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AN OVERVIEW UPDATE IN CHEMICAL, BIOLOGICAL AND NUCLEAR WEAPONS AND THEIR EFFECTS IN HUMAN HEALTH

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Invention of chemical weapons can be coincided with 20th century world history, as it altered the course of military events. Eventually, biological, nuclear, thermobaric and thermobaric weapons got evolved in ambit of research for novel drastic means for mass disastrous effects. This increasing need for more advanced and efficient weapons led to immeasurable living detriments, casualties and severe environmental consequences. The effects of prolonged exposure to toxic emissions affect the human organism in multiple systems and organs, provoking from mild symptoms to irreversible conditions and eventually lethal. Mutagenesis and oncogenesis incitement affect the cellular biomolecular structure through genetic alterations, an event that evolves with the passing of time and exhibits long-term effects. The repercussions caused have arisen intense concerns among the global community, leading to collective agreements and conventions. However, universal efforts to the direction of radical weapons' restraint ought to be intensified.

Keywords: *Chemical Weapons; Biological weapons; Nuclear weapons; Radiation weapons; Thermobaric weapons; Conventional Weapons; Weapons of mass destruction; Rockets fuels; Munitions fuels; Health Military Effects; Environmental Military Pollution.*

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ОБЗОР ХИМИЧЕСКОГО, БИОЛОГИЧЕСКОГО И ЯДЕРНОГО ОРУЖИЯ И ЕГО ВЛИЯНИЯ НА ЗДОРОВЬЕ ЧЕЛОВЕКА

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Изобретение химического оружия тесно связано с историей XX века, так как оно меняло ход военных событий. Со временем в результате разработки биологического, ядерного и термобарического оружия появилась область исследования новых радикальных средств массового поражения. Рост потребности в более модернизированном и эффективном оружии нанес неизмеримый ущерб качеству жизни, привел к жертвам и серьезным последствиям для окружающей среды. Влияние длительной экспозиции токсичных выбросов оказывает воздействие на различные системы и органы человеческого организма, вызывая изменения от слабо выраженных симптомов до необратимых состояний и в конце концов летальный исход.

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Стимуляция процессов мутагенеза и онкогенеза влияет на структуру клеточных биомолекул посредством генетических изменений, и такое событие протекает в течение определенного периода времени и приводит к отдаленным изменениям. Наблюдаемые последствия вызвали серьезные опасения всего мирового сообщества, что привело к заключению коллективных договоров и соглашений. Тем не менее необходимо усилить совместные действия, направленные на ограничение использования радикального оружия.

Ключевые слова: *химическое оружие; биологическое оружие; ядерное оружие; радиологическое оружие; термобарическое оружие; конвенциональное оружие; оружие массового поражения; ракетное топливо; топливо боевой техники; влияние военного дела на здоровье; влияние военного дела на загрязнение окружающей среды.*

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Introduction

The comparative toxicity and health effects of chemical, biological, radiological, nuclear and other weapons have been designed and written under the professional view of a physician, toxicologist, hygienist and health practitioner.

This independent study is a part of an ongoing initiative of the Laboratory of Toxicology, in Medical School, University of Crete, the aim of which is to record and compare the evolutionary trends in the toxicity of chemical, biological, radioactive agents and other military activities, in relation to health effects deriving from the exposure to such agents. In this effort, the target is to improve recognition, information and education on specifically health problems related to chemical, biological, nuclear, cconventional and radiological weapons and military activities. All along, but especially in times of economic crisis, any armament or disarmament program was based on the logic of cost and geostrategic benefits. Unfortunately today, there is an increasing expense for the growing armament programs and the continuing military equipment. Military logic perpetuates and enhances geostrategic competition and the development of defensive and/or military attacks programs, in contrast to the role and mission of international organizations and initiatives.

We gave special attention to this chapter, as there is lack of information about the correlating exposure to chemicals, nuclear, radioactive or biological agents and contemporary developing diseases in individuals [1], a fact that leads physicians to implement symptomatic and not causative treatment. It is generally recognized that no equivalent mechanism exists for the lack of prevention and control of life quality despite the rapid increase of respiratory, hematological, oncological, metabolic, endocrine, neurodegenerative, developmental, autoimmune, reproductive diseases and other environmental affects. These diseases augment care expenditure for severe and incurable chronic diseases, as these agents create an obscure diagnostic frame. Moreover, unequal living conditions and education opportunities existing, may act as a hindrance to an accurate quantitative risk assessment regarding exposure to harmful agents. Thus, an amended collective global strategy is deemed essential, for the assurance of an optimal and qualitative care in a wide range of health care environments.

A. Chemical Weapons

1. History of Chemical Weapons

Military use of the chemical warfare agent sulfur mustard caused the most, nearly 1.130.000 casualties during World War I. Subsequently, Germany (World War II) was known to possess the blister agents mustard and lewisite, and to have manufactured approximately 7200 tn/year of phosgene.

Throughout the Cold War, the United States, the Soviet Union and their Pact allies, in an effort to secure their position, developed new chemical weapon programs based in part on German nerve agents like sarin. The US, Canada, and Britain entered a Tripartite Agreement in 1946, in order to share research on chemical weapons. These efforts culminated in the development of the lethal and persistent VX. The Russian stockpile of R-VX, sarin, soman and phosgene was completely weaponized, while mustard, lewisite and mustard-lewisite mixture were stored. By the end of World War II, the U.S. had produced more than 87,000 tons of sulfur mustard, 20,000 tons of Lewisite, and 100 tons of nitrogen mustard.

In 60's, changes in the international security policy fostered navigation towards partial disarmament of several types of WMDs and simultaneously fostered development programs for new weapons. Binary weapons coincided on a time period of increasing political pressures about the hazards of large-scale chemical warfare. Over 60,000 U.S. service members had been used as human subjects in the U.S. chemical warfare defense research program (NAS 1993) [2]. By the late 1980s, the United States began the massive destruction of much of its chemical weapons. OPCW, after the CWC in 1993, has declared and destroyed about 100,000 million tons of chemical weapons and remained 20—25.000 million tones on chemical stockpiles around the world.

Many chemical weapon research programs often ran together with equally sophisticated biological weapons programs, enriching data on complex meteorological and

delivery system problems. With the passing of time, the increasing sophistication of mainstream chemical [3] and biological [4] weapons in the early post-war period [5] led to the development of new generations of nerve agents [6].

Chemical weapons [7] have also been used in Iran—Iraq war [8], Project Coast by the South African government during the apartheid era, Gulf war [9], Afghanistan war and Syrian war. At present, the US and Russia maintain a large and advanced arsenal of chemical and nerve agents [10] for tactical and strategic use. There was tolerance and extension by OPCW for the destruction of 40,000 tons of CW for 2020 and 2025 for Russia and USA respectively.

2. Generation of classical lethal chemical weapons

Classical chemical weapons that produce lethal effects can be classified according to the time period of their main usage. Thus, first generation chemical weapons were discovered and used during the World War I and the 1930s. They can be discerned in choking agents, blood agents and blister agents. Choking agents, which include phosgene, diphosgene and chloropicrin, potently provoke the manifestation of pulmonary oedema. Blood agents, like hydrogen cyanide and cyanogens chloride, incite the inhibition of the cytochrome oxidase system [11]. Blister agents (HD, L/HN-1,2,3) have been associated with blister formation, inflammation processes and potent total tissue destruction [12]. Second generation chemical weapons pertain to the nerve agents G and V, used during the WWII and the 1950s—1960s respectively. They both exhibit the same biological effects, as they impede the AChE action. The former, include GA, GB and GD, while the latter entail VX and R-33. Binary chemical weapons consist the third generation of chemical weapons, which exhibit the same biological actions as the nerve agents. Binary weapons are basically formed by GB-2, VX-3 and IVA-2 and their usage sprawled during the 1970s—1980s. Fourth generation weapons, used in the time space between 1980s and 1990s, are binary Novichok weapons (e.g. A-230, A-232, A-234) and present similar effects as nerve agents.

Non-lethal irritant agents include adamsite (DM), diphenyldichloroarsine (DA), chloroacetophenone, diphenylcyanoamine, riot control agents, CS-gas, chloropicrin, malodorants and toxic industrial chemicals-TIC (Fig. 1).

Lethal Chemicals present a broad classification, according mostly to their primary substances. *G-series* include sarin, soman and tabun. *V-series* contain VX, VE, VG, VM, V-gas (the Russian equivalent of VX). They exhibit twelvefold toxicity than soman, with low water solubility [13]. Insecticides have the same effects as those of V-series, impeding acetylcholine action [14]. Another cluster of chemicals include thiolo,-thionophosphates and carbamates. As a result of a proliferation process between the Soviet Union and the US during the Cold War while preparing for immunological war, were the *binary weapons* [15]. Furthermore, *Novichok 5* as a lethal chemical weapon exceeds the effectiveness of soman by 10 times and of VX by 5 to 8 times [16]. Incapacitants are chemical agents that mainly attack the central nervous system [17]. It is worth noting that the multifactorial Project Coast [18] contains chemical weapons such as irritants, agents, incapacitating agents, organophosphate and pesticides.

3. Effects due to exposure to Chemical Weapons

During World War I the casualties exceeded 1, 1 million and deaths were near 100.000 [19].

The effects of CW exposure pertain mostly to provocation of tumorigenesis and chronic inflammations [20]. Such pathological conditions relate to respiratory system lesions [21], ocular diseases [22] and skin abnormalities. Specifically, nasopharynx, larynx, lung cancer and asthma may be instigated [23], as well as chronic obstructive pulmonary disease and bronchiolitis obliterans [24]. Exposure to lewisite, even at very low doses, triggers apoptotic events and inflammatory reaction. Moreover, reactive oxygen species, produced due to unfolded protein response signaling, are responsible for skin lesions [25]. Sulfur mustard (mustard gas) has the ability to induce the formation of blisters on lungs and skin [26]. It is worth pointing that it present a particular capacity to construct complexes that persist in the environment and in the ocean floor for years [27]. Inhalation of sulfur mustard [28, 29], may foster the epithelial cells to shed, and consequently lead to chronic respiratory problems [30]. Moreover, severe hematopoietic diseases are connected to CW exposure, with the most distinct of them being leukemia (typical acute non-lymphocytic), suppression of the bone marrow and the immune system, and chronic inflammation and secondary permanent damages to vital organs. Ocular inflammations are also worth noting; chronic conjunctivitis, late recurrent keratitis and recurrent keratopathy. Psychological disorders are also of prominence, as individuals affected have been reported to suffer from post-traumatic stress disorder [31] (PTSD) and mood disorders.

Organophosphates, sarin, cyclosarin and VX initially incite during the first three hours of exposure the manifestation of several early symptoms [32]; cellular meiosis, rhinorrhea, headaches, nausea, restlessness, anxiety and overactivation of sweat glands [33]. The main symptoms encountered include tremor, convulsions, abdominal cramps, regurgitation and vomiting, diarrhea, fatigue and possibly lethality. The long term effects are associated with eliminated AChE levels [34], low grade fever, asthenopia, anaemia, dyskinesia and dysesthesia, palpitations, sleep disorders and insomnia, decreased attention and behavioral problems.

CS tear gas (2-chlorobenzalmalononitrile) induce pulmonary, heart and liver damage, and are also associated with clastogenic effect. *CN tear gas* (Phenacyl chloride) provoke mucus membrane irritancy, temporary loss of balance and orientation, allergic contact permanent dermatitis and syncope. *CR tear gas* (dibenzoxazepine) exerts its effects mainly through activation of the TRPA1 channel, acting as a lacrymatory agent and inciting persistent blepharospasm, causing in turn temporary blindness, carcinogenic activity, asphyxiation-pulmonary oedema and lethality. In addition, *OC tear gas*- pepper spray (oleoresin capsicum or capsaicin or its synthetic homologues, such as, e.g., pelargonic acid vanillylamide) causes loss of motor control, ocular lesions (54%), respiratory system diseases (32%) and skin lesions(18%).

During the Vietnam War, about 10% of the country had been intensively sprayed with 72 million litres of chemicals. Three million people, including 500,000 children, are now suffering from the legacies of chemical warfare, and many US veterans became ill and died due to the effects of long-term exposure to dioxin in Southeast Asia [35]. A report published in 2003 claimed that 650,000 people in Vietnam were still suffering from chronic ailments [36].

In a 1991 report, Iraq's implementation of chemical weapons had cost Iran approximately 50,000 casualties [37]. Indeed, according to current estimations, casualties ascend up to 100,000, due to perpetual adverse effects [38]. As of

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2002, out of a total of 80,000 survivors, 6,25 % extend their therapy and 1,25% are hospitalized [39].

In Tokyo subway sarin attack in 1995, out of 5,000 people being tested in hospitals, 531 were mildly infected with decreased blood cholinesterase [40], and 112 presented strongly cholinergic symptoms (weakness, breathing difficulty, tremor, bundles, muscle spasms and decreased cholinesterase by 20—80%) [41].

Kolokol-1 is perceived to be the chemical agent employed by the Russian Spetsnaz team during the Moscow theatre hostage crisis in October 2002, causing at least 129 deaths. Kolokol-1(3-methyl-fentanyl) is a super potent fenthanyl analogue-carfenthanyl, about 10000 times more potent than morphine and 100 times more potent than fenthanyl.

B. Biological Weapons (BW)

Attacks with biological agents remain a concern for military planners. These weapons include Bacterium, virus, protozoan, parasite, or fungus and biological toxins [42] that can be used purposefully as a weapon in bioterrorism or biological warfare (mycotoxins, ricin, botulinum toxin or saxitoxin, palytoxin, batrachotoxin, tetrodotoxin) [43]. More than 1,200 different kinds of potentially weaponizable bio-agents have been studied. They consist of *lethal agents* (Bacillus anthracis, Francisella tularensis, Botulinum toxin) or *incapacitating agents* (Brucella suis, Coxiella burnetii, Venezuelan equine encephalitis virus, Staphylococcal enterotoxin B).

According to Borzi and Crivelli [44], 239 tests on people were conducted in the years 1949—1969 to simulate biological attacks on some main US cities. Porton Down is the UK research centre for chemical and biological weapons, where during the WWII military scientists tested the first biological weapons. During the Cold War, the Ministry of Defence of USA (DoD) reported in 2002 that between years 1952—1971, pathogenic and toxic substances were diffused into the environment for the research of the induced effects on humans and ecosystems. In 1949, large scale experiments were conducted on the New York population and in the San Francisco Bay area. Biological aerosols were introduced into the atmosphere, for the verification of the possible number of individuals infected (CD 22 Project). In the so-called Large Area Converge operation (1957), soils were contaminated with Zn and Cd compounds for the evaluation of the diffusion rate of these elements. The biological warfare agents tested by DoD included Coxiella burnetii, Francisella tularensis and Staphylococcal Enterotoxin B.

Similarly, biological agents in Roodeplaat Research Laboratories in Pretoria of Project Coast (1981—1995) by the South African government during the apartheid era contained peptides and peptide-conjugates for CD4 receptors (Thymosin) and involving a broad range of toxins and bacterial strains.

Mass spectrometry has been presented as a useful tool for the quantification of the effects of biological agents, as it provides speed and sensitivity [45]. Thus, mass spectrometry could be successfully utilized in clinical practice [46].

C. Nuclear Weapons

Over 2,000 nuclear tests have been conducted in over a dozen different sites around the world from 1945 until today. According to estimates by the Natural Resources Defence Council (NRDC), by 1991 the Soviet Union had approximately 35,000 weapons as stockpile [47]. Moscow's current total stockpile is approximately 8,000 warheads [48].

In 2010 there were approximately 200 U.S. tactical nuclear weapons utilized in Belgium, Germany, Italy, the Netherlands, and Turkey [49]. An estimation published by Kristensen and Norris (2015) put the actual number of operational U.S. warheads at 2,080 [50]. President Obama in his 2015 National Security Strategy and the statement on the 45th Anniversary of the Nuclear Non-Proliferation Treaty, reiterated the goal of seeking a world without nuclear weapons [51].

It is estimated that Russia currently has 695 ± 120 metric tons of weapons grade-equivalent highly enriched uranium (HEU) and approximately 128 ± 8 tons metric tons of plutonium [52]. By 2013, France had reduced its nuclear arsenal to around 290 warheads [53]. China has approximately 260 nuclear warheads [54]. It was also estimated that China produced approximately 2 ± 0.5 tons of plutonium, with 1.8 ± 0.5 tons remaining [55]. In 2004, China joined the Nuclear Suppliers Group (NSG) [56].

Nuclear weapon effects have posed important environmental concerns in relation to justice matters. Low-level ionizing radiation that nuclear power plants emit and elevated nuclear waste are issues that lead to deleterious environmental effects [57]. Radiation exposure is associated with genotoxicity [58] and could potently cause [59] autoimmune diseases (e.g. arthritis [60]) and an increased risk of chronic lymphocytic leukaemia [61, 62, 63] and vascular endothelial lesions [64].

Effects of nuclear explosions on human health

The consequences of exposure to nuclear explosion products can be distinguished according to the onset of the exposure in four distinct stages [65]. Thus, the initial stage includes the first one to nine weeks of the exposure and presents the most severe effects. Deaths are occurring in a 90% because of thermal injury and/or blast effects and by 10% due to exposure to super-lethal radiation. In the intermediate stage, which pertains to the following ten to twelve weeks, deaths are induced by ionizing radiation in the median lethal range (LD50). The next thirteen to twenty weeks belong to the late period, in which some improvement in survivor's condition can be present. The delayed period, after the twenty weeks time, is characterized by multiple complications, mostly related to healing of thermal and mechanical injuries, and provided the individual was exposed from a few hundred to thousands mSv of radiation, it can be coupled with infertility, sub-fertility and blood disorders [66], elevated cancer rate [67, 68] (e.g. thyroid cancer [69, 70, 71]) observed after approximately five or more years, with lesser problems such as eye cataracts, and more minor effects as well in other organs and tissues could also be detected over the long term.

D. Radiological weapons

A radioactive explosion could cause significant short- and long-term health problems, with potential cellular damage [72], due to skin-penetrating ability of gamma rays. In fact, the same isotopes used for blood transfusions and cancer treatments in hospitals around the world, such as caesium, cobalt and iridium, could be deployed to build a bomb.

Health effects of DU (WHO-U.S. Department of Veterans Affairs)

Depleted uranium (DU) demonstrates both chemical and radiological toxicity [73], with the target organs being the kidneys and the lungs (lung cancer). Tolerable ingestion of

soluble uranium compounds should not exceed 0.5 μg per kg of body weight/day. Inhalation of soluble or insoluble DU by public should not exceed 1 μg/m^3. Occupational exposure to DU as an 8-hour time weighted average should not exceed 0.05 mg/m^3. Replacement to depleted uranium in penetrator ammunitions also possesses carcinogenic properties (lethal rhabdomyosarcoma).

Effects of radioactive contamination

Short term effects include radiation dermatitis, miscarriages in the first trimester. People exposed to doses greater than 1.5 Gy become disabled, and some eventually die.

Delayed effects may also appear after months to years after irradiation and include a wide range of effects. Indicatively some of them are carcinogenesis [74], cataract formation, chronic radiodermatitis, decreased fertility, and genetic mutations [75], leading to congenital abnormalities (e.g. microcephaly).

E. Thermobaric weapons

Thermobaric weapons constitute high explosive bombs that utilize oxygen from the surrounding air to generate an intense, high-temperature explosion. The first explosive charge bursts open the container at a predetermined height and disperses the fuel in a cloud that mixes with atmospheric oxygen. The second charge then detonates the cloud, creating a massive blast wave.

A fuel-air explosive (FAE) bomb has as high explosive dispersed TNT (2,4,6-trinitrotoluene), RDX (1,3,5-trinitro-1,3,5-triazocyclohexane), HMX (1,3,5,7-tetranitro-1,3,5,7-triazocycloactane), PETN (pentaerythritol tetranitrate) nitro-guanidine, and mixtures thereof. The thermobaric weapons fuels *ethylene oxide* and *propylene oxide* may cause breast and bones carcinogenic effects, mutagenicity and irritability.

Human effects of High Explosive Bombs

TNT (2,4,6-trinitrotoluene) provokes initial clinical symptoms, like nausea, vomiting, abdominal pain, fatigue and drowsiness, petechiae formation and jaundice. Haematological effects pertain to fatal aplastic anaemia and bone marrow hyperplasia. The liver is also multiply affected, as an individual may exhibit toxic jaundice and hepatitis, elevation of hepatic enzymes, hepatoma [76] and hepatocellular carcinoma. Important pathological conditions involve the reproductive system, with incitement of decreased semen volume, eliminated percentage of motile spermatozoa and significantly higher incidence of sperm malformation.

RDX (103 μg/l for drinking water and aquatic foodstuff) involves contamination of local drinking water supplies [77]. Acute or chronic toxic effects of exposure to RDX include hyperirritability, nausea, vomiting, generalized epileptiform seizures, and prolonged postictal confusion and amnesia.

During World War II, PETN was most importantly used in exploding-bridgewire detonators for the atomic bombs and as a component of some gun and rocket propellants. However, PETN is also used in the treatment of angina pectoris. Manufacturing inputs or decomposition products, residual solids or gases of some explosives can be toxic or carcinogenic such as lead, mercury, barium from primers and nitric oxides.

Powdered PTFE is deployed in pyrotechnic compositions as an oxidizer with powdered metals such as aluminium and magnesium. Upon ignition, these mixtures form carbonaceous soot and the corresponding metal fluoride, and release large amounts of heat. Aluminium and PTFE is as well utilized in some thermobaric fuel compositions (Fig. 2).

Health effects from rockets, munitions and aircrafts fuels

Perchlorate exposure causes hypothyroidism and neurodevelopmental disorders in embryos and young children [78]. N_2O_4/MMH-Monomethylhydrazine is explosive, poisonous, corrosive and carcinogenic. Asymmetrical dimethyl hydrazine-UDMH is mutagenic, fetotoxic and teratogenic, causing pain and burns to the eyes and skin, methemoglobinemia, destruction of red blood cells, glutathione depletion, swelling of mitochondria, respiratory [79] -liver-kidney-nerve damage. It may cause seizures via GABA synthesis inhibition and behavioral disorders, structural and reproductive system abnormalities (affected sperm quantity and motility). During combustion, the exhaust products contain toxic nitrogen oxides. The potential toxic emissions [80] are HCI, NO_2, HNO_3, hydrazine, O_3 and smaller amounts of other substances, as defined by the Launch Area Toxic Risk Analysis-LATRA [81].

Canaveral and Baikonur are launch areas with significant health effects due to NASA and European (ESA) rockets activities [82]. During the historical survey of solid-propellant rocket development [83], many studies have described the health and ecological effects of rocket fuels. 1,1-dimethyl hydrazine is the most liquid fuel widely used in space vehicles. Aerozine 50 is a 50/50 mix by weight of hydrazine and unsymmetrical dimethylhydrazine [84] (UDMH), typically with dinitrogen tetroxide as the oxidizer, with which it becomes hypergolic (components spontaneously ignite when they mingle with each other). Eighteen different products are formed directly from 1,1-dimethylhydrazine in soil and water by transformation or energetical decomposition. Some of them are gastrointestinal system, liver and lung — toxicants or have mutagenic [85] (chromosomal instability [86]), carcinogenic, teratogenic and embryotoxic effects.

Products of 1,1-dimethylhydrazine in soils affected by hydrazine-based rocket fuel spills [87], oxidation of unsymmetrical dimethyl hydrazine over oxide and noble metal catalysts and environmental problems of production, as well as storage and disposal of highly toxic rocket fuels, contamination of atmospheric air [88] during launch of carrier rockets of different classes, the response of plants [89] to highly toxic components of liquid-propellant rocket fuel or the negative impact on objects of the environment upon accidents during launches of rocket-space hardware [90], are published as seriously, cumulative and long-term ecological and environmental problems.

Russian researchers claimed that rocket launches in Baikonur [91] and Plesetsk cosmodromes [92] were causing serious adverse effects among residents. A study performed from 1998—2000 by the epidemiologist Sergei Zykov at the State Research Centre of Virology and Biotechnology in Novosibirsk, exhibited that approximately 1000 children, residing in Altai, were twofold likely to contract endocrine and blood disorders.

For the AMOS-6 mission at SpaceX's Cape Canaveral Space Launch Complex 40 in September 1, 2016, the anomaly was named as «a standard pre-launch static fire test» or «The root cause of the breach has not yet been confirmed, but attention has continued to narrow to one of the three COPVs inside the LOX tank». The investigation teams now focused on a breach of the cryogenic helium system on the second stage liquid oxygen (LOX) tank [93].

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Health effects from fuel emissions

NO_2 (NOELs asthmatic = 0,3 ppm) causes aggravated cough, irritation of eyes- nose and respiratory tract, headache, shortness of breath, chest tightness, feeling of impending choking, chest pain, sweating, cyanosis of the lips and extremities such as methemoglobinemia, tachypnea, tachycardia, fever. Moreover, the $2NO_2 + H_2O \rightarrow HNO_3 + HNO_2$ reaction may cause pneumonia, pulmonary oedema, lipid peroxidation and oxidative stress.

HNO_3 (NOEL = 0,2 ppm) is associated with acute bronchospasm and laryngospasm, local irritation, lowering of blood pressure and palpitations, acrocyanosis, cough, dyspnoea, sparkling secretions, cyanosis, headache, nausea, absorption of toxic substances, allergy, recurrent symptoms of bronchopneumonia or pulmonary fibrosis and death from lung oedema, according to the concentration and solubility of gases.

Ozone (NOEL: 160—180 μg / m^3) induces pulmonary-asthma inflammation and increase of histamine-fibronectin. Moreover, tumorigenic action may get exhibited through the increase of the oncogene cyclin D protein, triggered by the elevated activity of growth factors Ras / Raf / ERK like Mitogen Activated Protein Kinase-MAPK. This event in turn activates the transcriptional Myc factor.

Health effects and Environmental Pollution by Military Activities

US Military activities have contributed to the incitement of polluted environments at many sites around the world. Environmentally hazardous military activities in the USA have produced on average a ton of toxic waste per minute during the last eight years [94]. Toxic elements and compounds traced there included many different pollutants, from pesticides to nuclear waste. In 1995 the Department of Defence (DoD) identified 19,000 sites at 1,700 domestic military facilities and more than 2,800 sites at 1,600 former defense facilities in the United States [95].

In the Island of Vieques in Puerto Rico, deployed as a bombing range by the U.S. Government, health data indicated that the mortality cancer risk elevated up to 1.39 times high. Furthermore, military exercises in Okinawa, Japan have contributed to environmental damage by producing soil erosion, pollution of surface waters and damaging effects on marine life, emission of toxic chemicals (e.g. PCB, Cd, Hg, Pb, known to cause various health diseases) into the sea and release of radionuclides by nuclear submarines [96].

Regarding the USSR-Russian Military activities, the Arctic region provided a crucial base for naval power and a large portion of Moscow's sea based nuclear deterrent [97]. From 1958 to 1962, the large number of high yield atmospheric tests on the islands resulted in radioactive contamination not only to Russian territory but also in Alaska and northern Canada. From 1945 to 1988, more than 20 naval accidents involving nuclear-armed or nuclear-propelled submarines or warships occurred in northern seas [98]. The sinking of a number of U.S. and Soviet nuclear submarines along with their nuclear warheads at the bottom of the ocean has raised additional concern, regarding carcinogenic isotopes able to become dispersed through the Arctic Ocean [99].

Human effects from military base activities

Military experiments are conducted in many areas in Greece, Italy and Turkey. In Sardinia, the Italian Inter-force Test Range is installed for this purpose. In matrices samples, elevated remnants of Pb, Tl, Ti and Al surpassing the legal limits were detected. Impressively, hepatic and renal tissues of farm livestock, located over 20 km away from this military testing base, were found to contain illegally elevated amounts of Cd and Pb.

It is easily deduced that living organisms can eventually accumulate contaminating agents with accompanying genetic or epigenetic lesions. Elevated incidence rates of mutations and tumorigenesis have been found in workers and livestock, in territories where military testing was performed. Indicatively, compounds that could be detected in these sites were perchlorates, trinitrotoluene, 2 amino-4,4-DNT and 2,4-DNT [100].

For *arsenic* (*Ar*), the skin consists the main objective of long-term exposure, and there is strong likelihood of skin cancer manifestation [101]. Potent consequences also pertain to hepatic lesions, peripheral neuropathy and vascular disease, diabetes provocation and tumorigenesis in organs as the bladder, the lungs, the kidney (renal cancers) and the prostate.

Cadmium (Cd) presents potent carcinogenic properties. Long-term exposure to low doses of Cd may incite pulmonary pathologies (bronchitis and emphysema), debilitation of the skeletal system, hematological diseases (immune system attenuation and anemia), as well as renal and hepatic damage [102].

Chromium VI (*Cr*) when inhaled provokes deformity of architecture of the nasal epithelium and allergic reaction. Hepatic, renal and pulmonary lesions are likely to manifest as well as mutagenic events [103]. IARC has classified Cr as human carcinogen.

Nikel (Ni) uptake happens primarily via the gastrointestinal tract. However, deleterious effects can be observed in the respiratory system, with the clinical manifestation of pulmonary cancer, obstructive disorders, as well as allergic dermatitis. Ni is as well classified as a tumorigenic element.

Thallium (*Tl*) is particularly linked with renal inflammations, liver tissue necrosis, degeneration of the central nervous system and abnormal growth of bone and cartilage. Exposure to Tl prenatally is responsible for the childbirth of underweight infants [104].

2,4-Dinitrotoluene (DNT) is synthetically created. In individuals exposed, DNT induces decreased semen production, hepatic and kidney disorders. According to IARC, DNT belongs to the category of possible human carcinogens.

In Sardinia, research data reveal an ascending incidence of cancers in the hematopoietic and lymphopoietic system, in the cases of exposed individuals. Male patients exhibit an increase in these types of cancer rates of about 10%, while in the females the observed percentage is about 12% [106]. Furthermore, results collected from hospital impatients present an increase of about 210% and 264% for male and female individuals respectively, pertaining to diabetes rates [107].

The Vieques military installation, in Puerto Rico, has been associated with the instigation of increased levels of diabetes in the local population, as 1 out of 4 individuals suffers from diabetes. A possible hypothesis refers to the interaction of uranium with the molecular pathway of insulin and incites pancreatic lesion [108]. According to Kuznetsova et al [109], the elevated rates of individuals hospitalized due to diabetes occur because of the residential proximity to sites polluted with persistent organic pollutants wastes. About 90% of mortality rates induced by non-Hodgkin lymphoma appertain to village inhabitants, as well as 75% for hematopoietic and lymphopoietic system cancers [110].

Agreements and Conventions for weapons of Mass Destruction

The United Nations Atomic Energy Commission regarding nuclear safety was entered into force in June 1946. Many Multilateral Treaties (e.g. Partial Test Ban Treaty-PTBT of 1963, Nuclear Non-proliferation Treaty-NPT of 1968, Threshold Test Ban Treaty-TTBT in 1974 etc.) ban all nuclear_explosions, in all environments adopted by the United Nations General Assembly on 10 September 1996. The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management is the first international instrument to focus on minimizing the effects of hazardous radiological materials and developing best practices to promote an effective nuclear safety culture.

Moreover, the Multilateral Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on Their Destruction (CWC) was entered into force in 1997. As far as biological weapons are concerned, the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons (BTWC) was signed in Geneva in 1972 (Fig. 3).

It is also worth pointing that some multilateral treaties exist, that juristically restrict the launch, delivery and detonation of military weapons supplies, the elimination of army troops in the region of Central Europe, and the official permission of performing unarmed observation flights in the aerial space of other State Parties.

More than 124,000 gas tons were produced by the end of WWI, contrarily to the Hague Declaration (1899) and the Hague Convention (1907). It is remarkable that, despite the long time period that has passed after the Great War, chemical warfare has still a durable presence. Research programmes continued throughout the interwar period and beyond, conversely to public condemnation and the increasing casualties [111]. Throughout the Cold War, global superpowers developed new chemical weapon programs, changed the international security policy, developed new WMDs to develop armaments into the new millennium with novel technology support, despite conventions and agreements of destruction their chemical weapons stockpile [112].

In the near future, science through pharmacology and biotechnology will be able to control sectors of human functionality (consciousness, motor abilities, emotions and behavior) by the use of incapacitating agents. Incapacitants present a potential to be deployed for hostile purposes. Thus, a realistic solution could be a novel international formal pact that forbids the intervention in human beingness. Utilized for the diagnosis and research of infective pathogens are the Biosafety Level 4 laboratories, found in the State Research Centre of Virology and Biotechnology in Koltsovo, Russia and in the Centre for Disease Control and Prevention in Atlanta USA. In 2007, it was also announced that China would open its first BSL-4 laboratory at the Wuhan Institute of Virology in cooperation with France.

Conclusion

The existence of chemical weapons is intertwined with the tier of scientific and technological development. The acceptance and implementation of the CWC is an important step, as CWC would provide protection from potent adverse effects of this progress. CW further development is entrenched on the most advanced knowledge of modern scientific disciplines, particularly at chemistry and biology sectors. The hazard gets elevated, as the progress of non-lethal chemical weapons production perpetuates. In the future, new forms of accumulation of biochemical weapon stocks will occur, caused by the uncontrolled production of novel toxic compounds. Thus, scientific, medicine and toxicology societies hold the obligation to stand up against the military attacks which cause casualties, exhaustion of fossil fuels, increased military spending, health and poverty costs, poor quality of life and a future of chronic diseases in conditions of toxic climate burden and change. An international media effort is considered essential, for educational preparation in medical schools and effective management of toxic effects.

List of abbreviations

AChE: Acetylcholinesterase
BTWC: Biological and Toxin Weapons Convention
CW: Chemical Weapons
CWC: Chemical Weapons Convention
DU: Depleted uranium
HMX: 1,3,5,7-tetranitro-1,3,5,7-triazocyclooctane
OPCW: Organisation for the prohibition of Chemical Weapons
PETN: pentaerythritol tetranitrate nitro-guanidine
RDX: 1,3,5-trinitro-1,3,5-triazocyclohexane
R-VX: (R)-phosphinate VX agent
TNT: 2,4,6-trinitrotoluene
VE: S-(Diethylamino)ethyl O-ethyl ethylphosphonothioate
VM: S-[2-(Diethylamino)ethyl] O-ethyl methylphsphonothiate
VR (Russian VX, R-33): N,N-diethyl-2-(methyl-(2-methylpropoxy)phosphoryl)sulfanylethanamine
VX: Venomous agent X (O-ethyl S-[2-(diisopropylamino) ethyl]methylphosphonothioate
WMD: Weapons of Mass Destruction

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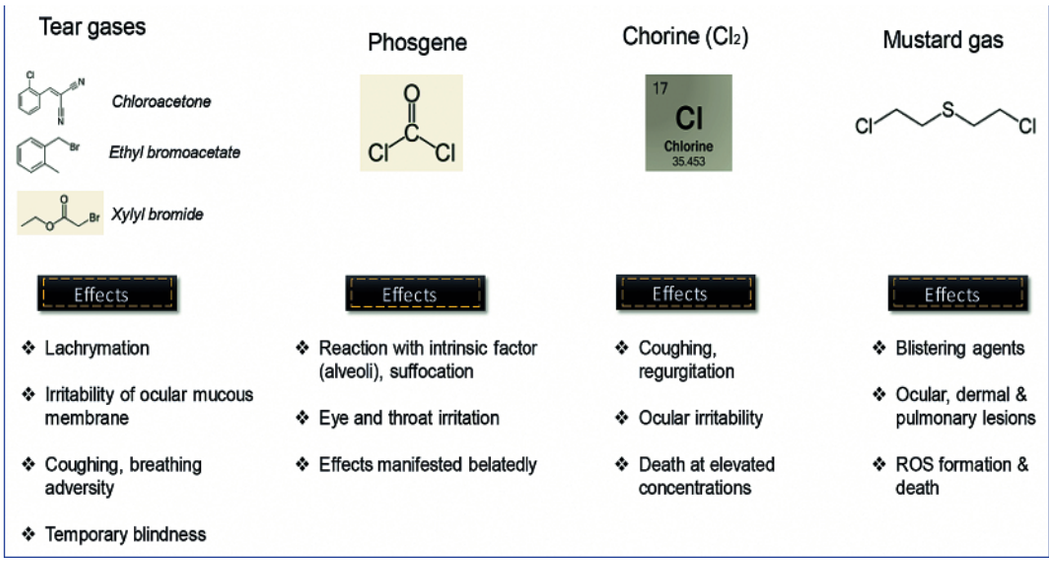

Figure 1. Several chemical warfare agents and pathological conditions they are linked with.

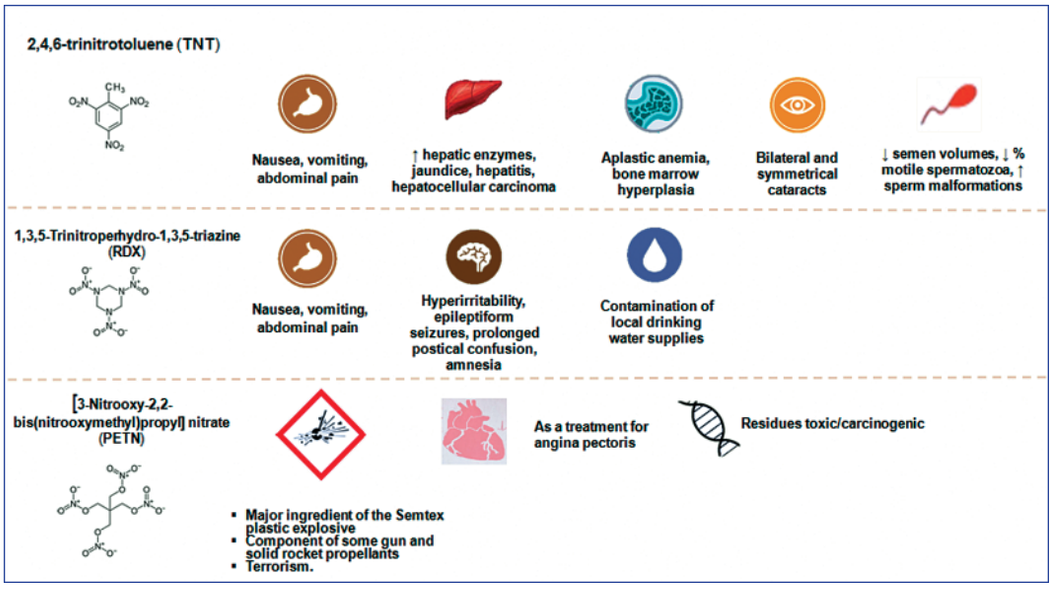

Figure 2. Health effects induced by high explosive bombs.

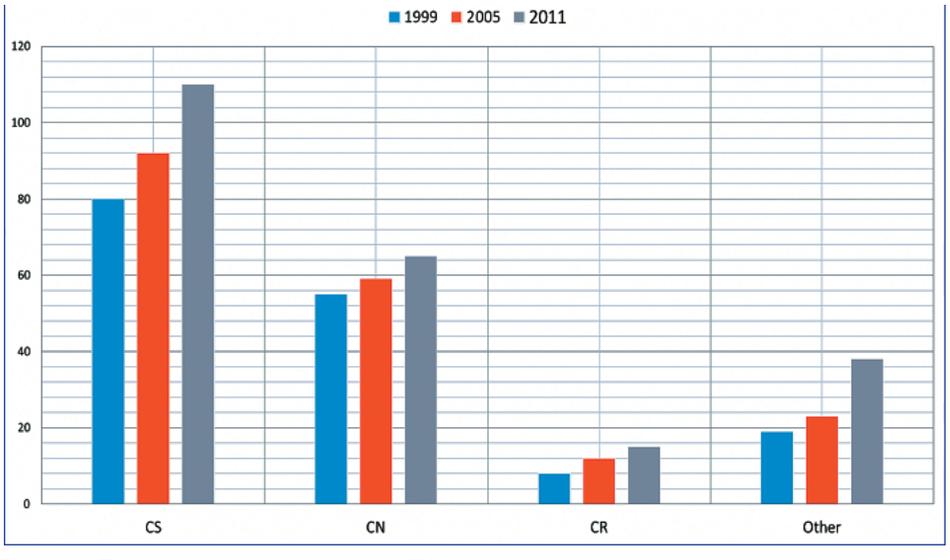

Figure 3. The number of countries in CWC declaring different types of riot control agents