

The auto-injector for first-aid on the battlefield contains 20 mg of morphine sulphate. The auto-injector is to be used if severe ('difficult to bear') pain occurs following a severe injury (e.g. extensive wounds, fractures). Usually, after several or a dozen or so minutes from use of the auto-injector the pain subsides or its intensity is reduced.

Persons in whom pain evidently does not subside within 30 minutes from first administration of morphine can receive an additional dose of the drug.

5.2. Contraindications

Auto-injectors with an analgesic must not be used in persons who are hypersensitive (allergic) to morphine. Auto-injectors with an analgesic should not be used for mild ('slight') pain accompanying an injury.

Use of alcohol after administration of morphine can intensify adverse drug reactions.

5.3. General notice

Morphine is a strong-acting drug. Use of auto-injectors inconsistently with the principles can cause loss of combat ability and adversely affect the soldier's health.

SR

Conclusions

Any equipment for emergency first treatment inevitably creates the need for optimum compromise between supply on the spot of accident or illness and portability. The aim of the procedure for the onsite treatment is not definitive, but the liquidation of a life threatening condition and prepare the patient for transport. Medical personnel should be familiar with the types of drugs and indications and contraindications for their use in patients. As a rule, selecting the drug should only be used when the dosage is known from experience. It is especially recommended clear ordering of drugs and possibly marking them as directed, to avoid any mistreatment. The pre-filled syringes were used during World War II to the administration, even on the battlefield, analgesics (e.g. morphine) wounded soldiers. The pre-filled syringes are used when there is a need to provide the drug in a small volume and an accurately measured dose to the patient so that they could do themselves, especially during combat operations. Auto-injectors of analgesic should not be used in patients who are hypersensitive (allergic) to morphine. An auto-injector of analgesic can not be used when the pain associated with trauma is negligible ("slight pain"). Morphine is a potent drug. Application of an auto-injector inconsistent with the principles may result in loss of combat capability of the soldier and adversely affect his health. The army used auto-injectors to inject into the body some drugs to prevent poisoning toxic warfare agents such as pralidoxime and other oximes, atropine, diazepam and analgesics such as morphine.

References:

1. Romano JA, Lukey BJ, Salem H: Chemical Warfare Agents. Chemistry, Pharmacology, Toxicology and Therapeutics; Ed., CRC Press, 2008
2. Shapira SC, Hammond JS, Cole LA: Essentials of Terror Medicine, Ed., Springer Science + Business Media LLC, 2009
3. Thiermann H, Kehne K, Steinritz D et al: Red Blood Cell Acetylcholinesterase and Cholinesterase Status: Important Tools for the Physician in a Nerve Agent Scenario, Bundeswehr Institute of Pharmacology and Toxicology
4. Lallement G, Clair P, Zabe D: A new auto-injector for emergency self-treatment of nerve gas poisoning with and improved pharmaceutical concept and design.
5. Role of Oximes in the Treatment of Anticholinesterase Agent Poisoning, Ed.: Oxford, 1996
6. Malloy CD: A History of Biological and Chemical Warfare and Terrorism, Ed.: Aspen Publishers, Gaithersburg, Maryland, 2001
7. Eyer P: The role of oximes in the management of organophosphorus pesticide poisoning. Toxicol Rev, 2003

8. Bajgar J: Development of antidotes against nerve agents in Czech Republic, Ed.: ASA Inc. 2009
9. Bajgar J, Fusek J, Kuca K et al: Treatment of organophosphate intoxication using cholinesterase reactivators: facts and fiction. Mini-Rev Med Chem, 2007
10. Ellison DH: Chemical and Biological Warfare Agents, Ed.: CRC Press, 2008
11. Arena JM: Poisoning. Toxicology, Symptoms, Treatments, Ed.: Charles C. Thomas
12. First Aid – Field Manual, Department of The Army, The Navy and Air Force of USA, Washington, 2009
13. Fusek J, Bajgar J, Kassa J, Vachek J: Present antidotal means against chemical warfare agents in the Czech Army, Military Medical Academy, Dept. of Toxicology, Hradec Králové, Czech Republic
14. Wright L, Pope C, Liu J: The nervous system, as a target for chemical warfare agents. Chapter 32, Handbook of Toxicology of Chemical Warfare Agents. Gupta RC (ed.), Elsevier – Academic Press, 2009
15. Melnick AL: Biological, Chemical, and Radiological Terrorism, Ed., Springer Science + Business Media LLC, 2008
16. Marrs TC, Maynard RL, Sidell FR: Chemical Warfare Agents – Toxicology and Treatment, Ed. John Wiley & Sons, Ltd., 2007
17. Thiermann H, Worek F, Reiter G et al: Modern strategies in therapy of organophosphate poisoning, Toxicoll Lett, 1999