

Appendix I: Sarin

Sarin is an organophosphorus compound, part of a family of chemicals that include other chemical warfare agents such as Tabun, Soman, and VX, as well as various pesticides and insecticides. In its pure form, sarin is a colorless and odorless liquid. It can evaporate, forming a gas that is toxic when even low concentrations are inhaled. Munitions are often designed to distribute the nerve agent as an aerosol, consisting of fine droplets of the liquid. When inhaled or deposited onto the skin, these droplets are extremely toxic. The aerosol is heavier than air, and eventually tends to collect in lower lying areas around the site of impact.

Sarin binds to and inhibits acetylcholinesterase, an enzyme that catalyzes the breakdown of acetylcholine, which is a biochemical messenger that activates muscles. Sarin exposure therefore leads to the over-stimulation of muscles and glands. Sarin also has a negative influence on the autonomic nervous system, which exerts “involuntary” control throughout the body, including secretion of internal fluids produced to moisten airways leading to the lungs, and on the involuntary muscles that control the gastrointestinal tract.

Symptoms depend both on the level and route of sarin exposure. Low levels can cause increased production of saliva, temporary excessive contraction of the pupils, a runny nose, and a feeling of pressure on the chest. Moderate exposure can cause coughing, excessive fluid discharge from the nose and mouth, difficulty breathing, muscular weakness, and tremors and convulsions. Diarrhea and vomiting are also often observed at these levels of exposure. High exposure can cause convulsions and loss of consciousness, and affects muscles and the part of the nervous system involved in breathing. Sarin exposure can cause death by suffocation due to the excessive buildup of fluids in the breathing airways and to loss of activity of the muscles used for breathing.

Exposure to other nerve agents, including some pesticides, can cause similar symptoms, but much higher levels of exposure are required in these cases.

Poisoning by sarin works faster when the agent is absorbed through the respiratory system, because the multiple blood vessels in the lungs distribute the toxic agent rapidly throughout the body. The injury caused by a sarin weapon therefore depends on the extent

to which the weapon turns liquid sarin, the form in which it is at room temperature, into aerosol, a mist of fine droplets, that can be inhaled or absorbed by the skin. In a sarin bomb, the liquid is converted into an aerosol by a small explosive detonation that bursts the carrier munition and creates an aerosol cloud. If the detonation is too large, however, the heat will damage the sarin, which decomposes rapidly at its boiling point of 158 degrees Celsius. This limitation usually means that not all the sarin liquid contained in a bomb turns into aerosol or vapor, and that liquid sarin is often found at an impact site immediately after an attack.

Sarin is a non-persistent nerve agent, which means that the agent quickly chemically degrades and disperses into the atmosphere. A non-persistent nerve agent dissipates and rapidly loses the ability to cause casualties after 10 to 15 minutes. The area of contamination will depend on many different factors, including the amount and purity of the sarin used, the effectiveness of the chemical munition in dispersing the agent, the outside temperature and humidity, the wind direction and speed, and the presence of buildings in the area, which might shield victims from the effects of the toxic cloud. Nerve agents are so toxic that munitions containing only a small amount of sarin, such as the 44 kilogram chemical payload of a KhAB-250 bomb, can readily disperse millions of lethal doses over an area several hundreds of meters in radius away from the impact site, depending upon the local meteorological conditions.

Many types of chemical bombs, like the KhAB-series, are stored empty without the payload because of the limited shelf-life of chemical agents like sarin after it is produced. The precursors for sarin are stored separately and only combined into the final product prior to use; the shelf-life of sarin depends on the specific reaction process used, the addition of other chemicals to stabilize the substance, and the amount of impurity present in the precursor chemicals.

The munitions and filling equipment used for chemical agents must have sealed joints in order prevent leakage and exposure. The integrity of these seals are tested prior to loading live agent into the munition to ensure no leaks occur. Once produced, the agent then needs to be transferred into the munition by a filling system through a filler hole in the bomb body. The crews filling chemical munitions with live agent must take precautions like using protective masks or respirators and wearing impermeable suits and boots.

The physical infrastructure necessary to produce multiple liters of live agent, successfully transfer this agent into a weapon, and effectively deliver the agent to the battlefield as an aerosol, droplet, or vapor form requires knowledge of chemical production and functioning equipment. Also required is a cadre of trained personnel operating equipment in a safe manner without exposing themselves to the effects of the live agent.

UN inspectors concluded that sarin was used in a chemical attack in Ghouta, near Damascus, in August 2013. Evidence documented by Human Rights Watch strongly suggests that government forces were responsible for the attack. In June 2014, OPCW announced that it had shipped Syria's declared chemical weapons out of the country. OPCW has said that it inspected all declared sites, except two, which it could not reach because of safety and security concerns. It said that Syria declared those sites as abandoned and that the chemical weapons program items they contained were moved to other declared sites, which were inspected.

Appendix II: Victims Killed in Khan Sheikhoun¹⁰⁸

No.	Name	Sex	Age
1	Melhem Jihad al-Youssef	Male	30
2	Yasser Ahmad al-Youssef	Male	40
3	Ammar Yasser al-Yousef	Male	7
4	Mohammed Yasser al-Youssef	Male	10
5	Sanaa Haj Ali	Female	40
6	Abdalkarim Ahmad al-Youssef	Male	
7	Ahmad Abdel Hamid al-Youssef	Male	9 months
8	Aya Abdel Hamid al-Yousef	Female	9 months
9	Dalal Ahmad al-Sah	Female	
10	Ibrahim Mohamed al-Youssef	Male	
11	Mohamed Hasan al-Youssef	Male	11
12	Hend Turki al-Youssef	Female	69
13	Faisal Raslan	Male	
14	Umran Suhail al-Youssef	Male	
15	Ahmad Suhail al-Youssef	Male	
16	Nouhad Ahmad al-Youssef	Male	
17	Malak Turki al-Youssef	Female	
18	Nour Nouhad al-Youssef	Female	
19	Hasan Mohamed al-Youssef	Male	
20	Ahmad Ibrahim al-Youssef	Male	
21	Imad al-Dein Mohamed al-Qadeh	Male	
22	Mohamed Imad al-Qadeh	Male	A child
23	Hend Imad al-Qadeh	Female	A child
24	Aboudi Imad al-Qadeh	Male	A child
25	Turki Mohamed al-Qadeh	Male	
26	Nour al-Azraq	Female	
27	Hend Turki al-Qadeh	Female	A child
28	Mohamed Turki al-Qadeh	Male	A child
29	Adnan Turki al-Qadeh	Male	A child
30	Rajaa Mohamed al-Mohamed	Female	

¹⁰⁸ The fatality list has been compiled from a range of sources including the Syria Civil Defense, the Idlib Health Directorate, and the relatives of the deceased.

No.	Name	Sex	Age
31	Anas al-Khalid	Male	
32	Fatima al-Soussi	Female	
33	Mustafa Anas al-Khalid	Male	A child
34	Alaa Anas al-Khalid	Female	A child
35	Shahid Anas al-Khalid	Male	A child
36	Abd al-Rahman Anas al-Khalid	Male	A child
37	Khadija Anas al-Khalid	Female	A child
38	Ahmad Khalid Halawa	Male	
39	Khalid Halawa	Male	
40	Shaimaa Ibrahim al-Jawhar	Female	A child
41	Ahmed Shahoud al-Reem Abu Mahanna	Male	
42	Najeeb al-Jawhar	Male	
43	Safiya al-Haj Youssef	Female	
44	Mayar al-Mar'i	Male	A child
45	Mohammed Mohieddin Najem al-Sayed	Male	
46	Siham Mohieddin al-Sayed	Female	
47	Ola Muhhand Makhzoum	Female	
48	Rahaf Suhail al-Youssef	Male	
49	The wife of Mohamed Najem al-Sayed, name unknown	Female	
50	Ahmad Ezzo Najem al-Sayed	Male	
51	The wife of Mustafa al-Sayed, name unknown	Female	
52	The daughter of Mazen al-Sayed, name unknown	Female	
53	Riad Khalid al-Kirowan	Male	
54	Maram Hasan Halawa	Male	A child
55	Abd al-Ghafour Maarati	Male	35
56	Abdallah Ghassan al-Shahna	Male	
57	Badran Abd al-Rahman al-Rahmoun	Male	26
58	Ahmad Hasram	Male	27
59	Amer al-Naif	Male	
60	Alaa al-Naif	Male	
61	Mohamed al-Naif	Male	
62	Alaa Mohamed al-Naif	Male	
63	The wife of Alaa Mohamed al-Naif, name unknown	Female	
64	The sister-in-law of Alaa Mohamed al-Naif, name unknown	Female	
65	Darar al-Alaywi Abu Imad	Male	
66	Ahmad Omar Ramadan	Male	

No.	Name	Sex	Age
67	Jamila Hafez al-Qasim	Female	55
68	Mohamed Jamal al-Qasim	Male	30
69	Faris Mohamed Sayed al-Barhoum	Male	14
70	Maher Mohamed Sayed al-Barhoum	Male	12
71	Suha al-Qassim	Female	22
72	Fatima Jamal Qassim al-Hamoud	Female	15
73	Hayyan al-Ali	Male	40
74	Sara al-Sleiman	Female	32
75	Ahmad Hayyan al-Dibbs	Male	7
76	Mohamed Hayyan al-Dibbs	Male	9 months
77	Hayyan Abdallah al-Dibbs	Male	32
78	Yamen al-Shayeb	Male	
79	Sham al-Shayeb	Female	A child
80	Jude al-Shayeb	Male	A child
81	Mohamed al-Shayeb	Male	A child
82	Sara Mansour	Female	
83	Mustafa al-Azkour	Male	
84	Samer	Male	18
85	Ahmad Hosram	Male	Born in 1990
86	Musa al-Sayed or Musa al-Hussein	Male	
87	Asmaa al-Sayed or Asmaa al-Hussein	Female	
88	Ruba Ahmad al-Saleh	Female	A child
89	Hadeel Ahmad al-Saleh	Female	A child
90	Batoul Ahmad al-Saleh	Female	A child
91	Mohamed Ahmad al-Saleh	Male	
92	Mohamed Awad Turkia	Male	

Appendix III: Victims Killed in al-Salaliyah¹⁰⁹

No.	Name	Sex	Age
1	Saleh al-Mohamad	Male	90
2	Khayriah al-Saleh	Female	80
3	Fatima al-Mohamad	Female	40
4	Fatim Mohamad al-Raheel	Female	10
5	Israa Mohamad al-Raheel	Female	6
6	Ahmad Mohamad al-Raheel	Male	2
7	Somaa' al-Raheel	Male	50
8	Fadia al-Saleh	Female	30
9	Ghazal Ali al-Raheel	Female	5
10	Abdallah Ali al-Raheel	Male	4
11	Mohamad Ali al-Raheel	Male	5
12	Maysar al-Saleh	Male	35
13	A'tour al-Mohamad	Female	30
14	Dam al-Hana Maysar al-Saleh	Female	6
15	Ramadan Maysar al-Saleh	Male	2
16	Malak Maysar al-Saleh	Male	1
17	Daughter of Sawah al-Mohamad, name unknown	Female	
18	Daughter of Sawah al-Mohamad, name unknown	Female	
19	Mohamad Walid al-Mohamad	Male	4
20	Mahdi al-Mohamad	Male	60
21	Fasel al-Saleh	Male	55
22	Hakmiya Mahdi al-Mohamad	Female	25
23	Yaa'koub Mahdi al-Mohamad	Male	7
24	Youssef Mahdi al-Mohamad	Male	5
25	Mahdi Mahdi al-Mohamad	Male	3
26	Nawal al-Saleh	Female	17
27	Raeida Musa al-Saleh	Female	35
28	Hussein al-Mohamad	Male	22

¹⁰⁹ The fatality list was compiled by a local resident.

No.	Name	Sex	Age
29	Badr Hussein al-Saleh	Male	25
30	Kamara al-Saleh	Female	80
31	Ali Daher al-Musa	Male	4
32	Maryam Daher al-Musa	Female	2
33	Fatima Kassar al-Saleh	Female	13
34	Doha Kassar al-Saleh	Female	9
35	Amouna Ahmad al-Saleh	Female	15
36	Sabouha al-Saleh	Female	32
37	Zamzam Ahmad al-Saleh	Male	12
38	Bilal Ahmad al-Saleh	Male	13
39	Daughter of Ahmad al-Saleh, name unknown	Female	4
40	Ahmad al-Saleh	Male	35
41	Daher al-Moussa	Male	35
42	Sawah al-Mohamad	Male	25

Appendix IV: Victims Killed in Jrouh¹¹⁰

No.	Name	Sex	Age
1	Maryam Ali al-Mohamad	Female	30
2	Safa' Mohamad al-Hasan	Female	9
3	Hussein Mohamad al-Hasan	Male	5
4	Nour Mohamad al-Hasan	Female	2
5	Zeinab Suleiman al-Mohamad	Female	25
6	<u>Raneem</u> Munzer al-Hassan	Female	7
7	Yasser Munzer al-Hasan	Male	4
8	Mohamad Munzer al-Hasan	Male	2
9	Mamdouh Hasan al-Mohawish	Male	80
10	Sami Mamdouh al-Hasan	Male	35
11	Adnan Mamdouh al-Hasan	Male	30
12	Zaima Mohamad al-Hasan	Female	30
13	Mohamad Sfooq al-Hasan	Male	40
14	Sfooq Mohamad al-Hasan	Male	73
15	Leen Adnan al-Hasan	Female	2
16	Reem Adnan al-Hasan	Female	One month
17	Hashem Sami al-Hasan	Male	6
18	Reem Sami al-Hasan	Female	5
19	Sultan al-Awad	Male	20
20	Mahdi al-Hmeid	Male	29
21	Ahmad al-Hmeid	Male	42
22	Saloua al-Ali	Female	22
23	Khalif al-Thaher	Male	45
24	Abed al-Razzak al-Hussein	Male	70
25	Sobhiah al-Hussein	Female	63

¹¹⁰ The fatality list was compiled by an activist from the Syrian Revolution Coordination Committee and many names were corroborated by local residents who spoke to Human Rights Watch.