

Incapacitants interactive

Following the terrible consequences experienced by both the victor and the vanquished from chemical weapons in World War I, there was a public outcry for more “humane” weapons. Throughout the 1920s and 30s the victims of mustard, phosgene and chlorine attacks continued to die from complications of these chemicals.

One answer to produce a more humane weapon was to produce an incapacitant that was non-lethal and did not have persistent effects.

Definition

Under the Department of Defense definition, an incapacitant is an agent that produces temporary physiological or mental effects, or both, which will render individuals incapable of concerted effort in the performance of their assigned duties. An incapacitant that has marked central nervous system effects and renders the individual unable to perform his duties due to its psychobehavioral effects is called a deleriant.

History

Following World War II, with the recent discovery of more inhumane agents such as nerve gas and Zyklon B. a cyanide used in Nazi gas chambers, a concerted effort was made to create a more humane agent as an area control compound that would render the enemy non-functional but not with a significant mortality rate. There were other proposed uses for such agents as well and the Central Intelligence Agency took a keen interest in this area. A number of agents were tested during the Cold War. These included:

- β **Microwave and thermal sources;**
- β **Disruptive noises and music (remember the music played during the invasion of Grenada);**
- β **Irritants such as CS (tear gas), CN (Mace), CA, CR (British), DM (a vomiting agent) and pepper spray.**
- β **Psychoactive agents including;**
 - β **Central nervous stimulants such as amphetamines, caffeine, strychnine, metrazole, nicotine and cocaine.**
 - β **Central nervous depressants such as barbiturates such as methohexital, opioids, benzodiazepines and antipsychotics such as haloperidol.**
 - β **Psychedelics such as Psilocybin, harmine, MDMA (Ecstasy), marijuana, Lysergic acid (LSD -25), and ibogaine, anesthetics such as sutemtamil.**

- β Delerients especially anticholinergics such as scopolamine, atropine and glycolic acid derivatives. The tests also included several glycolate anticholinergics.

One of these 3-quinclidinyl benzylate was a member of a larger family of esters of glycolic acid and later termed BZ by NATO. This agent was first experimentally studied to be used, like hyoscyamines, in gastrointestinal disease. When side effects of disorientation and hallucinations developed, the drug was commercially withdrawn and turned over to the United States Army for further investigation. This agent proved particularly effective in small dosages and became the only agent in the United States inventory to be weaponized beginning in 1960. This production was continued until 1988 at which time stockpiles began to be destroyed. This task is now reported to be complete.

BZ is a powerful anticholinergic that is related to atropine and scopolamine. It exerts its effects physiologically in a manner directly opposite that of nerve gas. The use of anticholinergics and other mind-altering drugs in warfare is not new.

The first recorded instance of an attempt to incapacitate the enemy was in 600 BC when Solon's soldiers threw Hellebore roots into the steam supplying water to their enemy to create diarrhea. In 184 BC, Hannibal used belladonna plants, a rich source of atropine and other hyoscyamines, to create disorientation in his enemies. In 200 BC the Carthaginians used Mandragora laced wine to induce narcosis. The Bishop of Muenster in 1672 AD attempted to use belladonna in grenades in an assault on the city of Groningen. Natives have used plants containing anticholinergics alkaloids to poison invading and occupying troops throughout history including Africa and Southeast Asia.

To complete our history, it is necessary to look at modern approaches to incapacitants. The United States Military, realizing the continuing need for an incapacitant, still is conducting research in these areas. The Department of Defense Joint Non-Lethal Weapons Program (JNLWP) produced a 1997 Report - A Year in Review, in its first year of operation, which gives some details of the concept, structure, funded programs and other Non Lethal Weapons (NLW) activities. Funded programs include:

- **Modular Crowd Control Munition (MCCM) Ground (Electric) Vehicle Stopper**
- **Portable Vehicle Immobilisation System (PVIS) NL Bounding Munition (Mine)**
- **40mm NL Crowd Dispersal Munition UAV NL Payload/Delivery System**
- **Under Barrel Tactical Delivery System (UBTDS) Foams Applications**
- **Maritime Vessel Stopper Acoustic Programme**

- **Vortex Ring Gun**

More specifically, the DoD is researching incapacitants that avoid natural and synthetic drugs or chemicals currently. These include Non-Lethal Crowd Dispersal (M203). Blunt impact trauma. 40mm round for M203 grenade launcher, Acoustic Bio-Effects: Vehicle mounted or portable mechanical pressure wave generation capable of range of non-lethal to lethal effects, Mines (Claymore): Pre-emplaced claymore mine, kinetic weapon (rubber balls) and flash bang. Sting and flash effects at 5-15 meters, Stoppers - Ground: disable electronic components of vehicle by microwave transmitter or Maritime: under development by US Navy, Speed Bump and Net: Pre-emplaced net being designed to stop a 5,100lb vehicle traveling at 40-60 mph within 200ft, without serious injury to occupants. Area Denial technology includes 66mm Vehicle Launched Payload: Kinetics, Pyrotechnics (whistles, flash/bang) to be launched at standoff from vehicle to deter riotous crowds, Unmanned Aerial Vehicle (UAV) NL Payloads: could include stingballs, chemicals, malodorants, electronic disablers, lasers, Bounding NL Munition: Bounding mines could deliver entanglement nets (sticky and electric). These are Useful for perimeter defense, Canister Launched Area Denial System (CLADS): Dispensing of various NL payloads from vehicle mounted canister launcher rack, Foam Applications: to seal hatches, doors and windows. Incapacitate personnel and small arms, Acoustic Generators. Vortex Ring Gun: Vortex ring gas impulses with flash, concussion, non-lethal chemical agents and/or marker, and an Underbarrel Tactical Payload Delivery System: An underbarrel NL kinetic weapon. ^{2,3,4}

Thomas quotes an article written by a Russian Army Major, I. Chernishev, who describes work being done in Russia on 'psychotronic war' and 'psy' weapons. These included methods for disrupting the psyche of an individual including: ESP research, clairvoyance, telepathy, telekinesis and psychokinesis.

An increasing amount of literature is becoming available on the ethics and utilization of non-lethal weapons. ^{5,6,7,8,9} Agents currently excluded by FM 8 - 285 as incapacitants are insecticides, flame and smoke, and riot control agents.

Epidemiology

Delerients and other incapacitants are readily available world - wide. Anticholinergics are readily found in plants such as belladonna (*Atropa belladonna*), mandrake root, Black henbane (*Hyoscyamus niger*), the thornapple or Jimson weed (*Datura stramonium*) and woody nightshade

(Solanum dulcamara) and Jerusalem cherry (Solanum pseudocapsicum), all members of the Solanaceae botanical family (along with tobacco coincidentally)

While BZ is commercially available and used by scientists as QNB, it is not simple to make in a home laboratory. As BZ almost selectively affects the central nervous system it has become the scientific standard for the study of the central effects of anticholinergics.

George Robertson, Minister of the British Ministry of Defense, reported in February 1998 (Reuters) that Iraq had the same or a similar agent stockpiled in large numbers called Agent 15. The specific nature of this agent has not been verified or released. Thus it is possible that various terrorist organizations have secured some of this agent. It has been reported that Iraq resumed its offensive chemical and biological warfare production after it expelled United Nations inspectors.

BZ would be dispersed as an aerosolized solid or dissolved in solvents such as DMSO for ingestion or percutaneous use. Any sudden delirium in a previously healthy person or group of people should raise reasonable suspicion that an incapacitant may have been employed. It may be employed in hijackings, to take over an area or aircraft, to gain entrance to secure area and to cause panic.

Toxicology

An incapacitant is a chemical agent that produces a temporary disabling condition that persists for hours to days after exposure to the agent has occurred (unlike that produced by riot control agents). In the narrower sense the term has come to mean those agents that are:

- (1) Highly potent (an extremely low dose is effective) and logistically feasible.**
- 2) Able to produce their effects by altering the higher regulatory activity of the central nervous system.**
- (3) Of a duration of action lasting hours or days, rather than of a momentary or fleeting action.**
- (4) Not seriously dangerous to life except at doses many times the effective dose.**
- (5) Not likely to produce permanent injury in concentrations which are militarily effective.**

These criteria eliminate many drugs that might otherwise be considered as incapacitants. Opiates and strong sedatives are too

dangerous on account of their low margin of safety and milder tranquilizers cause little actual loss of performance capability. Many compounds have been considered as incapacitants and medical staffs must be on the alert to detect and report any unusual clinical appearances. All lethal agents in low doses may produce incapacitating effects and it is possible that new agents for incapacitation may be developed.

BZ is a stable crystalline solid that is suitable for dissemination by heat producing munitions. Its mw is 337.41 and formula is $C_{21}H_{23}NO_3$. Its melting point is $167^{\circ}C$ and boiling point is $320^{\circ}C$. It contains the moiety COH-CO-O and is a glycolic acid ester. Its half-life after dispersment is 3 to 4 weeks in moist air. It is very persistent on moist surfaces, in water and in soil.

It is similar in action to atropine but more potent. The Incapacitating dose of atropine that affects 50% of a population (ID_{50}) is about $140 \mu g/kg$ it is only $6.2 \mu g/kg$ for BZ.. This is also termed median incapacitating dose by NATO and the DoD. BZ is 80% as effective by the oral route as compared to the intravenous route. By inhalation it is about 40 to 50% as effective as by intravenous route. The safety margin between the lethal and the incapacitating dose is 30.

Scopolamine is seven times more potent regarding central activity than atropine but is shorter lasting in its effects. An injection of less than 1 mg of BZ and 1.5 mg of scopolamine hydrobromide will cause an average 70 kg man to become delirious. 10 to 12 mg of atropine will have the same effect.

Both affect the peripheral nervous system resulting in tachycardia, mydriasis and reduced depth of field and alterations in muscle tone. Some more potent synthetic anticholinergics can produce delirium with little or no peripheral effects. Death from excess dosage is probably due to cardiotoxicity though central toxicity is considered likely as well. Goodman calculated that the LD50 of atropine is 453 mg (95% Confidence level: 335-612 mg) ^{10,11}

Pathophysiology

BZ is an anticholinergic. This is a class of drugs that blocks, as a competitive inhibitor of acetylcholine, the post synaptic and postjunctional muscarinic receptor sites on the peripheral and/or the central nervous system. Also the exocrine glands and smooth muscle muscarinic receptors are affected. The nicotinic receptors in the skeletal muscle are not affected. Though atropine and scopolamine are better-known anticholinergics, BZ is more potent. Both atropine and scopolamine (hyoscine) are esters of tropic acid and contain a tertiary nitrogen moiety. This permits these agents to readily cross the blood brain barrier. In the central nervous system anticholinergic compounds disrupt the high integrative functions of memory, problem solving, attention and comprehension. Relatively high

doses produce toxic delirium, which destroys the ability to perform any military task.

Differential Diagnosis

This agent must be differentiated from other anticholinergics, indoles such as LSD, alcohol, bromides, lead, barbiturates, anxiety states and cannabinoids. The indoles do not cause a complete loss of identity. The individual on LSD is aware of what is being said but cannot respond appropriately. Neither the indoles or other hallucinogens present with the typical clinical picture of an anticholinergic overdose with dilated pupils, flushed face, dry mouth, and hyperthermia. Anxiety states also do not have this appearance.

Medical disorders must be considered and ruled out such as occupational poisonings with solvents such as carbon disulfide, carbon monoxide, hepatic failure, renal failure, hypothyroidism (rare), acute schizophrenia, and psychosis affiliated with other mental disorders

Clinical Effects of BZ

The effects can be seen in four stages and are dose dependent.

Stage 1 occurring from 0.5 to 4 hours after exposure (dermal application can be delayed in onset up to 36 hours.) – Mild central nervous effects are seen in this stage and parasympathetic effects such as dry mouth, tachycardia, flushing. These effects have been popularized as “dry as a bone”, “red as a beet”, “hot as a hare”. They affect the following systems:

- ◆ Ocular- Mydriasis, loss of near vision, dry.
- ◆ Oral – Xerostomia
- ◆ Cardiac – Labile effects. Tachycardia lasting 1 to two days. Not diagnostic.
- ◆ Skin – Decreased sweating, flushing, hyperthermia.
- ◆ Genitourinary – Bladder distention. Decreased tone and force.
- ◆ Neuromuscular – Incoordination, ataxia, muscular weakness.
- ◆ Central effects (dose dependent)
 - Change in level of consciousness – Drowsiness, sedation, stupor to coma.
 - Perceptual – “mad as a hatter” – Visual hallucination, illusions.
 - Disturbances in judgment and insight. – Vulgarity, inability to use visual cues, confabulation.

- Attention and memory –Loss of short-term memory, Easy distractibility.
- Deficits in expression and comprehension. - Slurred speech, flat voice, perseveration, semiautomatic speech, handwriting deteriorates, cannot converse meaningfully.
- Disorientation – Time and place, picking behaviors, mumbling, disrobing, vulgarity.
- Sharing of illusions and hallucinations. – Mass hysteria, Folie a deux, folie en familee.
- Paranoia – prominent in the recovering stage.

Stage II - 4 to 20 hours – stupor, hyperthermia and ataxia.

Stage III- 20 to 96 hours – Fluctuating delirium.

Stage IV – paranoid behavior and deep sleep.

Laboratory Tests

There are no laboratory tests available to measure this agent, which binds to muscarinic receptor sites. A therapeutic trial of 1 to 2 mg of a specific antidote physostigmine may be utilized.

Treatment

General – Remove from involved or contaminated area. Decontaminate (wearing proper protective garments) with soap and water. Do not use bleach. Manage heat stress and hyperthermia. Observe and in about half the cases, restrain. Give the specific antidote, physostigmine. It is the only one of its class to readily cross the blood brain barrier since it is non-polar. Physostigmine (Antilirium or Eserine) is extracted from the Calobar bean (African ordeal poison) and is a carbamate anticholinergic. By reversibly inhibiting acetylcholinesterase (Ache, physostigmine permits a buildup of acetylcholine, which then causes a nullification of much of the effects of BZ (or other anticholinergics). Physostigmine’s actions only last about 45 minutes so that frequent dosing is required by mouth or by IM. A low IV drip is preferred in a restrained patient. An IM test dose of 2 to 4 mg is indicated in a case of anticholinergic poisoning and is given every one to 4 hours for 3 to 5 doses. This is usually enough to permit the victim to recover the rest of the way without the need for further therapy. One would not expect to see any significant adverse effects as might be expected with this dosage in the absence of an antagonistic agent. These are salivation, intestinal cramping and diarrhea generally. The IV dose is 30 µg/kg has been shown to be effective though 45 µg/kg was used in cases manifesting more severe delirium. Rapid IV administration is not advised and can lead

to convulsions or a fatal cardiac arrhythmia. If given in error, the adverse effects of physostigmine can be rapidly reversed with 1 to 2 mg IM of atropine. For reasons that are not certain, physostigmine is not effective if given within the first four hours after the onset of BZ effects. The antagonist also does not shorten the length of BZ intoxication, only ameliorate its effects.¹²

There are no detection instruments for this agent. Nor are any vaccines available.

Prophylaxis

In the case where there is proper intelligence indicating the use of an pending aerosolized anticholinergic agent attack, protection is provided by the M40 military mask and protective clothing. This would not be the usual case in the civilian sector or with delayed dermal application. It would also not be the case with the agent added into a water or food supply.

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