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## **Nuclear and Bioterrorism Implication on Environment**

### **ABSTRACT**

Terrorism is now a global threat, spreading its shadows over regions which were previously regarded as the exclusive domain of the military superpowers. One of the prime threats is nuclear terrorism, using nuclear or radiological agents. To assess the threat, it is important to include all factors that make it possible.

*Key words:* dirty bomb, IAEA, nuclear power plant, radiological contamination, radiological weapon, risk assessment, biological agents, bioregulators, medical treatment, protection, decontamination, toxin agents, warfare.

### **Introduction**

Terrorism is not a new phenomenon. However, today's terrorists, be they international cults like Aum Shinrikyo or individual nihilists like the Unabomber, act on a greater variety of motives than ever before. More ominously, terrorists may gain access to weapons of mass destruction, including nuclear devices, germ dispensers, poison gas weapons, and computer viruses. Also, new is the world's dependence on a nearly invisible and fragile network for distributing energy and information.

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A Nuclear terrorism denotes the use, or threat of the use, of nuclear weapons or radiological weapons in acts of terrorism, including attacks against facilities where radioactive materials are present.<sup>2</sup>

In legal terms, nuclear terrorism is an offence committed if a person unlawfully and intentionally “uses in any way radioactive material ... with the intent to cause death or serious bodily injury; or with the intent to cause substantial damage to property or to the environment; or with the intent to compel a natural or legal person, an international organization or a State to do or refrain from doing an act”, according to 2005 United Nations International Convention for the Suppression of Acts of Nuclear Terrorism.<sup>3</sup>

The notion of terrorist organizations using nuclear weapons (especially very small ones, such as suitcase nukes) has been a threat for long and it is considered plausible that terrorists could acquire a nuclear weapon. In 2011, the British news agency, *the Telegraph*, received leaked documents regarding the Guantanamo Bay interrogations of Khalid Sheikh Mohammed. The documents cited Khalid saying that, if Osama Bin Laden is captured or killed by the Coalition of the Willing, an Al-Qaeda sleeper cell will detonate a “weapon of mass destruction” in a “secret location” in Europe, and promised it would be “a nuclear hellstorm”.<sup>4</sup>

Bioterrorism is terrorism involving the intentional release or dissemination of biological agents. These agents are bacteria, viruses, or toxins, and may be in a naturally occurring or a human-modified form. Bioterrorism is a criminal act against unsuspecting civilians using pathogenic biological agents, such as biological warfare agents.<sup>5</sup>

<sup>2</sup> A **nuclear weapon** is an explosive device that derives its destructive force from nuclear reactions, either fission or a combination of fission and fusion. Both reactions release vast quantities of energy from relatively small amounts of matter.

A **radiological weapon** or **radiological dispersion device (RDD)** is any weapon that is designed to spread radioactive material with the intent to kill, and cause disruption upon a city or nation.

It is primarily known as a dirty bomb or salted bomb because it is not a true nuclear weapon and does not yield the same explosive power. It uses conventional explosives to spread radioactive material, most commonly the spent fuels from nuclear power plants or radioactive medical waste.

Internet: [www.absoluteastronomy.com](http://www.absoluteastronomy.com).

<sup>3</sup> Internet: <http://untreaty.un.org/cod/avl/ha/icsant/icsant.html>.

<sup>4</sup> Hope, Christopher. “WikiLeaks: Guantanamo Bay terrorist secrets revealed”. <http://www.telegraph.co.uk/news/worldnews/wikileaks/8471907/WikiLeaks-Guantanamo-Bay-terrorist-secrets-revealed.html>. Retrieved April 27, 2011.

Gould, Martin. “WikiLeaks: Al-Qaeda Already Has Nuclear Capacity”. <http://www.newsmax.com/Newsfront/WikiLeaks-GuantanamoBay-al-Qaida-terrorist/2011/04/25/id/393982>. Retrieved April 27, 2011.

<sup>5</sup> Garth L. Nicolson, *Bioterrorism, Bioterrorism and Biological Warfare Agents*, <http://www.immed.org/illness/bioterrorism.html>.

According to the U.S. Centers for Disease Control and Prevention (CDC):<sup>6</sup> A *bioterrorism attack* is the deliberate release of viruses, bacteria, toxins or other harmful agents used to cause illness or death in people, animals, or plants. These agents are typically found in nature, but it is possible that they could be mutated or altered to increase their ability to cause disease, make them resistant to current medicines, or to increase their ability to be spread into the environment. Biological agents can be spread through the air, water, or in food. Terrorists tend to use biological agents because they are extremely difficult to detect and do not cause illness for several hours to several days. Some bioterrorism agents, like the smallpox virus, can be spread from person to person and some, like anthrax, cannot.<sup>7</sup>

Bioterrorism is an attractive weapon because biological agents are relatively easy and inexpensive to obtain, can be easily disseminated, and can cause widespread fear and panic beyond the actual physical damage they can cause. Military leaders, however, have learned that, as a military asset, bioterrorism has some important limitations; it is difficult to employ a bioweapon in a way that only the enemy is affected and not friendly forces. A biological weapon is useful to terrorists mainly as a method of creating mass panic and disruption to a state or a country.<sup>8</sup>

### Brief Overview

Brief overview of relevant historical events can aid in our understanding of nuclear terrorism threats. Development of nuclear weapons began in the 1940s.<sup>9</sup> In 1941, the British began a nuclear weapons' research program.<sup>10</sup> Fearing German production of nuclear weapons during World War II, the United States and allied nations joined efforts and the Manhattan Project began.<sup>11</sup> In 1945, the United States dropped an atomic bomb on Hiroshima, Japan, and created the world's first radiologic public health emergency, resulting in 60,000-70,000 immediate deaths.<sup>12</sup> When this failed to persuade the Japanese to surrender, the United States dropped a second bomb on Nagasaki, Japan, 3 days later, resulting

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<sup>6</sup> Stable Internet address: <http://www.bt.cdc.gov/bioterrorism/>.

<sup>7</sup> *Bioterrorism Overview*, Centers for Disease Control and Prevention, 12/02/2008, <http://www.bt.cdc.gov/bioterrorism/overview.asp> retrieved 22/05/2009.

<sup>8</sup> Stable Internet address: <http://en.wikipedia.org/wiki/Bioterrorism>.

<sup>9</sup> Stable Internet address: <http://jnm.snmjournals.org/content/47/10/1653.full#ref-6>.

<sup>10</sup> Ibid.

<sup>11</sup> Ibid.

<sup>12</sup> Ibid.

in another 40,000 deaths. The Japanese surrendered within 5 hours of the second bombing. Within 5 years, an estimated 340,000 Japanese, mostly civilians, had died as a result of the 2 bombs.<sup>13</sup>

In 1949, the Cold War began with the Soviet Union's first nuclear test.<sup>14</sup> The United Kingdom, France, and China also joined the United States in nuclear weapons' testing.<sup>15</sup> Since 1949, approximately 2,000 nuclear test explosions have taken place around the world.<sup>16</sup>

Throughout history, warriors have sought to devise more effective means of mass destruction. Biological weapons have been of interest for centuries and have been utilized in numerous battles. State-sponsored programs have intensively researched optimal organisms and techniques for their dissemination. Recent advances in molecular biology have allowed successful manipulation of bacteria and viruses to provide resistance to conventional treatments. Large stockpiles of such altered bioweapons now exist and are available for terrorist use.

U.S. President Barack Obama calls nuclear terrorism "the single most important national security threat that we face".<sup>17</sup> In his first speech to the U.N. Security Council, President Obama said that "just one nuclear weapon exploded in a city — be it New York or Moscow, Tokyo or Beijing, London or Paris — could kill hundreds of thousands of people".

In 1969, President Richard Nixon sought to end proliferation of biological weapons, signing an executive order prohibiting any use of biological agents under any circumstances. Broader efforts followed in 1972, with the Biological Weapons Convention (BWC), signed by many members of the United Nations (including the US, the USSR, and Iraq) to prohibit "the development, production, and stockpiling of chemical and bacteriological (biological) weapons."<sup>18</sup> Nevertheless, the Soviet Union felt the BWC was meaningless and in the 1970s embarked on a much broader program that involved over 60,000 individuals.<sup>19</sup>

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<sup>13</sup> Stable Internet address: <http://jnm.snmjournals.org/content/47/10/1653.full#ref-7>.

<sup>14</sup> Ibid.

<sup>15</sup> Ibid.

<sup>16</sup> Ibid.

<sup>17</sup> Graham Allison (January 26, 2010). "A Failure to Imagine the Worst". *Foreign Policy*. Retrieved: 25/02/2011 <http://www.hks.harvard.edu/index.php/newsevents/news/commentary/failure-to-imagine-worst>.

<sup>18</sup> Stable Internet address: <http://www.unog.ch/80256EE600585943/%28httpPages%29/04FBBDD6315AC720C1257180004B1B2F?OpenDocument>.

<sup>19</sup> Wolfinger K. "Interviews with Biowarriors. Bioterror", Nova Online Web Site. Available at: <http://www.pbs.org/wgbh/nova/bioterror/biowarriors.html>. Accessed June 19, 2010.

Biopreparat, the civilian arm of the Soviet bioweapons program, focused its efforts on the development of mixed agents, combining multiple viruses in one novel genome (the Hunter Project) and developing bacteria resistant to all known antibiotics and vaccines (Project Bonfire). The inclusion of viruses inside bacteria to form so-called “superbugs” was also a focus, according to Sergei Popov, a former senior Soviet scientist.<sup>20</sup> The official activity of Biopreparat significantly decreased with the collapse of the Soviet Union in 1991, although continued research likely continued until the late 1990s. Moreover, the whereabouts of many of its scientists and their products are unknown.<sup>21</sup>

### NUCLEAR TERRORISM SCENARIOS

Nuclear terrorism could include:

1. Acquiring or fabricating a nuclear weapon
2. Fabricating a dirty bomb
3. Attacking a nuclear reactor, e.g., by disrupting critical inputs (e.g. water supply)
4. Attacking or taking over a nuclear-armed submarine, plane or base.<sup>22</sup>

Nuclear facilities, including nuclear reactors and fuel storage depots, are potential terrorist targets.<sup>23</sup> Modern commercial nuclear reactors are well secured and protected, contained by walls of steel and concrete that are several meters thick. These barriers prevent dispersal of radioactive material should “melt down” from the heat produced by the radioactive fission products occur. The barrier secondarily protects the reactor from air or other outside explosive attack, and even high-level explosives would be unlikely to significantly penetrate the protective barrier.

Only a reactor that is being refuelled, with its containment structure open, would be at risk for releasing radioactive material into the surrounding environment.<sup>24</sup> However, in this scenario, the reactor would be shut down, and much less radioactive material would be present compared with active operation (since fission

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<sup>20</sup> Ibid.

<sup>21</sup> Lewis S. History of Biowarfare. Bioterror: Nova Online Web Site. Available at: <http://www.pbs.org/wgbh/nova/bioterror/history.html>. Accessed June 19, 2010.

<sup>22</sup> Ruff, Tilman (November 2006), *Nuclear terrorism*, <http://energyscience.org.au/FS10> Nuclear Terrorism.pdf.

<sup>23</sup> *National Council on Radiation Protection and Measurements. Management of Terrorist Events Involving Radioactive Material. Bethesda, MD: National Council on Radiation Protection and Measurements; 2001:138.*

<sup>24</sup> Ibid.

products quickly decay to low levels during shutdown). The Nuclear Regulatory Commission has stated that the likelihood of a direct attack on a reactor, resulting in both direct damage to the reactor and the release of radioactive materials, is low.<sup>25</sup> If a terrorist attack on a nuclear facility were able to penetrate a reactor and breach containment, release of radioactive material and subsequent health effects would likely be on a smaller scale than Chernobyl, because efficient and effective dispersal of source materials requires an explosion with significant energy.<sup>26</sup> Depending on the nature of the explosives used and material attacked, the area at risk for health effects would range from a few city blocks to several miles.<sup>27</sup>

Nuclear facility fuel storage depots are less well protected than nuclear reactors, but spent fuel contains much less radioactive material. A terrorist attack on spent fuel would be unlikely to expose a population to significant amounts of radiation.<sup>28</sup> However, as with an RDD, though the mortality and level of radiation exposure resulting from a terrorist attack on a nuclear facility would be relatively low, the psychological impact, even of an unsuccessful attack, might be severe. An analysis of the Three Mile Island incident has demonstrated that mental health issues were one of the main public health consequences of the event.<sup>29</sup>

The successful use of a nuclear weapon by terrorists would require significant technical and financial resources for planning; access to fissile material; expertise to construct a weapon; the ability to covertly transport and place the weapon; and the motive, will, and ability to detonate the weapon without detection.

A weapon constructed *de novo* by a terrorist group would likely be much larger than a stolen weapon and would, therefore, be easier to detect. Weapons with increasing nuclear yield potential would be larger and more detectable, not only because of size but also because of increasing radiation signature.<sup>30</sup>

Detonation of a nuclear weapon, resulting in an initial air blast and the release of radiation, produces pressure and heat waves causing the greatest amount of destruction. Radiation from the first minute after detonation, or initial radiation, accounts for only about 5% of the total energy release, whereas the fallout from longer-lived radionuclides, or residual radiation, represents only an additional 10% of the total energy.<sup>31</sup>

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<sup>25</sup> Stable Internet address: <http://jnm.snmjournals.org/content/47/10/1653.full#ref-18>.

<sup>26</sup> Stable Internet address: <http://jnm.snmjournals.org/content/47/10/1653.full#ref-8>.

<sup>27</sup> Ibid.

<sup>28</sup> Stable Internet address: <http://jnm.snmjournals.org/content/47/10/1653.full#ref-15>.

<sup>29</sup> Stable Internet address: <http://jnm.snmjournals.org/content/47/10/1653.full#ref-6>.

<sup>30</sup> Internet page: <http://jnm.snmjournals.org/content/47/10/1653.full#ref-8>.

<sup>31</sup> Internet page: <http://jnm.snmjournals.org/content/47/10/1653.full#ref-19>.

In 1987, a non-terrorism-related radiological emergency in Brazil involved health effects and radioactive material mirroring what might be expected in a radiation terrorism scenario. In this incident, a group of men seeking scrap metal dismantled an abandoned teletherapy unit at the Goiania Institute of Radiotherapy, exposing the unit's platinum core containing 137 Cs.<sup>32</sup> The purchaser of this scrap metal then unknowingly distributed the radioactive material among relatives, friends, and children, resulting in contamination of 249 people and 4 deaths.<sup>33</sup> The well-documented physical, economic, and psychosocial impacts on the area were significant.<sup>34</sup>

More recently, threats of radiological terrorism from al Qaeda were raised in 2002 when 31 year old Jose Padilla was detained on suspicion that he intended to deploy a radiological dispersal device (RDD) in the United States<sup>35</sup>; detailed plans for RDDs were uncovered after the destruction of an al Qaeda training camp in Afghanistan.

### **Problems in Serbia**

There are no nuclear power plants in Serbia yet, but the problem is that domestic coal reserves, excluding Kosovo, with the current level of electricity production, is sufficient only for the next 50 years, and therefore we should think about developing potentials for gas and nuclear power plants. The first obstacle to the construction of nuclear power plants in Serbia is the so-called "moratorium" which was passed after the Chernobyl tragedy — the Law on Prohibition of Construction of Nuclear Power Plants, which was adopted in June 1989 by the Assembly of SFRY, which is still in force in Serbia.

Experts from the Vinča Institute point out that a nuclear power plant of 1,000 MW spends about 50 tons of fuel a year and produces approximately 500 cubic meters of low and medium radioactive waste. A power plant of the same power consumes about 2.5 million tons of coal a year and produces eight million tons of carbon dioxide, 40 million tons of sulfur dioxide, six million tons of dust and a half million tons of fly ash.<sup>36</sup>

Each year, 326 kilograms of sulfuric acid fall on every hectare in the radius of 100 kilometers around the power plant "Nikola Tesla". World scientific experts believe that 30 kilograms of sulfuric acid per hectare per year leads to

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<sup>32</sup> Internet: <http://jnm.snmjournals.org/content/47/10/1653.full#ref-5>.

<sup>33</sup> Ibid.

<sup>34</sup> Ibid.

<sup>35</sup> Internet: <http://jnm.snmjournals.org/content/47/10/1653.full#ref-5>.

<sup>36</sup> Internet page: <http://www.astrozmaj.com/system/izborposla/aktuelnosti/ekologija/nuklearnapostroyenja.html>, Retrieved 25/05/2011.

environmental disaster, and therefore, in the radius of 100 kilometers around the power plant Nikola Tesla, eleven environmental disasters are happening at the same time.<sup>37</sup>

Although the authorities in Serbia are against the construction of nuclear power plants, Croats are planning to build one in the near future near Erdut, almost on the border with Serbia, while Hungarians are planning one in Pécs, and should seek the consent of the neighboring country. The decision on these locations is not yet definitive, but the decision on building new nuclear power plant “Belene” near “Kozloduy” in Bulgaria is. At approximately one hundred kilometers from our border are two nuclear power plants – “Kozloduy” at Bulgarian-Romanian border and “Paks” in Hungary, and little further, on the Black Sea in Romania is “Cherna Voda”, while at the Croatian-Slovenian border is “Krsko”.<sup>38</sup>

### **Program – recovering lost weapons and material**

In August 2002, the United States launched a program to track and secure enriched uranium from 24 Soviet-style reactors in 16 countries, in order to reduce the risk of the materials falling into the hands of terrorists or “rogue states”. The first such operation was *Project Vinča*, “a multinational, public-private effort to remove nuclear material from a poorly-secured Yugoslav research institute.” The project has been hailed as “a nonproliferation success story” with the “potential to inform broader ‘global cleanout’ efforts to address one of the weakest links in the nuclear nonproliferation chain: insufficiently secured civilian nuclear research facilities.”<sup>39</sup>

In order to reduce the danger of attacks using nuclear waste material, European Union Commissioner Loyola de Palacio suggested in November 2002 the creation of common standards in the European Union, especially in the new member states operating Soviet-era reactors, for subterranean nuclear waste disposal.

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<sup>37</sup> Ibid.

<sup>38</sup> Ibid.

<sup>39</sup> Deborah Block. US Military Practices Medical Response to Nuclear Attack *Voice of America*, 26 July 2010. <http://www1.voanews.com/english/news/usa/US-Military-Practices-for-Nuclear-Attack-99269609.html>.



## **Radioactive Waste**

Miroslav Pajić, from the Ecological Movement of Bor, says that there is a strong suspicion that nowadays, as well as before, radioactive waste is being imported, which is then processed in the Bor Smelter, and that that is the main reason of endangered health of population living nearby. Specifically, in Bor, within blending down of domestic concentrates, other imported concentrates are also blended down, deriving from nuclear power plants.

In countries that have nuclear power plants, there is waste originating from parts of these power plants, made of copper. These parts are then brought to our country and processed as crumbled copper, which is radioactive because it originates from radioactive environment.

When the instruments registered a significant increase in radioactivity over Belgrade in August 1989, and when it was established that the wave came from the East, cargo from the ship Barbara Blomberg, which was cruising in Serbian waters on Danube, as well as cargo from the ship Union, which was stationed in the Bar port, were under suspicion.

By blending down the concentrate from the ship Union, more than 500 kilograms of mercury, arsenic and thallium fell on Bor.

The sole existence of the said amounts of highly-enriched uranium proves that Vinča still has extremely privileged position in this country, which provides excellent opportunities for abuse. Everything that is being imported for the needs of Vinča, is exempted from regular customs and other mandatory controls. A complete insight into all that's there has only a small number of people, and they, due to fear or, which is much worse, personal gain, keep everything under a veil of secrecy. One thing is certain: having failed to make an atomic bomb, as was originally conceived, and since it is not engaged in solar energy, wind and other useful things for mankind, Vinca has converted into its own contradiction and stores nuclear waste of Europe, at an air distance of only 7 km from Belgrade!

## **Conclusion**

Terrorism dates back to antiquity, but our understanding of it as a public health threat is still in its nascent stages. Focusing on radiation and nuclear terrorism, we apply a public health perspective to explore relevant physical health and psychosocial impacts, the evolving national response infrastructure created to address terrorism, and the potential roles of nuclear medicine professionals in preparing for and responding to radiological and nuclear terrorism.

The 1968 Treaty on the Non-Proliferation of Nuclear Weapons sought to promote nuclear disarmament and prevent the development of additional nuclear weapons and the spread of nuclear weapons' technology.<sup>40</sup> At present, 187 countries have signed the treaty.<sup>41</sup> However, several countries continue to have active nuclear weapons' programs, and the concern exists that terrorist organizations have or may obtain nuclear weapons.<sup>42</sup>

A nuclear terrorist attack can be conducted in three basic ways, by detonation of a nuclear weapon, by sabotage or diversion of a nuclear facility or by dispersion of radioactive material into the environment (radiological weapon). Each possibility is specific and with different consequences.

Nuclear terrorism can be prevented by establishing a global system that requires from all countries to strictly follow international rules of trading, storing and using nuclear and radioactive materials and to produce an efficient national legislation. The United Nations have provided a basis for such legislation in the form of the International Convention for the Suppression of Acts of Nuclear Terrorism.

The use of biological agents and toxins in warfare and terrorism has a long history. Human, animal and plant pathogens and toxins can cause disease and can be used as a threat to humans, animals and staple crops. The same stands for biological agents. Although the use of biological agents and toxins in military conflicts has been a concern of military communities for many years, several recent events have increased the awareness of terrorist use of these weapons against civilian population. A Mass Casualty Biological (Toxin) Weapon (MCBTW) is any biological and toxin weapon capable of causing death or disease on a large scale, such that the military or civilian infrastructure of the state or organization being attacked is overwhelmed. A militarily significant (or terrorist) weapon is any weapon capable of affecting, directly or indirectly, that is, physically or psychologically, the outcome of a military operation. Although many biological agents such as toxins and bioregulators can be used to cause diseases, there are only a few that can truly threaten civilian populations on a large scale. Bioregulators or modulators are biochemical compounds, such as peptides, that occur naturally in organisms. They are a new class of weapons that can damage nervous system, alter moods, trigger psychological changes and kill. The potential military or terrorist use of bioregulators is similar to that of toxins. Some of these compounds are several hundred times more potent than traditional chemical warfare agents. Important

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<sup>40</sup> <http://jnm.snmjournals.org/content/47/10/1653.full#ref-6>.

<sup>41</sup> <http://jnm.snmjournals.org/content/47/10/1653.full#ref-6>.

<sup>42</sup> <http://jnm.snmjournals.org/content/47/10/1653.full#ref-6>.

features and military advantages of new bioregulators are novel sites of toxic action; rapid and specific effects; penetration of protective filters and equipment, and militarily effective physical incapacitation. This overview of biological agents and toxins is largely intended to help healthcare providers on all levels to make decisions in protecting general population from these agents.

On 22<sup>nd</sup> of August 2011, a substantial amount of weapons-grade uranium was removed from a nuclear reactor in Serbia to a site in Russia. Details of the operation were provided by the US State Department on August 23. In this highly successful cooperative project, officials from the United States, the Republic of Serbia, and the Russian Federation successfully transferred a quantity of highly-enriched uranium (HEU) from the Vinča nuclear reactor near Belgrade — enough for two nuclear weapons — to a facility in the Russian Federation where it will be blended down for use as a conventional nuclear fuel. The transfer of 48 kg of highly-enriched uranium in about 5000 rods. Still, in Serbia we have low level of coal reserves and high level of electricity production. We still do not have ideas of should and where to put nuclear power plants. But on the other side on a small we will be surrounded with maybe 8 nuclear plants. And we still have a problem with terrorist organization.

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