Questions and Answers about the UN Report and Clarifications of my interpretation of the Report

Background paper by Dan Kaszeta, dan@kaszeta.org Twitter: @DanKaszeta

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Introduction

I have received numerous questions, comments, and requests for clarification about the UN Report and the various observations I have made about that report. As I do not have time to reply individually to everyone who has corresponded with me, I have prepared this paper as a general attempt to address these various issue. In order to quell various minor points of disagreement and debate, I am include ample references to accepted scientific texts and journal articles.

Q: The UN report lists IPMPA, MPA, and DIMP, as well as several other chemicals. What are these chemicals and what could they indicate?

IPMPA or IMPA: Isopropyl Methylphosponic Acid. It is referred to as IMPA in most of the reference works I consulted. IMPA is a degradation (i.e. breakdown) product of Sarin. Under acidic conditions, Sarin reacts with water in a process called hydrolysis to produce Hydrogen Fluoride (HF) and IMPA[1]. IMPA further degrades into MPA (see below) and isopropyl alcohol. The degradation of Sarin into IMPA is shown in Appendix A. IMPA is considered a highly specific indicator of Sarin as there is no other general explanation for its presence in environmental or medical samples. My own search of the literature finds no references to IMPA other than in its relationship to Sarin. Because of the physical and chemical characteristics of human blood and blood plasma, Sarin degrades rapidly into IMPA in human blood. IMPA in blood plasma then turns into MPA. Myself, and doubtless many other authorities, consider the presence of IMPA as definitive proof that Sarin was present. IMPA is quite persistent in the environment and can last for a long period of time.

MPA: Methylphosphonic Acid. MPA is a degradation product of IMPA. Two other chemical warfare nerve agents, Soman (GD) and Cyclosarin (GF) degrade into acids (PMPA and CMPA, respectively), which in turn degrade into MPA. For this reason, MPA on its own is a generic indicator of nerve agent exposure, as it cannot tell, in isolation, whether it came from Sarin, Soman, or Cyclosarin. In practice, however, the forensic picture is clear when MPA is found in the same place at the same time as IMPA.

DIMP: Diisopropyl Methylphosphonate. DIMP is a byproduct of Sarin manufacture. It occurs in varying percentages in Sarin as a result of the production process. It is reputedly quite to refine all of the DIMP out of Sarin, and it is well established that the US military went to great expense to do so. Indeed, the largest known presence of DIMP contamination is at Rocky Mountain Arsenal, where the US produced Sarin the 1950s.[2] The most likely explanation for the presence of DIMP is as an impurity in manufactured Sarin. The UN report (page 34) also makes reference to DIMP as a thermal decomposition product of Sarin. By this, it is meant that Sarin can degrade into DIMP when heated. Another potential explanation for DIMP at the rocket impact sites is that some Sarin was heated to decomposition point by rocket propellant or the conventional explosive used as a bursting charge.

MPFA: Methylphosphonofluoridic Acid. Also know as Methylfluorophosphonic Acid (MFPA) or MF in many references. The presence of MPFA is very interesting. MPFA is a thermal decomposition product of Sarin, after exposure to heat[3]. In this regard, MPFA found at the scenes could be as a result of thermal decomposition of Sarin. MPFA is also a hydrolysis product of Sarin under alkaline conditions, under which Sarin degrades to MPFA and isopropyl alcohol.[4] The other possible source of MPFA is equally interesting and possibly revelatory. MPFA is a decomposition product of DF. DF (also known as Methylphosphonic difluoride) is a well established component of Binary Sarin. Binary Sarin is produced when several components are mixed together, generally in the munition itself, to produce Sarin. DF rapidly hydrolyzes in the environment to Hydrogen Fluoride and MPFA.[5] Its presence at the sites associated with the larger 330mm-360mm rocket (nomenclature for this device varies), but not with the small 140mm rocket, raises my suspicions that the larger rocket was a binary device. Presence of DF daughter products such as MPFA may be due to presence of unmixed DF that rapidly degraded upon exposure

Hexamethyleneteramine: Also known as hexamine. This compound is used for manufacture of several different conventional high explosives[6]. It has wide uses in industry, but of particular military interest, it is a base component for a wide variety of conventional explosives, including RDX, C-4, Hexogen, Dinitrohexamine, and HMTD. This is a general indicator of the presence of such conventional explosives. It may be due to an explosive bursting charge.

Hexafluorophosphate: The phrase “hexafluorophosphate” is a suffix usually appended to another element. Found on its own, it is an ion. For example, Lithium hexafluorophosphate is commonly found in lithium batteries. It is not certain which chemicals may have been the parent compounds of the hexafluorophosphate ions found. There are numerous possible parent compounds that could be responsible here, and without further information I cannot speculate. Ammonium hexafluorophosphate has been noted as a component of rocket propellants[7]. Another example among many on the modern battlefield is the presence of potassium hexafluorophosphate in flares[8]. Many hexafluorophosphates have been investigated for their utility as corrosion inhibitors. (Corrosion is a problem in Sarin storage.) Any chemist or chemical engineer with insight on this issue, please contact me.

Diisopropyl dimethylpyrophosphonate and other exotic chemicals: A number of exotic chemicals are found in trace amounts. Most of these are substances that I am not immediately familiar with the other substance noted in the report. They are obvious considered interesting by the OPCW laboratories that analyzed the samples. If there is a chemist or chemical engineer reading this paper who can shed light on the exact nature of these chemicals, as possible degradation products (thermally or by hydrolysis) or manufacturing impurities, please contact me and I will gladly update this report with further information.

Q: One article claims "not a single environmental sample in Moadamiyah that tested positive for Sarin." - What is your reaction to this?

I consider this statement to be a misleading half-truth that “cherry picks” from the UN report. It is true in respect to the fact that no actual Sarin was found in the 13 environmental samples taken from Moadamiyah. But the samples show DIMP, IMPA, and MPA, all of which are strong indicators of Sarin, as I discuss above. The environmental samples are clear indicators that Sarin was used because of the clear presence of chemicals that are clearly decomposition products (IMPA, MPA) and impurities (DIMP), all of which persist longer in the environment than Sarin itself.

There are several plausible reasons why the UN team did not collect a sample of actual Sarin at the Moadamiyah. Any or all of the following explanatory or contributory factors may have applied to this circumstance:

- The 140mm rocket alleged to have been used in Moadamiyah is patently smaller than the devices used elsewhere. Therefore, there it would carry far less chemical agent than larger devices. There may have been less Sarin to find at each individual site where the 140mm rocket was used.

- The UN report states that they did not find the actual warhead. Their photos are of the rocket section, not the agent-carrying portion of the rocket.

- The lack of a payload-carrying section indicates to me that the explosive bursting charge of the rocket functioned as intended. The US Army used approximately a 3.3:1 ratio by weight of Sarin to conventional explosive in the US’s closest analogue to the 140mm rocket[9], the M55 115mm rocket. As a Soviet-designed 140mm rocket carried approx. 2.2 kg of Sarin, a comparable ratio would indicate an explosive charge of 650-700 grams of explosive. From my own direct experience with explosives in my military and law enforcement training, such a quantity would shred the rocket’s warhead section into small fragments. As metal fragments are a likely place to collect a Sarin sample, the fragments at Moadamiyah may have been too small to locate or indeed too small to contain an effective sample of the agent.

- A fully effective and efficient explosive dissemination of a 140mm rocket carrying Sarin would create an aerosol of finely divided droplets, with little or no pooling or puddles of Sarin, making it harder to find a trace of actual Sarin. This factor presumes that the munition efficiency (the percentage of Sarin dispensed as an aerosol to create rapid effects) of the 140mm rocket is higher than that of the larger system used elsewhere. Based on my knowledge of chemical weapons design, I believe this to be the case.

- If the location in Moadamiyah under investigation had been exposure to more ventilation, more moisture, or both, the evaporation and degradation of Sarin would have been increased relative to other locations. With the information available to me, I cannot know whether this was the case or not.

Q: The same article claims "It is scientifically improbable that survivors would test that highly for exposure to Sarin without a single trace of environmental evidence testing positive for the chemical agent." How do you answer this question?

This is an untrue statement unsupported by the facts. The statement appears to betray an ignorance of the relationship of Sarin to its degradation products. As I state above Sarin degrades into IMPA and/or MPFA. IMPA is a direct daughter compound of Sarin.

Q: The article also states that sarin can last "for months, sometimes years in the environment." Could you clarify the situation where that would be the case?

The persistence (or not) of Sarin in the environment depends on numerous variables. The fate of Sarin in the environment is effected by evaporation, hydrolysis, and thermal decomposition. I will address each in turn:

> **Evaporation**. Sarin has a non-trivial vapor pressure and a relatively low “latent heat of vaporization” (the energy required to go from liquid state to vapor state) at normal temperatures. Therefore, Sarin is a volatile liquid, and it will evaporate into the air if given the chance to do so. In open contact with the air, Sarin liquid cannot be expected to last for more than a few hours. 30 minutes at 15º C is stated by one German authority[10]. In situation where the liquid Sarin is trapped and not exposed to air, it may persist for some time.
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> **Hydrolyis**. Sarin will decompose into IMPA or MPFA in contact with moisture. Sarin not in contact with moisture, such as humidity in the air or soil, will last longer.
>
> **Thermal decomposition**: Sarin thermally decomposes rapidly above 150º C.

Sarin without direct contact with air or water or extreme heat simply has less means to evaporate or degrade. Sarin trapped in a way where it has no access to air or water will significantly increase its persistence in the environment. In addition, liquid Sarin absorbs into some surfaces. I find samples 27 and 28 particularly revealing, as they are from window seals/gaskets. This is exactly where I would look for Sarin.

Q: Would you agree with the UN's claim on page 5 of the report that "The environmental, chemical and medical samples we have collected provide clear and compelling evidence that surface-to-surface rockets containing the nerve agent Sarin were used in Ein Tarma, Moadamiyah and Zamalka in the Ghouta area of Damascus."?

Yes. I believe that the environmental samples are conclusive. The medical evidence is somewhat less conclusive in my mind, but only because the methodology by which the samples were analyzed is not clearly stated.

Q: Considering the evidence in the UN report, do you agree with the articles conclusion that the 140mm artillery rockets fired at Moadamiyah did not contain Sarin?

I <u>do not agree</u> with this conclusion. I can think of no other reason to account for the presence of DIMP and IMPA at the scene.

Q: An article quotes you as saying "environmental and medical evidence cannot conceivably be considered a scientifically or statistically accurate sample of the population of affected victims. It would be considered scientifically unsound to draw widespread conclusions based simply on this sample." Could you expand on what you mean here?

The only point I am making with that statement is that the sample population of 36 individuals is too small to be considered statistically adequate to represent the entire population of thousands of people affected by the attacks. It is just too small a slice of the theoretical data set to allow one to draw widespread conclusions about the whole incident. A statistician could shed more light on the science behind this, as it has been over 20 years since my last statistics class.

My statement should not be taken to mean that we cannot learn from the data collected on the 36 people. Nor should my original statement be taken as a statement that I do not believe Sarin was used. As I state in my earlier report, I firmly believe Sarin was used, based on the evidence of the UN Report. My statement just means we can't apply those particular findings based on 36 people to the broader population of many thousands with any expectation of accuracy.

Q: The same article also highlights you're concerns over the mixture of symptoms not matching that of past sarin attacks; "Is it possible that we are looking at exposure to multiple causes of injury? Were some of the examined victims exposed to other things in addition to Sarin? I am not stating that Sarin was not used. It clearly was. My point is that it is either not behaving as we have understood it in the past or that other factors were at work in addition to Sarin" Could you expand on that point?

The point I was trying to make is as follows: One logical explanation behind the diverse and variegated signs and symptoms noted in the report may be the fact that we are looking at exposure to more than one thing. In simpler terms, did other chemicals cause injury <u>in addition</u> to Sarin.

There are numerous ways in which this could be the case. One possibility is widespread presence of smoke and other respiratory irritants. One theory I would like to explore is <u>binary chemical weapons</u>.

A binary chemical weapon is one that combines several components to create the chemical agent desired, generally by mixing the two chemicals in flight on the way to the target. Both the US and Soviet Union developed this technique during the Cold War. For example, a binary weapon could create Sarin. One excellent example of this was the M687 artillery shell developed by the US Army.[11] The M687 was designed to combine two canisters mid flight after being fired from a 155mm howitzer. One canister contained DF (Methylphosphonic difluoride – see above) while the other canister contained a mix of isopropyl alcohol and isopropyl amine. The two canisters would mix to create Sarin. The actual success of inflight mixing was very difficult to achieve and was the result of much research, development, and test firing both with simulant chemicals and live agents.

My theory is that the larger 330-360mm rocket may have been designed as a binary agent to combine chemicals to create Sarin. However, the 'dark art' of perfecting the in-flight mixing may not have been learned by its designers. In such a case, the device would disseminate a mix of chemicals upon impact or detonation. Some Sarin would be created, but an awful lot of precursors would be present. None of these precursors are pleasant substances and their general proclivity to cause respiratory and eye irritation could explain the relatively ubiquitous but generic respiratory and eye symptoms. In addition, the presence of MPFA at the locations tied to the larger rocket, but not the smaller rocket, could support this theory. This is because MPFA is a direct decomposition product of DF, the Sarin binary component.

Q: Wouldn't the attackers just mix up the chemicals, THEN pour them into the rocket?

There's no theoretical reason why that couldn't happen. It's just that it seems a dim idea to do it that way. Taking dangerous chemicals and mixing them in open air to create an even more dangerous chemical, which would evaporate and cause a downwind hazard seems like a difficult thing to get soldiers to do, and that's speaking in my capacity as a former Chemical Corps Officer. Anyone forced to do do would probably rush and make mistakes or do a poor job of it. Mixing binary components before putting them both in the weapon would negate all of the advantages of having a binary weapon in the first place. Using pure, unitary agent would achieve much higher efficiency at the same or lower (non-trivial) level of danger to the troops handling the agent. I see little point in a binary system that isn't an in-flight mixing technique.

About the author: Dan Kaszeta is the author of "CBRN and Hazmat Incidents at Major Public Events: Planning and Response" (Wiley, 2012) as well as a number of magazine articles and conference papers. He has 22 years of experience in CBRN, having served as an officer in the US Army Chemical Corps, as CBRN advisor for the White House Military Office, and as a specialist in the US Secret Service. He now runs Strongpoint Security, a London-based CBRN and antiterrorism consultancy. Mr. Kaszeta also holds a part-time post as Senior Research Fellow with the International Institute of Nonproliferation Studies and is a contributor to Wikistrat.

Appendix A:

Degradation Pathways of Sarin, Soman, and Cyclosarin by Hydrolysis

Medical Aspects of Chemical Warfare

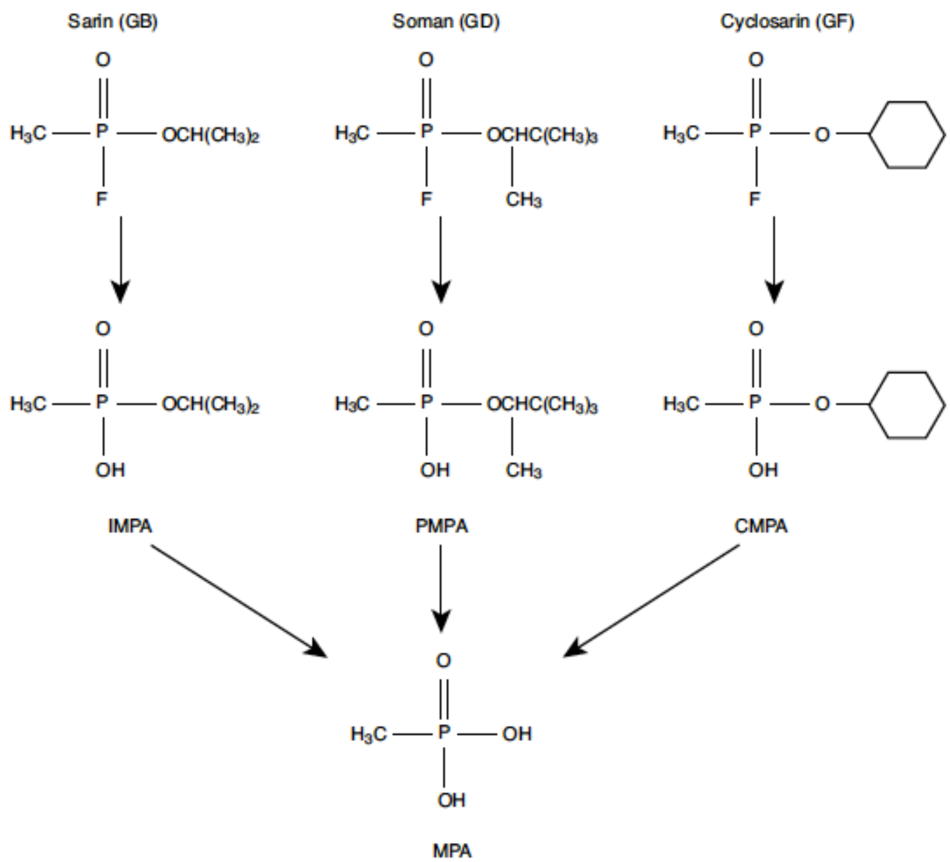

Fig. 22-2. Hydrolysis pathway of sarin (GB), soman (GD), and cyclosarin (GF). Hydrolysis pathway of nerve agents proceeds through the alkyl methylphosphonic acids IMPA, PMPA, and CMPA to MPA. Analysis of the alkyl methylphosphonic acids allows identification of the parent agent, while assay of MPA is nonspecific.
CMPA: cyclohexyl methylphosphonic acid
IMPA: isopropyl methylphosphonic acid
MPA: methylphosphonic acid
PMPA: pinacolyl methylphosphonic acid

Source: Medical Aspects of Chemical Warfare (2008), page 696.

References

[1] US Army Field Manual 3-11-9, Potential Military Chemical/Biolgical Agents and Compounds, 2005. Available online in various sources., page II-18

[2] http://www.rma.army.mil/cleanup/facts/dimp.html

[3] Crenshaw, M, Methylphosphonofluoridic Acid: A Thermal Degradation Product of Some Nerve Agents, Battelle Memorial Institute, Jan 2002. Available online through dtic.mil

[4] US Army Field Manual 3-11-9, op. cit. page II-18

[5] Ibid, page II-69.

[6] US Army Technical Manual 9-1300-214, Military Explosives, 1985.

[7] US Patent 4023995, 17 May 1977.

[8] Douda, et al. See: www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA495417

[9] See: www.ipd.anl.gov/anlpubs/2001/04/39332.pdf see page A-26.

[10] Richardt, A. et al. CBRN Protection. Wiley-VCH, 2013. p. 357.

[11] http://en.wikipedia.org/wiki/M687