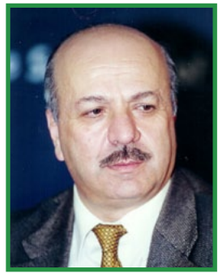
Sarin: A Lethal Nerve Gas That Kills in Minutes



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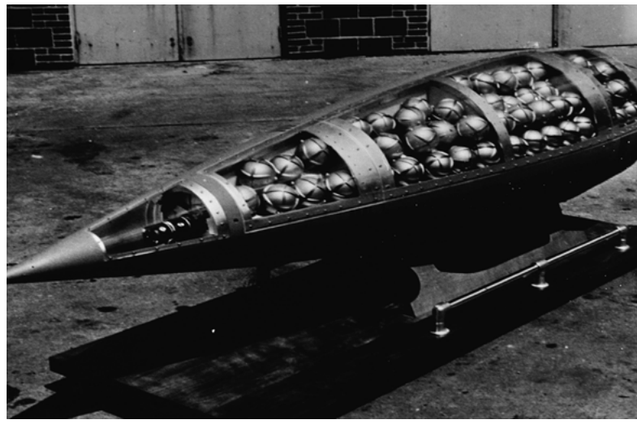
What is Sarin?

- Sarin is a humanmade chemical warfare agent classified as a nerve agent. Nerve agents are the most toxic and rapidly acting of the known chemical warfare agents. They are similar to certain kinds of pesticides (insect killers) called organophosphates in terms of how they work and what kind of harmful effects they cause. However, nerve agents are much more potent than organophosphate pesticides.
- Sarin originally was developed in 1938 in Germany as a pesticide.
- Sarin is a clear, colorless, and tasteless liquid that has no odor in its pure form. However, sarin can evaporate into a vapor (gas) and spread into the environment.
- Sarin is also known as GB.

History: Where sarin is found and how it is used

Sarin was discovered in 1938 in Wuppertal-Elberfeld in Germany by scientists at IG Farben attempting to create stronger pesticides; it is the most toxic of the four G-Series nerve agents made by Germany. The compound, which followed the discovery of the nerve agent tabun, was named in honor of its discoverers: Schrader, Ambros, Gerhard Ritter and Van der Linde.

In mid-1939, the formula for the agent was passed to the chemical warfare section of the German Army Weapons Office, which ordered that it be brought into mass production for wartime use. A number of pilot plants were built, and a high-production facility was under construction (but was not finished) by the end of World War II. Estimates for total sarin production by Nazi Germany range from 500 kg to 10 tons. Though sarin, tabun and soman were incorporated into artillery shells, Germany did not use nerve agents against Allied targets.



U.S. Honest John missile warhead cutaway, showing M134 Sarin bomblets (c. 1960)

- **1950s (early): NATO adopted sarin as a standard chemical weapon, and both the USSR and the United States produced sarin for military purposes.**
- 1953: 20-year-old Ronald Maddison, a Royal Air Force engineer from Consett, County Durham, died in human testing of sarin at the Porton Down chemical warfare testing facility in Wiltshire, England. Ten days after his death an inquest was held in secret which returned a verdict of “misadventure”. In 2004, the inquest was reopened and, after a 64-day inquest hearing, the jury ruled that Maddison had been unlawfully killed by

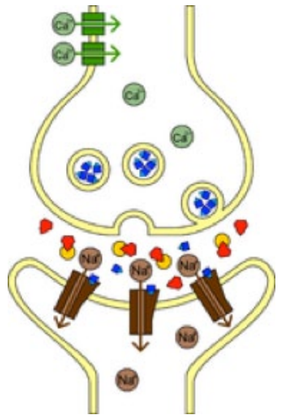
the "application of a nerve agent in a non-therapeutic experiment."

- 1956: Regular production of sarin ceased in the United States, though existing stocks of bulk sarin were re-distilled until 1970.
- March 1988: Over the span of two days in March, the ethnic Kurd city of Halabja in northern Iraq (population 70,000) was bombarded with chemical and cluster bombs, which included sarin, in the Halabja poison gas attack. An estimated 5,000 people died.
- April 1988: Sarin was used four times against Iranian soldiers in April 1988 at the end of the Iran–Iraq War, helping Iraqi forces to retake control of the al-Faw Peninsula during the Second Battle of al-Faw. Using satellite imagery, the United States assisted Iraqi forces in locating the position of the Iranian troops during those attacks.
- 1993: The United Nations Chemical Weapons Convention was signed by 162 member countries, banning the production and stockpiling of many chemical weapons, including sarin. It went into effect on 29 April 1997, and called for the complete destruction of all specified stockpiles of chemical weapons by April 2007.
- 1994: The Japanese religious sect Aum Shinrikyo released an impure form of sarin in Matsumoto, Nagano, killing eight people and harming over 200.
- 1995: Aum Shinrikyo sect released an impure form of sarin in the Tokyo Metro. Thirteen people died.
- 1998: In the US, Time Magazine and CNN ran false news stories alleging that in 1970 U.S. Air Force A-1E Skyraiders engaged in a covert operation called Operation Tailwind, in which they deliberately dropped sarin-containing weapons on U.S. troops who had defected in Laos. CNN and *Time Magazine* later retracted the stories and fired the producers responsible.
- 2004: Iraqi insurgents detonated a 155 mm shell containing binary precursors for sarin near a U.S. convoy in Iraq. The shell was designed to mix the chemicals as it spins during flight. The detonated shell released only a small amount of sarin gas, either because the explosion failed to mix the binary agents properly or because the chemicals inside the shell had degraded with age. Two United States soldiers were treated after displaying the early symptoms of exposure to sarin.
- 21 August 2013: Sarin was used in an attack in the Ghouta region of the Rif Dimashq Governorate of Syria during the Syrian civil war. Varying sources gave a death toll of 322 to 1,729, and said that none of the victims had physical wounds.

How People can be Exposed to Sarin

- Following release of sarin into the air, people can be exposed through skin contact or eye contact.
- They can also be exposed by breathing air that contains sarin.
- Sarin mixes easily with water, so it could be used to poison water. Following release of sarin into water, people can be exposed by touching or drinking water that contains sarin.
- Following contamination of food with sarin, people can be exposed by eating the contaminated food.
- A person's clothing can release sarin for about 30 minutes after it has come in contact with sarin vapor, which can lead to exposure of other people.
- Because sarin breaks down slowly in the body, people who are repeatedly exposed to sarin may suffer more harmful health effects.
- Because sarin vapor is heavier than air, it will sink to lowlying areas and create a greater exposure hazard there.

Biological effects



Sarin (red), acetylcholinest-erase (yellow), acetylcholine (blue)

Like other nerve agents, sarin attacks the nervous system by stopping nerve endings in muscles from switching off. Death will usually occur as a result of asphyxia due to the inability to control the muscles involved in breathing function.

Specifically, sarin is a potent inhibitor of acetylcholinesterase, an enzyme that degrades the neurotransmitter acetylcholine after it is released into the synaptic cleft. In vertebrates, acetylcholine is the neurotransmitter used at the neuromuscular junction, where signals are transmitted between neurons from the central nervous systems to muscle fibres. Normally, acetylcholine is released from the neuron to stimulate the muscle, after which it is degraded by acetylcholinesterase, allowing the muscle to relax. A build-up of acetylcholine in the synaptic cleft, due to the inhibition of cholinesterase, means the neurotransmitter continues to act on the muscle fibre, so that any nerve impulses are effectively continually transmitted.

Sarin acts on cholinesterase by forming a covalent bond with the particular serine residue at the active site. Fluoride is the leaving group, and the resulting phosphoester is robust and biologically inactive.

Its mechanism of action resembles that of some commonly used insecticides, such as Malathion. In terms of biological activity, it resembles carbamate insecticides, such as Sevin, and the medicines pyridostigmine, neostigmine, and physostigmine.

Immediate Signs and Symptoms of Sarin Exposure

- People may not know that they were exposed because sarin has no odor.
- People exposed to a low or moderate dose of sarin by breathing contaminated air, eating contaminated food, drinking contaminated water, or touching contaminated surfaces may experience some or all of the following symptoms within seconds to hours of exposure:
    - Runny nose
    - Watery eyes
    - Small, pinpoint pupils
    - Eye pain
    - Blurred vision
    - Drooling and excessive sweating
    - Cough
    - Chest tightness
    - Rapid breathing
    - Diarrhea
    - Increased urination
    - Confusion
    - Drowsiness
    - Weakness
    - Headache
    - Nausea, vomiting, and/or abdominal pain
    - Slow or fast heart rate
    - Low or high blood pressure
- Even a small drop of sarin on the skin can cause sweating and muscle twitching where sarin touched the skin.
- Exposure to large doses of sarin by any route may result in the following harmful health effects:
    - Loss of consciousness
    - Convulsions
    - Paralysis
    - Respiratory failure possibly leading to death
- Showing these signs and symptoms does not necessarily mean that a person has been exposed to sarin.

What the Long-Term Health Effects are

Mild or moderately exposed people usually recover completely. Severely exposed people are not likely to survive. Unlike some organophosphate pesticides, nerve agents have not been associated with neurological problems lasting more than 1 to 2 weeks after the exposure.

How People can Protect Themselves, and What they Should do if they are Exposed to Sarin

- Recovery from sarin exposure is possible with treatment, but the antidotes available must be used quickly to be effective. Therefore, the best thing to do is avoid exposure:
    - Leave the area where the sarin was released and get to fresh air. Quickly moving to an area where fresh air is available is highly effective in reducing the possibility of death from exposure to sarin vapor.
        - **If the sarin release was outdoors, move away from the area where the sarin was released. Go to the highest ground possible, because sarin is heavier than air andwill sink to lowlying areas.**
        - **If the sarin release was indoors, get out of the building.**

If people think they may have been exposed, they should remove their clothing, rapidly wash their entire body with soap and water, and get medical care as quickly as possible.

- *Removing and disposing of clothing:*
    - Quickly take off clothing that has liquid sarin on it. Any clothing that has to be pulled over the head should be cut off the body instead of pulled over the head. If possible, seal the clothing in a plastic bag.

Then seal the first plastic bag in a second plastic bag. Removing and sealing the clothing in this way will help protect people from any chemicals that might be on their clothes.

- If clothes were placed in plastic bags, inform either the local or state health department or emergency personnel upon their arrival. Do not handle the plastic bags.
- If helping other people remove their clothing, try to avoid touching any contaminated areas, and remove the clothing as quickly as possible.

- *Washing the body:*
  - As quickly as possible, wash any liquid sarin from the skin with large amounts of soap and water. Washing with soap and water will help protect people from any chemicals on their bodies.
  - Rinse the eyes with plain water for 10 to 15 minutes if they are burning or if vision is blurred.
- If sarin has been swallowed, do not induce vomiting or give fluids to drink.
- Seek medical attention immediately. Dial 911 and explain what has happened.

How Sarin Exposure is Treated

Treatment consists of removing sarin from the body as soon as possible and providing supportive medical care in a hospital setting. Antidotes are available for sarin. They are most useful if given as soon as possible after exposure.

Infos

Alzheimer: la Piste des Médicaments contre la Tension Confortée

Une étude irlando-canadienne publiée paraît conforter la piste des médicaments contre la tension pour ralentir le déclin cognitif lié à la maladie d'Alzheimer, pathologie contre laquelle aucun médicament n'est aujourd'hui efficace.
Cette étude, publiée dans la revue britannique BMJ Open, s'est intéressée à une classe de médicaments couramment utilisée contre l'hypertension et largement génériquée, les inhibiteurs de l'Enzyme de Conversion de l'Angiotensine (ECA), plus précisément aux inhibiteurs à action centrale (CACE en anglais).
Les chercheurs ont comparé le déclin cognitif de 361 patients canadiens souffrant principalement d'Alzheimer mais aussi de démence vasculaire et de démence mixte. La démence vasculaire est un trouble cognitif apparaissant après des accidents vasculaires cérébraux (AVC) tandis que la démence mixte associe Alzheimer et lésions vasculaires.
Sur l'échantillon, 85 malades prenaient un inhibiteur CACE avant le début de l'évaluation, 276 n'en prenaient pas et parmi ce dernier groupe, 30 ont commencé un traitement CACE après le démarrage de l'évaluation.
«Cette étude montre une petite réduction dans le rythme du déclin cognitif (...) chez les patients prenant un inhibiteur CACE comparativement à ceux qui n'en prennent pas du tout», selon l'étude dont le principal signataire est Dr William Molloy de l'Université de Cork en Irlande.
Pour les 30 patients à qui on a nouvellement prescrit le médicament, les résultats paraissent plus nets: lors des six premiers mois de traitement, non seulement le déclin cognitif est enrayé mais les performances cérébrales s'améliorent.
«C'est la première étude à démontrer que les performances cognitives s'améliorent chez les patients qui commencent» ce type de traitement, souligne l'étude.
Mais cette étude «observationnelle» est limitée dans sa portée, avec de possibles biais faussant les résultats, reconnaissent les auteurs pour lesquels «une étude plus approfondie» serait «nécessaire pour confirmer les résultats et déterminer la durée des effets». «Si ces données peuvent être reproduites dans un essai à l'aveugle suffisamment long, ces médicaments devraient présenter des avantages significatifs pour retarder ou même prévenir la démence», conclut l'article.
Mais il faut encore relativiser tout cela, selon les auteurs, avec des données récentes qui «suggèrent» à l'inverse un effet potentiellement néfaste, «accélérateur» de ces inhibiteurs de l'ECA, sur le développement de la maladie d'Alzheimer.
La recherche sur la maladie d'Alzheimer est pavée de déceptions. L'un des derniers échecs thérapeutiques en date est celui du traitement expérimental Gammagard du groupe pharmaceutique américain Baxter.
Cette maladie ne bénéfice aujourd'hui que de traitements se limitant à soigner les symptômes, avec une efficacité «au mieux modeste», selon un avis de 2011 de la Haute autorité de santé (HAS).En 2010, une étude américaine avait pointé une autre piste parmi les médicaments anti-hypertenseur: les antagonistes des récepteurs de l'angiotensine (ARA).