

日本化學災害救援體系譯介

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提要

- 一、在1993到2003年之間，日本經歷了世界上最沈重、有關恐怖化學事件的負擔，其中包含了：1994年的Matsumoto(松本)沙林攻擊、1995年的東京地鐵沙林攻擊、1998年和歌山砒事件、1998年的新瀉疊氮化鈉、1998年長野氰化物事件等。
- 二、1995年另外兩件在東京地下鐵和鐵路站廁所釋放，被阻止下來。這些事件促使日本加強以下化學災害應變系統的構件：1.災害現場危害區域劃分、2.緊急醫療中心、3.大規模除污系統、4.個人防護裝備、5.化學偵檢、6.資訊共享與協調及7.教育與訓練。
- 三、恐怖份子期利用化學武器攻擊G8，複製類似東京沙林事件慘劇，如今，日本擁有一個整合的化學災害應變系統，其內容涉及：地方消防局、警察局、緊急醫療網、地區醫院、日本自衛隊及日本毒物資訊中心。

Introduction

The history of events related to chemical warfare agents in Japan dates back to World War II. From 1944 to 1946, more than 5,000 Japanese workers involved in the production and subsequent decommissioning of chemical weapons were injured by chemical warfare agents.¹ Following the dismantling of the Japanese chemical weapons program, Japan enjoyed a 50-year respite from major chemical emergencies until the emergence of chemical terrorism in the mid-1990s. This article reviews the recent burden of chemical terrorism in Japan and the chemical emergency response system that evolved as a result.

壹、前言：

日本有關化學戰劑的歷史，可溯源至第二次世界大戰，從 1944 到 1946 年，因製造和拆卸化學武器而受到化學戰劑感染受傷的工人超過五千人（註1）。隨著化學武器計畫的拆卸，日本享受了 50 年重大化

註1 Nishimoto Y, Yamakido M, Ishioka S, et al. Epidemiological studies of lung cancer in Japanese mustard gas workers. Princess Takamatsu Symp 1987; 18:95-101

學緊急事件的休止期，直到 1990 年代，化學恐怖主義的出現。

Recent Chemical Terrorism- Related Events

During the 1990s, Japan experienced the largest burden of chemical terrorism-related events in the world. The first chemical attack occurred on 27 June 1994, when the Aum Shinrikyo cult members released sarin from a truck into a crowded residential area in Matsumoto, killing seven and injuring 586 persons.² Less than a year later, on 20 March 1995, Aum Shinrikyo terrorists released sarin vapor in five subway trains of the Tokyo subway system, killing 12 and injuring >5,500 persons.^{3–6} On two occasions later that year, Aum Shinrikyo terrorists placed cyanidegas- producing devices in a total of five public restrooms in the Tokyo subway and railway stations. All of these devices were discovered before cyanide was released. During 1998, >30 intentional chemical releases were reported in Japan. On 25 July 1998, arsenic was deliberately mixed into a curry and rice meal that was served at a summer festival in the community of Wakayama, killing four and injuring 58 festival-goers.⁷ A few weeks later, on 10 August 1998, someone deliberately added sodium azide to the contents of a teapot in Niigata, poisoning nine persons. This event was publicized widely in Japan, leading to five more copycat incidents involving sodium azide. On 31 August 1998, someone contaminated a can of oolong tea produced in Nagano with cyanide via a pinhole in its base, killing one person.

貳、近期和化學恐怖主義有關的事件

在 1990 年代，日本經歷了世界上最沈重的化學恐怖攻擊事件。第一起化學攻擊事件發生於 1994 年 6 月 27 日，Aum Shinrikyo(奧姆真理教)教派成員從一台卡車，將沙林毒劑釋放到 Matsumoto(松本)一個擁擠的居住區，造成 7 人死亡，586 人受傷(註²)。不到一年後，在 1995 年 3 月 20 日，Aum Shinrikyo 恐怖份子在東京地下鐵五節列車上釋放沙林毒氣，造成 12 人死亡，5500 餘人受傷(註^{3、4、5、6})。當年兩起事件後，Aum Shinrikyo 恐怖份子在東京地下鐵和鐵路站的 5 間廁所中，放置氰化物氣體產生裝置，這些裝置在作用前即被發現。在 1998

註2 Okudera H: Clinical features on nerve gas terrorism in Matsumoto. J Clin Neurosci 2002;9(1):17-21.

註3 Okumura T, Takasu N, Ishimatsu S, et al. Report on 640 victims of the Tokyo subway sarin attack. Ann Emerg Med 1996;28:129-135.

註4 Okumura T, Suzuki K, Fukada A, et al. The Tokyo subway sarin attack: Disaster management. Part I. Community emergency response. Acad Emerg Med 1998;5:613-617.

註5 同註 4，Part II. Hospital response. Acad Emerg Med 1998;5:618-624

註6 Okumura T, Suzuki K, Fukada A, et al. The Tokyo subway sarin attack: Disaster management. Part III. National and international response. Acad Emerg Med 1998;5:625-628..

年期間，在日本發生 30 多起蓄意化學性釋放事件被報導出來。1998 年 7 月 25 日，在和歌山社區的一個夏季節慶中，砷被蓄意的混入咖哩飯中，殺死了 4 個人、並造成 58 位參加節慶的人士受傷(註⁷)。幾週後，1998 年 8 月 10 日，在新瀉有人蓄意在茶壺中，放入疊氮化鈉，毒害了 9 個人，這事件被大肆宣傳，造成超過 5 件的仿效疊氮化鈉事件。在 1998 年 8 月 31 日，有人在罐裝烏龍茶底部的小孔放入氰化物，造成 1 人死亡。

Chemical Emergency Response System in Japan

The 1995 Tokyo subway sarin attack was a watershed event for the development of the chemical emergency response system in Japan. Following this attack and the ensuing flood of smaller chemical releases in 1998, Japan began to improve the following components of its chemical disaster response system: (1) scene demarcation; (2) emergency medical care; (3) mass decontamination; (4) personal protective equipment (PPE); (5) chemical detection; (6) information- sharing and coordination; and (7) education and training. The 2000 Kyushu-Okinawa G8 Summit provided further impetus for the Japanese government to refine its emergency management of chemical events. As the host nation for this high-profile meeting, Japan recognized the potential for a terrorist attack involving the use of nuclear, biological, or chemical (NBC) agents, and sought to further improve many of the system components described below.

參、日本的化學災害應變系統

1995 年東京地鐵沙林事件是日本化學災害應變系統發展的分水嶺。隨著這起攻擊事件之後，1998 年面臨洪水般而來的小規模化學外釋，日本開始改善下列各項化災應變系統：1.災害現場危害區域劃分、2.緊急醫療中心、3.大規模除污系統、4.個人防護裝備(personal protective equipment, PPE)、5.化學偵檢、6.資訊共享與協調及 7.教育與訓練。

2000 年九州-沖繩 G8 高峰會提供了日本政府一個改良化學事件緊急管理的助力，身為此次會議的主辦國家，日本認知到遭受核子、生物、化學戰劑恐怖份子攻擊的可能性，所以日本企圖改善以下各項系統：

Scene Demarcation

Prior to the 1995 Tokyo subway sarin attack, emergency response at the scene of a chemical release was divided into two areas, a “dangerous zone” (contaminated area) and a “safe zone” (uncontaminated area). Following the

註7 Kishi Y, Sasaki H, Yamasaki H, et al. An epidemic of arsenic neuropathy from a spiked curry. *Neurology* 2001;56(10):1417-1418.

attack, authorities recognized the need to delineate a physical area for the on-scene decontamination of victims and responders. Accordingly, emergency response at the scene of a chemical incident is now demarcated into a hot zone (contaminated area), a warm zone (area where decontamination occurs), and a cold zone (uncontaminated area).

一、災害現場危害區域劃分：

在 1995 年東京地下鐵沙林攻擊之前，化學外釋事故現場的緊急應變被分為兩區塊：危險區域(汙染區域)和安全區域(未汙染區域)。隨著該攻擊，當權者認知到必須為現場消除的受害者及應變人員描繪出一個具體範圍。據此，在化學事件的緊急應變現象，現在被劃分成熱區(受汙染區域)、暖區(正在進行除汙作業區域)及冷區(未受汙染區域)。

Emergency Medical Care

Before the 1995 Tokyo subway sarin attack, on-scene physicians were not equipped with nerve agent antidote auto-injectors. Since the attack, physicians of the Japanese Self-Defense Forces have been supplied with antidote auto-injectors and the education and training required for their use. Despite this advance, a number of critical areas in the emergency care of victims of chemical terrorism still must be addressed. First, under Japanese law, only physicians are allowed to perform endotracheal intubation and administer medications to the victims of a chemical attack at the site of an incident. Despite the lessons learned from the Tokyo subway sarin attack, Japanese emergency medical technicians (EMTs) still are prohibited from performing these life-saving interventions.⁴ Second, physicians in Japan primarily are hospital-based, and do not routinely participate in out-of-hospital emergency responses. In addition, the Japanese Disaster Medical Assistance Team concept is quite young and the study of its effectiveness has just begun. Third, the Japanese Self-Defense Forces, including its physicians, are restricted legally from responding to a terrorist event involving the use of chemicals unless the local Governor gives his or her permission due to the so-called “civilian control dogma”, thus creating yet another barrier to the performance of life-saving emergency care at the scene of a terrorist attack involving the use of chemicals

二、緊急醫療中心：

在 1995 年東京沙林攻擊之前，事故現場的醫療人員都未攜帶神經戰劑解毒針。攻擊後，日本自衛隊的物理學家，都備有抗毒素自動注射器及其使用的必要教學與訓練。儘管有了這些進展，在緊急

醫療化學恐怖攻擊的受害者，一些關鍵救護處理步驟仍然必須著手處理。

首先，依據日本法律，在化學攻擊的事故現場，僅允許內科醫生給予傷者氣管插管與藥物治療。儘管由東京地鐵沙林毒氣攻擊中所學到的教訓，日本緊急醫療技術人員(Emergency Medical Technician, EMTs)仍然被禁止介入這些救命行為。此外，日本的內科醫生主要是以醫院為主，並不會定期地參與醫院以外的緊急應變行動。此外，日本災害醫療支援團隊的概念相當淡薄，且才剛開始研究它的有效性。第三，日本的自衛隊，包括醫生被限制不能合法的使用恐怖事件中的化學品，除非地方政府許可，這就是所謂的民治教條，因此造成現場生命救援緊急照護的另一項阻礙。

Mass Decontamination Systems

Prior to the Tokyo subway sarin attacks, none of the fire services had systems to provide mass decontamination. They only had sufficient systems for decontamination of first responders. Following the attack, authorities recognized that hospitals also must be able to decontaminate chemically contaminated victims who come to hospitals without using the emergency medical services (EMS) system. 8 As a result, the Japanese Ministry of Welfare distributed mass decontamination equipment and supplies to 130 hospitals located throughout Japan. In addition, authorities are planning to widen the distribution of mobile decontamination systems to include the fire services. These mobile decontamination systems are comprised of inflatable tents with two decontamination lines (one for ambulatory and another for non-ambulatory patients), a warm water supply, wastewater collection, lighting, and air-conditioning.

三、大規模除污系統(Mass Decontamination Systems, MDS)

在東京地鐵遭沙林毒劑攻擊之前，所有消防部門都無法提供大規模除污。他們的除污系統僅能滿足第一線應變人員。在攻擊事件後，相關當局認為醫院也必須能夠針對那些未使用緊急醫療服務(EMS)系統而進入醫院的污染受害者，進行除污[註8]。因此，日本福利部將大規模除污設備撥至日本各地的130家醫院。此外，當局正計畫擴大發放機動式除污系統至消防單位。這些機動式除污系統是由兩線(一線是針對能行走的病患，另一線則是針對不能行走的病患)

註8 Okumura T, Yamane K, Kimura F, et al. Mass Decontamination in chemical disaster in Japan. (Japanese). JJAAM 2001;12:455-454

可膨脹帳棚、溫水供應器、廢水收集器、燈光以及空調系統所組成。

Personal Protective Equipment (PPE)

In the 1940s, Japanese workers injured while handling chemical warfare agents were largely unprotected by PPE. Prior to the 1995 Tokyo subway sarin attack, on-scene emergency response units and hospitals still were not equipped with sufficient types and quantities of PPE required for the management for chemical events. Following the attack, authorities recognized the need for PPE at all levels of emergency response. Today, local fire and police services, and the Japanese Self-Defense Forces

are equipped with sufficient types and quantities of PPE (including Level-A). In addition, the Japanese Ministry of Welfare distributed PPE to hospitals throughout Japan. A major limitation is that only four sets of PPE have been provided to each hospital.

四、個人防護裝備(PPE)

在 1940 年代，大部份處理化學戰劑的工作患者都是沒有 PPE 的保護。在 1995 年東京地鐵沙林毒劑攻擊前，事故現場的緊急應變單位以及醫院，仍然未配備足夠型式與數量的 PPE 來處理化學事件。攻擊後，當局同意所有緊急應變等級對 PPE 的需要。今天，地方的消防隊、警察局以及日本自衛隊，都配有足夠型態與足量的 PPE(包括了 A 級防護服)。此外，日本福利部將 PPE 發放至全日本的醫院。其中最大的限制是每家醫院僅有 4 套 PPE。

Chemical Detection

In the early 1990s, Japan had only a limited capacity to detect chemical agents involved in terrorism-related events. During the Tokyo subway sarin attack, the Tokyo Metropolitan Fire Defense Agency had personnel and analysis equipment, but was unable to identify sarin, since it was not included in its library of possible substances. Meanwhile, the Tokyo Metropolitan Police Agency was able to identify the sarin within three hours of the attack, but only because it had the benefit of information collected in the 1994 Matsumoto sarin incident. In the 1998 Wakayama arsenic incident, it took eight days for the victims to be diagnosed as having arsenic poisoning (they were first diagnosed with food poisoning, and later, with cyanide poisoning). These events underscored the need for Japan to create the laboratory capacity for the rapid detection of chemical agents used in terrorism-related events. In 2000, the Japanese Government distributed chemical analysis equipment to 73 emergency centers throughout Japan, including gas chromatography/mass spectrometry, high performance liquid chromatography, and induction combination plasma mass spectrometry

technology. In addition, eight major Japanese cities have established NBC task forces and have positioned the necessary chemical analysis equipment in their local police departments. The Japanese Self-Defense Force also has established the laboratory capacity for rapid detection of chemical agents.

五、化學偵檢(Chemical Detection)

在 1990 年代早期，日本僅有有限的能力去偵檢包含恐怖主義相關事件中的化學戰劑。在東京地鐵沙林攻擊期間，日本大都市的消防防禦作為有個人的分析設備，但無法鑑定出沙林毒劑，因為它並未包含在可能物質的資料庫內。其實，東京大都會警察單位在攻擊 3 小時內能夠鑑定出沙林毒劑，只因為他們有收集到 1994 年 Matsumoto 沙林事件的資訊。1998 年 Wakayama 砷事件，花了 8 天的時間，才診斷出受害者體內有砷毒(他們初診為食物中毒，之後認為是氰化物中毒)。由這些事件中，日本必須創造出能夠在恐怖主義相關事件中快速偵檢化學戰劑的實驗室能力。2000 年，日本政府發放化學分析設備至全國 73 處的緊急中心，包括了 GC/MS，高效能的 LC，以及導入電漿質譜技術。此外，在日本的主要 8 大城市中，已經設置了 NBC 工作隊，並將必要的化學分析設備置於它們當地的警察部門。日本自衛隊也已經建立了能夠快速偵檢化學戰劑的實驗室能力。

Information Sharing and Coordination

Although Japan had two poison information centers before the Tokyo subway sarin attack, no systems for information sharing were in place in case of a chemical disaster. After the attack, the Japanese Government compiled a list of key personnel with expertise in the management of chemical incidents, began to convene regular meetings, and set-up an electronic list (e-list) of clinical toxicologists. Non- governmental e-lists for clinical toxicologists also were established. These e-lists now comprise standard routes for the exchange of information about chemical poisoning in Japan. At the same time, the Japanese government created a model for the coordination of responses to events involving the use of chemicals; the emergency responses are coordinated at the local level by an on-scene command center and at the national level by the Japanese Poison Information Center (JPIC). According to this model, the community EMS dispatch station collects information regarding the victims' condition from the hospitals via fax and forwards this information to the JPIC using fax transmission. Using this information, the JPIC then determines a possible cause and faxes its impression back to the community EMS dispatch center, which, in turn, relays this

information to the hospitals (also using fax). In the 1998 Wakayama arsenic incident, the emergency medical technicians (EMTs) distributed the victims to hospitals throughout the city. As a result, news that the first case had died in a hospital did not reach the other hospitals (where physicians believed that the cause of this incident was non-lethal food poisoning) until the next morning after four of the victims had died.

六、資訊共享與協調(Information Sharing and Coordination)

雖然在東京地鐵沙林攻擊前，日本已有兩處毒物資訊中心，但卻沒有即時的資訊分享(例如:化學災害)系統。攻擊過後，日本政府整合了一系列具有管理化學事件的重要專家人員，開始定期開會研討，並建立臨床毒物專家的電子名單。同時也建立非政府組織的臨床毒物專家的電子名單。這些電子名單構成了有關在日本發生的化學中毒資訊的標準資訊交換路徑。在此同時，日本政府創造出用以回應包括化學事件的協調模式，在地方層級的緊急回應是由單一的現場指揮中心負責協調，在國家層級則是由日本中毒資訊中心(JPIC)負責協調。根據此種模式，社區的 EMS 發送站透過傳真收集有關來自醫院傷者的狀況資訊，並使用傳真將此訊息傳至 JPIC。接著，JPIC 根據此訊息來決定可能的原因，並以傳真回傳給地區 EMS 發送中心，接著再轉送至醫院(也是利用傳真)。1998 年和歌山砒事件，緊急醫療技術人員(EMTs)將傷者分送至市內各地醫院。結果，第一個死亡案例未傳送至其它醫院(院內的內科醫生認為此事件是由非致命的食物中毒所造成)，直到隔日早晨 4 名傷者死亡為止。

Education and Training

Prior to the Tokyo subway sarin attack, no education and training programs were in place for the emergency management of chemical disasters in Japan. Following the attack, the Japanese Poison Information Center established seminars for chemical disaster management for emergency physicians and laboratory analysis for laboratorians. In March 2001, the Japanese Poison Information Center conducted three-day seminars for emergency physicians in Tokyo and Osaka that included lectures and tabletop exercises (repeated every year since). The Japanese Society for Clinical Toxicology also holds education and training programs for laboratorians. In addition, the Japanese Association for Active Medicine also has provided physicians with training in decontamination and the proper use of PPE, and the Japanese Association for Disaster Medicine produced an educational video that demonstrates the integrated chemical disaster response to the release of an unknown gaseous substance. 9 According to the

scenario shown in the video, numerous victims have collapsed in a park, and telephone calls for emergency assistance reach the local fire department first. At the beginning, it is unclear whether the scenario involves an intentional chemical release or a deliberate terrorist attack. Responding organizations include local fire services, police services, EMS, and the Japanese Self-Defense Forces. The key features of the chemical disaster response depicted in this video have been conducted (Table 1). An NBC terrorism emergency management seminar. Although these activities are listed in a given order, many occur simultaneously as the emergency responses unfolded. The Japanese Association for Disaster Medicine intends to distribute this video widely in order to assist with the education and training of emergency responders throughout the country.

七、教育與訓練(Education and Training)

在東京地鐵沙林攻擊前，在日本沒有針對化學災害緊急管理進行相關教育以及實驗室內的分析人員辦理化學災害管理研討會。2001 年 3 月，JPIC 為東京與大阪的緊急醫療人員舉辦了 3 天的研討會，其中包括了演講以及桌上練習(此後，每年舉辦一次)。日本臨床毒化物學會也為實驗人員辦理教育訓練計畫。此外，日本用藥協會也為內科醫生進行有關除汙以及適當使用 PPE 的訓練，且日本災害藥物協會製播了教育影片，內容包括了整合的化災回應到未知氣體物質的外釋[註 9]，根據影片所展示的劇本，在一公園內有許多受害者倒臥，大量電話湧入地方消防部門請求緊急支援。剛開始並不清楚到底是故意的化學外釋，亦或是謹慎的恐怖攻擊。應變機構包括了當地的消防部門、警察部門 EMS 以及日本自衛隊。影片中幾項重要的化災回應已列於表 1。NBC 恐怖緊急管理研討會，雖然這些行動已經列於表中，但也同時展現出許多同時發生的緊急回應。日本災害用藥協會企圖將此影片擴大發行，以協助並提供國內緊急應變人員的教育與訓練。

Conclusion

Over the past decade, Japan has experienced the largest burden of chemical terrorism-related events in the world. These events have spurred Japan to develop a chemical disaster response system that involves local fire and police services, local EMS, local hospitals, Japanese Self-Defense Forces, an on-scene unified command center, various laboratories attached to these entities, and the Japanese

註 9 Kawashima T, Kaku N, Okumura T, et al. Outline of the chemical disaster simulation drill (Japanese). *Kyukyugaku* 2002;26(2):215-218

Poison Information Center. While many components of a mature chemical disaster response system have been established since the 1995 Tokyo subway sarin attacks, a number of deficiencies still must be addressed.

肆、結語：

在過去十年，日本經歷了許多恐怖主義相關的化學災害。這些事件已經刺激日本朝向化學災害回應系統發展，包括了地方消防局與警察部門、地方 EMS、地區醫院、日本自衛隊、單一現場指揮中心、所有部門的附屬實驗室以及 JPIC。從 1995 年東京地鐵沙林攻擊後，雖然絕大部分的化災回應系統都已建立完善，但仍有許多缺點必須持續改善。

附表

Feature

- Dispatch of firefighter first responders wearing level-A PPE
第一線消防員應著 A 級防護服
- Zone demarcation into hot, warm, and cold zones by firefighter first responders
由第一線消防員將災區劃分為熱、暖、冷區
- Establishment of on-scene decontamination facilities in the warm zone
在暖區設置現場除污設施
- Establishment of an on-scene command center in the cold zone
在冷區設立現場指揮中心
- Unified command and control at the on-scene command center, involving police services, fire services, Japanese Self-Defense Forces, and EMS
單一的現場指揮與管制中心，包括了警察部門、消防部門、日本自衛隊以及緊急醫療系統
- Information-sharing at the on-scene command center
現場指揮中心的資訊共享
- Identification of the responsible chemical agent (e.g., sarin)
可靠的化學戰劑（如沙林）鑑定
- Identification and rescue of victims in hot zone by firefighters wearing level-A PPE
在熱區是由穿著 A 防的消防員鑑定並救出傷者
- Evacuation of victims from hot zone to warm zone, with simple respiratory support
以簡單的空呼器，將傷者由熱區撤至暖區
- Triage of victims at primary triage post in warm zone

在暖區對傷患作初步的分類

- Direction of ambulatory victims to one decontamination area and non-ambulatory victims to another decontamination area within the warm zone
引導能自行走路的傷患至暖區中的除污區，不能自行走路的傷患至暖區中的另一除污區
- Provision of basic life support to non-ambulatory victims at primary triage post
主要分類站提供不能自行走路傷患必要的維生系統
- Decontamination of the victims within the warm zone
在暖區的傷患除污
- Protection of privacy, management of personal belongings, and prevention of hypothermia during decontamination
保管私人物品並避免於除污期間體溫過低
- Provision of emergency medical care during decontamination, including antidotal therapy upon identification of responsible chemical agent
在除污期間提供緊急醫療照護，包括了解毒劑
- Transport of decontaminated victims into the cold zone
將除污後的傷患移至冷區
- Secondary triage of victims into “red”, “yellow”, or “green” categories according to the severity of their injuries at secondary triage post in cold zone
其次在冷區根據受傷的嚴重性，將傷患分成紅、黃、綠三類
- Prioritized EMS transport of decontaminated victims from cold zone to hospitals according to triage classification
根據分類站的分類，首先將除污後的傷患由冷區移至醫院
- Prioritized provision of emergency medical care to victims in cold zone awaiting transport to hospitals according to triage classification
優先提供冷區內待送至醫院的傷患緊急醫療照護
- Hospital decontamination of victims who bypass EMS and go directly to hospitals (outside hospital)
非由 EMS 轉運或自行就醫之傷患，須由醫院進行除污
- Environmental decontamination of the hot zone by Japanese Self-Defense Force personnel wearing level-A PPE
由著 A 防的日本自衛隊在熱區進行環境除污