



Review Article

Medical Intervention in terrorist attacks with chemical warfare agents: over ten years since the sarin gas terrorist attacks in Japan (Part 2)

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ABSTRACT

After the September 11 (2001) terrorist attacks in the USA and the subsequent mailing of letters contaminated with *B. anthracis* spores, a high perception of risk has become noticeable regarding the possibility of attacks with weapons of mass destruction, particularly by groups associated to the Al Qaeda terror network. For this reason, the medical personnel –both extra- and intrahospitalary– has become concerned about how to act and perform in this type of events. In the case of chemical warfare agents, the guiding principles of medical support are based on the experiences and on the lessons learned by the personnel that dealt with the sarin terrorist attacks in Japan in 1994 and 1995. The present paper aims at delving deeper into these lessons and findings of over ten years ago, bearing in mind that any and every medical service and organisation should adapt them to their particular environment, situation and characteristics.

Key Words: *Chemical terrorism. Chemical warfare agents. Emergency medicine. Decontamination.*

INTRODUCTION

Part I of this paper consisted of an analysis of basic aspects of medical intervention in the event of terrorist attacks with chemical agents, such as the coordination of bodies involved in the handling of the incident, the correct use of personal protective equipment (PPE), characteristics and limitations of the identification and detection systems, as well as the importance and difficulty posed by differential diagnosis and triage. This second part will continue to analyse other equally important aspects, as has been shown by the lessons

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RESUMEN

Actuación sanitaria en atentados terroristas con agentes de guerra: más de diez años después de los atentados con sarín en Japón (2ª parte)

Tras los atentados del 11 de septiembre de 2001 en EE.UU. y, sobre todo, desde los envíos de sobres con esporas de carbunco, existe una alta percepción del riesgo sobre posibles atentados con armas de destrucción masiva por grupos asociados a la red terrorista Al Qaeda. Esto ha llevado a que el personal sanitario extra-hospitalario y hospitalario se interese sobre cómo debería ser su actuación en este tipo de incidentes. En el caso particular de los agentes químicos de guerra la base de la actuación sanitaria son las lecciones aprendidas por el personal sanitario que participó en los atentados terroristas con sarín que tuvieron lugar en Japón en 1994 y 1995. El presente trabajo intenta profundizar en estas lecciones aprendidas hace ya más de diez años, teniendo en cuenta que será cada servicio y organización sanitaria el que deberá adaptarlas a su situación y características particulares.

Palabras clave: *Terrorismo químico. Agentes químicos de guerra. Medicina de emergencias. Descontaminación.*

learned by the medical intervention in the sarin gas incident in Japan and other incidents involving chemical agents.

ANTIDOTES AND MANAGEMENT OF MEDICAL RESOURCES

In addition to the resources needed for support and symptomatic treatments, the great unknowns –which can be of critical significance in the event of chemical agent attack – are the antidotes (see Table 1 in part 1). Antidotal treatment for neuro-

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toxic agents involves atropine, an oxime and a benzodiazepine as an anticonvulsant. One of the main disadvantages is that a wide-ranging oxime has yet to be developed, that is, an oxime which is fully effective against any warfare neurotoxic agent or anticholinesterasic organophosphorous compound¹. HI-6, the oxime with the most wide-ranging mechanism of action, is only commercially available in special self-injectors known as double chamber injectors, which are not yet developed to the full. The non-availability of a wide-ranging oxime and the subsequent ineffectiveness of available antidotal treatments has led to the research and development of what is known as “modern” treatment, based on the use of sweepers^{1,2}. Compared to the levisites, Dimercaprol, also known as BAL (British Anti-Lewisite) has shown some efficacy in counteracting systemic effects, especially in the bone marrow³. Hydroxocobalamine or the combination of sodium nitrite and sodium thiosulphate are the antidotal treatments available in Spain for cyanide agent intoxication^{4,5}. Physostigmine is also indicated for cases of serious BZ intoxication, although it has a narrow safety margin⁶. Although the ideal scenario would be administration of the antidotal treatment by medical personnel, the first persons on the scene should be fitted with self-injectors for rapid intramuscular administration of antidotes against neurotoxic warfare agents which can bring about death in a few minutes. This need is fundamental in the case of soman intoxication, as the acetylcholinesterase inhibiting this agent undergoes a rapid (2-4 minutes) ‘aging’ process, after which the oximes become ineffective⁷. The Iran-Iraq war experiences have shown that a fast administration of antidotal treatment means a higher probability of recovery with no sequelae⁸.

On the day of the sarin gas attack in Tokyo there were sufficient quantities of atropine but not of pralidoxime, mainly stored in rural area hospitals where agricultural activities increase the risk of intoxication by organophosphate insecticides⁹. Nobody, however, was capable of moving such reserves to the Tokyo hospitals. St. Luke International Hospital was fortunate enough to have a good stock of pralidoxime (100 ampoules) and the hospital’s pharmacy service was able to rapidly obtain more¹⁰. This situation highlights the need to establish a system to manage medical resources in the event of attacks with chemical weapons of mass destruction.

In the USA, following the attacks of September 11th 2001 (9/11), the Strategic National Stockpile (SNS) was created on the 1st of March, 2003 for the local and state-wide supply of antidotes, antibiotics and vaccines, among others, in the event of mass destruction chemical attack and other public health emergencies^{11,12}. The SNS enables local and state supply of medical resources in less than 12 hours, via its storage facilities strategically located all over the country to ensure the mi-

nimum period can be met. The SNS is nothing less than an extension of the National Pharmaceutical Stockpile (NPS) created in 1999 which was able to dispense medication and medical supplies to New York City on 9/11 less than 7 hours after the attack¹³. Since its creation, the SNS has been used to solve non-terrorist public health problems. These real operations coupled with the simulations carried out to date have enabled the correction of errors in the composition of stockpiled assets, in the activation protocols and in the transport of the medication and supplies requested¹⁵⁻¹⁹.

Although management of resources on a national level is important, resources must initially be managed at a local level¹³⁻¹⁵. In the US the pharmaceutical dispensing service at Maimonides Medical Centre, which played a central role in 9/11 and the incidents with anthrax spores, has designed a Pharmacy Team to respond to Emergencies (PTRE) prepared to manage medical resources required in the event of chemical weapons incidents²⁰. Lyophilized atropine storage systems have even been designed at a hospital level enabling the fast preparation of pre-filled syringes by the pharmaceutical department²¹.

EFFECTS AND PSYCHOLOGICAL ASSISTANCE

Both terrorist attacks with conventional weapons and those with chemical weapons result in a high number of casualties with psychological effects such as: direct victims of the weapons, people in the area under attack not directly affected by the weapon, victim relatives and intervening personnel²²⁻²⁵. Psychological effects usually persist even years after the event. The aim when using chemical weapons is not only to intoxicate people, but also to spread fear and panic among the population, in the same way that in a military setting the aim is to undermine the morale of the troops. Several studies published in biomedical journals show that in incidents involving hazardous substances the victims suffer more stress and psychological effects²⁶⁻³⁰. A recent study polled victims who 8 to 40 days previously had been exposed to hazardous substances; it showed that the somatization syndrome was significantly higher compared with the control group³¹. One of the first cases published which showed the importance of psychological effects in hazardous material incidents took place in 1973: a ship moored in a port in New Zealand was unloading barrels containing an organophosphorous compound, when a dock worker noticed a strange smell and a label on the barrels reading “poison”³². Word of mouth resulted in 643 people seeking medical help, although it is believed that only 241 dock



workers could have actually had direct contact with the barrels.

In the Tokyo attack in 1995 more than 5,000 people went to the hospitals and medical centres but less than 20% showed clinical signs of sarin gas intoxication, whereas the rest had undergone subclinical exposure or presented with symptoms of a psychogenic origin³³. The psychological effects persisted even 5 years after the attack³⁴. Likewise, during the Iran-Iraq war, the cases of psychological “sick leave” hindered differential diagnosis made military by medical personnel due to the so-called “worried healthy”, ie troops with no clinical symptoms or signs of intoxication but with a high degree of anxiety and due to the so-called “worried sick”, troops who, without having been exposed to the agent, presented with intoxication symptoms of a psychogenic origin⁸.

During the Gulf war in 1991 the Israeli government provided civilians with nuclear, biological and chemical (NBC) defence masks and self-injectors with antidotes against neurotoxic agents, which led to cases of asphyxia due to misuse of the mask under stress situations³⁵ and cases of atropine intoxication when, on hearing the alarms of Iraqi scud missile attacks, people believed they suffered intoxication by neurotoxic agents³⁶. Likewise, during this war US military personnel suffered panic attacks, hyperventilation and even inability to put on the NBC masks despite having had no problems during the training sessions, whenever the alarms for false positives from the detection devices were activated³⁷.

Competition among the media can trigger dissemination of sensationalist information, fostering a fear of the unknown and spreading panic among the population³⁸⁻⁴¹, which can aggravate the situation in the medical centres⁴². The method of communicating information by public authorities can have the same effect. For instance, in June 2005, following a fire in a dairy factory in New Zealand, the firefighters’ spokesman stated to the media his concern that the combination of caustic soda and sulphuric acid stored in the plant could produce mustard gas, which is completely false, but which nonetheless created social alarm among the population living close to the area of the incident⁴³. It is important that both the first personnel on the scene and the medical personnel acting as spokespersons before the media bear in mind that the public’s perception of risk will be affected by the information given. In fact, some authors report that the public finds information provided by medical personnel more credible than that given by other spokespersons⁴⁴⁻⁴⁶. The so-called “Giuliani model” of press conference which yielded good results in the anthrax envelope incidents after 9/11 was based, in part, on the Mayor of New York City passing the microphone over to his medical advisor to transmit confidence to the public⁴⁷.

VICTIM DECONTAMINATION

One of the most often mentioned lessons learned from the terrorist attacks in Japan has been the need to decontaminate not only the intervening personnel at their exit from the incident zone but also the victims. The aim is to end or reduce the contact between the casualty and the chemical agent and prevent secondary contamination⁴⁸.

In Matsumoto and Tokyo the underground workers, firefighters, policemen and medical personnel suffered secondary contamination upon contact with non-decontaminated victims^{10,49-53}. Okumura et al⁵⁴ report that 9.9% of the first intervening personnel suffered secondary contamination during the Tokyo attack. Likewise, the casualties taken to hospitals in Tokyo and Matsumoto led to secondary contamination of the hospital staff⁵⁵⁻⁵⁷. At St. Luke Hospital approximately 23% of the hospital staff reported symptoms related to secondary contamination: 39.3% of auxiliary nurses, 26.5% of nurses, 25.5% of volunteers, 21.8% of physicians and 18.2% of administrative staff¹⁰. The most affected areas were the chapel, used as an additional area, and the Intensive Care Unit, the first due to poor ventilation and the second perhaps because it held the more seriously affected victims and was the area where those who had had presumably been exposed to the highest concentrations of sarin gas were taken¹⁰. On the other hand, the least affected area was the emergency department, perhaps due to its good ventilation and its entrance directly into the street which was frequently opened and closed. Both in the first personnel on the scene and the Tokyo hospital staff the effects were local and in some cases victims received antidotal treatment⁵⁵. Only one underground worker died a few minutes after picking up a bag containing 600 grams of sarin at 35%⁵⁸. In fact, the low grade of purity of the sarin used in Tokyo may have been the reason for fewer serious cases of secondary contamination⁵⁸.

It is important to bear in mind the rapid absorption by the skin of agents such as VX^{59,60} or mustard gas, which is not detectable after 30 minutes⁶¹, which would require the decontamination process to be performed as quickly as possible.

Decontamination products

One of the main problems posed by decontamination of personnel is the type of decontaminant to be used⁶². These decontaminants can act by detoxification, absorption, dilution or physical removal.

Some warfare chemical agents are lipophilic (eg. mustard gas) and initial decontamination with water can spread the contamination over a larger body surface area, increasing lo-

cal effects and fostering the absorption and thus systemic effects. In these cases absorbent products should be used first (eg. Fuller's earth) which absorb the liquid contamination from the body surface area^{63,64}. In fact, among the military NBC PPE complementary materials provided for soldiers is a mitten with absorbent material for emergency decontamination by the individual himself. In a civilian scenario this could translate as emergency decontamination with absorbent products by rescue teams or decontamination station staff, at the entrance to the affected area.

In the event of chemical agents in gas form at room temperature, removal of clothing and a water shower (or soap and water) should be enough, whereas in the case of solids or liquids, the water can dilute and spread the agent over the surface of the body^{48,65}. When decontaminating, special care must be taken with substances that react violently to water (eg. cesium, lithium, potassium, sodium and rubidium, among others)⁶⁶. For some authors the removal of clothing can mean a 75-90% elimination of the contamination^{48,67-70}. However, the National Institute of Standards and Technology (NIST) reports that the type of clothing must also be taken into account, calculating it may only represent 50% decontamination in some cases⁷¹. Another added problem in clothing is that it must be removed by cutting it off, thus preventing contamination spread^{66,72}. Phosgene and lewisite decompose rapidly in the presence of water or in highly moist environments^{65,73}. In the case of victims by ingestion the risk of secondary contamination via vomiting must be taken into consideration.

Sodium hypochlorite at 0.5% is indicated for decontamination of victims of vesicant and neurotoxic agents, as it favours hydrolysis and the oxidation of the agents⁷⁴. Concentrations of 1% have proven efficacious in the detoxification of mustard gas in contact times even under 5 minutes, exceeding the efficacy of some commercial decontaminants specifically manufactured for decontamination of warfare chemical agents⁷⁵. Hypochlorite continues to act in the water collected from the decontamination process. The advantage of sodium hypochlorite is that it is an easily and readily available product, through the pharmacy services. There are commercial products of proven efficacy for decontamination of chemical warfare agents but their expiration and high cost are disadvantages to be taken into account. The time spent showering or washing depends on each specific case (type of agent, extension of the contamination, characteristics of decontamination station and decontaminant used, among others)^{66,76}, but for practical reasons some authors recommend 5-6 minutes per victim^{66,72}.

Commercial decontamination equipment is based on the application of the decontaminant and its rapid aspiration rate.

These devices were designed for decontamination in the event of nuclear or radiological incidents, as they spray a chelating substance – usually Schubert's solution – to then absorb the complex chelates formed with radioactive particles. Their efficacy in the case of chemical contamination has not been proven; its cost and maintenance are also factors to be taken into consideration.

In open wounds and eyes hypochlorite must not be used; it is best to use saline solution. Decontamination products are currently being developed based on endogenous enzymes (eg. Mutant butylcholinesterases) with a large detoxifying capacity and which could be applied to open wounds⁷⁷.

The possibility that the physical-chemical characteristics of chemical agents can change- thus hindering the decontamination process- must also be taken into consideration. This is the case with "thickening", involving the addition of an acrylate to increase the persistence of the agent, also helping it to adhere to surfaces, rendering the decontamination process more difficult⁷⁸. This is also the case with "dusty agents", particles which act as a continuous release of the agent, increasing its persistence and hindering decontamination.

Decontamination stations

Although we shall not go into much detail as to the steps involved in victim decontamination, which depends on the intrinsic characteristics of each commercial model, the decontamination lines of outpatient casualties should be separated from those of non-outpatient victims who must be transported on stretchers⁷⁹. This last task means extra work for the station staff. Various commercial manufacturers currently provide decontamination stations on tracks or rollers to help move along patients on stretchers (Figure 1).

In the beginning this process was carried out manually by station personnel, which meant at least 30 minutes per non-outpatient victim and considerable physical effort on the part of the staff. Modern stations have allowed this time to be reduced to around 10 minutes, demanding much less effort from the staff. Stations should be equipped with tents to protect the victims' privacy, particularly when in the presence of the media. Furthermore, in order to avoid hypothermia, room temperature should be matched with that of the water in the showers.

An additional problem faced by decontamination stations are active agents or toxic metabolites left in the waste water. Some stations are fitted with water, and even air, collection systems, in which pressure differences force the water or air to pass through filters. This water collection system might lo-



gically become saturated and, in any event, once the decontamination process is complete, the area where the station was erected might require more aggressive decontamination and control.

Contamination Control

Some intervening units perform a control process at the entrance and/or exit of the decontamination station. In addition to the problems mentioned in Part I of this paper on false positives and false negatives yielded by detection devices, the performance of a control on the entire body surface area of a victim can take some time, which from an operational perspective is not very effective, being much simpler and more practical to decontaminate all those who hail from the affected area.

Pre-hospital decontamination

The US Environmental Protection Agency (EPA) and the National Institute for Occupational Safety and Health (OSHA) recommend the division of the affected area into 3 zones: hot, arm and clean (also known as cold zone)⁸⁰ (Figure 2). The hot zone is the area directly affected by the chemical agent. The warm zone is so-called because, despite initially being a clean area, it is where the decontamination task will be carried out, which means a concentration of personnel and/or materials which may be contaminated. The name 'warm zone' should be taken seriously and, in terms of protection, must be considered a hot zone. Computer systems such as ALOHA® or PEACWMD®, among others, are useful in quickly determining the danger areas and hot zone boundaries based on the information available on the agent, the type of incident and meteorological conditions. The exit from the decontamination station marks the boundary for the clean zone. Within the clean zone another boundary must be identified - the so-called support zone -, where all supplies and materials will be held. This boundary usually depends on the extent of the resources deployed.

Only the State Guard and Police Force, firefighters and rescue personnel should enter the hot zone. These, depending on action protocols, may or may not be accompanied by medical personnel. Behind the decontamination stations, that is, following on from the Warm Zone, are the Advance Medical Posts and the Medical Evacuation Centres. Most of the medical staff will therefore be located at the end of the decontamination station to enable them to treat the victims without the need for PPE. However, before the victims enter the decontamination area itself, they must pass through a



Figure 1. Decontamination line of non-outpatient victims. Station personnel uses Level B protection according to the classification of the US Environmental Protection Agency (EPA).

primary triage area and an emergency medical treatment station designed to stabilize the patient before entering the decontamination zone. The medical staff in both areas must wear PPE, with the resulting restriction on intervention capacity.

Hospital decontamination

Although all those exiting the hot zone should ideally have been decontaminated, the truth is that by the time the hot and warm zones are set up and controlled, victims will have arrived or be arriving at the hospital; hence the importance of coordination centres to inform and alert nearby medical centres in order to control arrivals and deploy, or in absence of means, to improvise decontamination systems⁴⁵⁻⁸¹. In the Tokyo attack, 35% of victims treated at St. Luke Hospital arrived of their own accord, not necessarily entering via A&E, but by any of the three hospital entrances^{10,82}. Control and cordoning-off of the underground stations took about 30 minutes by which time many victims had left the hot zone by their own means or in private vehicles or taxis^{54,82,83}. In these cases it is imperative that security personnel control and direct the access to hospital by people and ambulances. The coordination centres should also organize transport to hospitals to enable

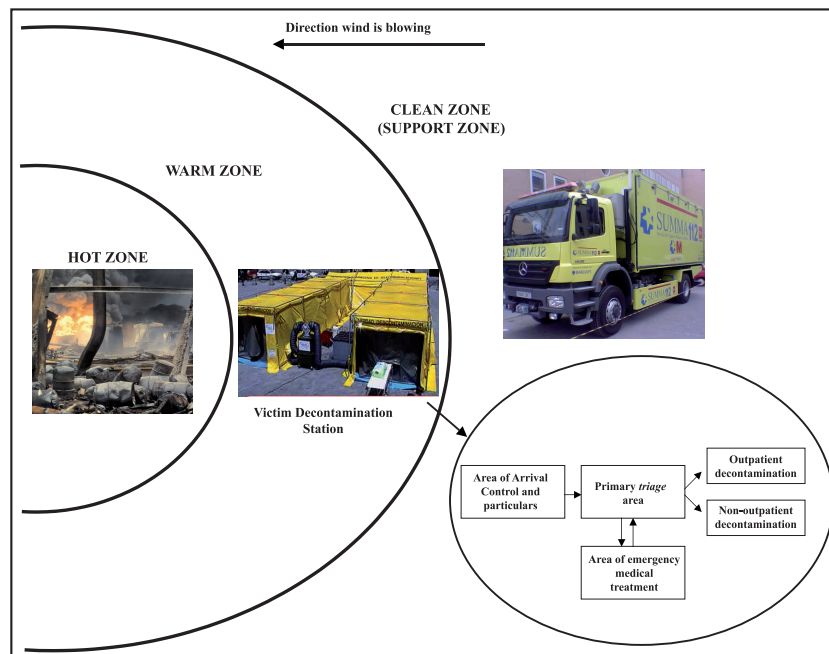


Figure 2. Zones into which the intervention area is divided in the event of a chemical agent accident or attack. More details are included on the victim decontamination station.

the ambulances to arrive at suitable areas for victim reception. On their part, among their disaster action plans, hospitals must have specific action protocols for chemical agent incidents covering all aforementioned aspects.^{62,67,84-90}

The structure of victim decontamination stations in hospitals should be similar to that of the warm zone, with a line for outpatient victims and another for victims on stretchers. Some hospitals have a permanent area fitted with showers to carry out decontamination, but the usual and most practical way is to perform this in deployable equipment outside the emergency department.^{45,68}

Use of PPE in hospital decontamination stations

Hospital staff coming into contact with the victims hailing from the affected area should follow the same PPE selection criteria as those explained in Part I of this paper. Nevertheless, the OSHA allows for the possibility of reduced protection levels due to possible contamination transferred to the hospital in the body, clothing and personal belongings being much less than that transferred to the warm zone adjacent to the hot zone. This will largely be due to the lower number of victims than in the warm zone and the volatilization and dissipation of the agent during transport to the hospital. In fact, a review of biomedical publications on chemical substance incidents suggests that the incidence of secondary contamination of hospital personnel by victims is low^{55,57,89,91-105}. Despite incomplete data provided by the

authors in some cases, secondary contamination is usually due to non-decontamination of the victims upon exiting the hot zone, or before coming into contact with hospital A&E staff. Nonetheless, in some cases provisional closure of the emergency department for decontamination has been required, which can be an added complication in the management of a mass casualty incident. Cases of secondary contamination have even been attributed to contact or exposure to the gastric content of individual intoxicated with cyanide salts or arsenic compounds.^{83,100} Based on this information and on two models for predicting the level of protection to be worn by hospital decontamination personnel in the event of a chemical agent incident^{106,107}, the OSHA recommends the use of Level C with assisted ventilation filter masks with an assigned protection factor (APF) of 1000, that is, that the concentration inside the mask is 1000 times lower (0.1%) than the concentration of the agent in the air⁷². The filter must be combined with a HEPA (High Efficiency Particulate Air) filter to prevent the passage of solid particles. On the other hand, the OSHA reports that once the threat has been appraised, the hospital must assess the need to increase the level of personal protection. In fact, there have been some cases of secondary contamination of hospital staff by very volatile agents or gases at room temperature which should not pose a risk due to dissipation after a few minutes⁹⁸. For this reason, at least the staff responsible for receiving the victims and guiding them through the decontamination station should wear the highest possible level of protection. Several authors, in agreement with the OSHA,



recommend level C because Level B means added weight for the staff, that is, less agility and higher cost for the hospital in terms of acquisition and maintenance^{66,79,83,97,108}. However, they all report that some situations may require higher levels of protection. For Baker¹⁰⁹ level C with NBC military filters is adequate protection as he believes that there are few possibilities that terrorists will develop new chemical warfare agents that are not adsorbed by activated carbon, which is a mistake given reports that the chemical agents of interest by terrorist groups associated or related to the Al Qaeda network are mainly industrial chemical products instead of 'classical' warfare agents¹¹⁰. Koenig¹¹¹ published an excellent article in 2003 entitled "undress and take a shower", he reflecting the difficulties of arriving at a consensus in the choice of level B or level C. The difficulties of purchase and maintenance of level B equipment for hospitals, as well as personnel training and the difficulty of wearing such kits, were acknowledged but it was also recognised that if, in some cases, 80% of the victims are to arrive at the hospital of their own accord without previous decontamination, level C equipment cannot be enough to protect the staff. Moreover, the Tokyo experience shows that several hours after an attack the identity of the agent may still be unknown, with no option left available for selection of the right filter¹¹². Kirk et al⁴⁵ suggest that hospitals should have a group of people specially trained in the use of PPE's and the performance of decontamination processes, available round the clock. In this case, the personnel would indeed be prepared for working under level B protection.

Training

Before the response phase (during the incident) there must be a preparation phase in which the extra-hospital and hospital emergency plans are established and personnel is trained and tested by means of drills and simulations designed to detect intrinsic problems in each intervening unit or in each hospital^{73,113}. Furthermore, suitable training in personnel chemical defence has proven to modify their perception of risk and instils a greater sense of duty¹¹⁴. After the 9/11 attacks the UK National Health Service (NHS) distributed 2,500 equipment kits which included PPE and a blow-up decontamination tent to health centres and hospitals all over the country. Several simulations were held, highlighting problems with PPEs, especially of an ergonomic nature, likewise confirming the need for previous training of all the personnel to enable adequate use of the equipment¹¹⁵.

CHRONIC AND LONG TERM EFFECTS

After a chemical agent incident a follow-up of victims and epidemiological studies of affected zones must be carried out in order to identify chronic and long term effects. Even years after exposure, victims of the Matsumoto and Tokyo attacks bear physiological and psychological sequelae^{34,52,56,57,83,116-123}. There is also a certain amount of controversy as to whether the subclinical exposure to warfare neurotoxic agents (low concentrations which are not even sufficient to produce clinical symptoms or signs of intoxication) can lead to delayed neuropathy by organophosphates, similar to that induced by certain organophosphorous insecticides⁷. Thanks to the experience of Iranian physicians during the Iran-Iraq war we know today that mustard gas intoxications have important long term effects which may appear years after exposure, mainly affecting the respiratory system, skin and eyes³.

CONCLUSIONS

Although since 9/11 there is a high level of perceived risk of the possible use of chemical warfare agents by groups related or associated with the Al Qaeda terrorist network, no attack has taken place to date. There have, however, been a number of attempts and, worst of all, it is clear that these groups are actively working to obtain chemical substances for use in terrorist attacks. The difficulty in obtaining 'classical' chemical warfare agents has turned their interest towards easily obtained industrial chemicals which, if used in a terrorist attack, could have catastrophic consequences such as those produced by the dispersion of methyl isocyanate in Bhopal (India) in 1984. This is why many analysts believe that the occurrence of a terrorist attack with chemical agents is simply a matter of time.

Despite the fact that the sarin gas attacks in Japan happened over ten years ago, the lessons learned by medical personnel are still current today and, in many cases, are yet to be implemented. It is important that each medical service and organization adapts these measures to their specific situation. Their incorporation of the protocols and action plans for both hospital and extra-hospital staff will help minimise the consequences of a possible attack with such agents. A new incident will bring new lessons to be learned to help improve medical intervention and remind us of the gulf which exists between theory and practice. What would be sad would be if the new lessons to be learned were exactly the same as those learned more than ten years ago in Japan.

REFERENCES

- 1- Pita R, Anadón A, Martínez-Larrañaga MR. Actualización de las intoxicaciones por agentes neurotóxicos de guerra: tratamiento farmacológico (2). *Aten Farm* 2002;4:178-88.
- 2- Sogorb MA, Vilanova E, Carrera V. Nuevas perspectivas en los tratamientos de intoxicaciones por insecticidas organofosforados y agentes nerviosos de guerra. *Rev Neurol* 2004;39:739-47.
- 3- Pita R. Armas químicas: agentes vesicantes de guerra. En: Ministerio de Justicia, editor. *Curso de armas químicas y biológicas*. Madrid: Centro de Estudios Jurídicos. En prensa 2006.
- 4- Dueñas A, Nogué S. Intoxicación por el humo de los incendios: tratamiento antidótico a base de vitaminas. *Med Clin (Barc)* 2000;114:658-60.
- 5- Sauer SW, Keim ME. Hydroxocobalamin: improved public health readiness for cyanide disasters. *Ann Emerg Med* 2001;37:635-41.
- 6- Organización del Tratado del Atlántico Norte (OTAN). Incapacitants. En: *NATO handbook on the medical aspects of NBC defensive operations (Chemical) - AMedP-6(C) Volume III. STANAG 2463*. 1ª ed. Brussels: NATO Standardization Agency (NSA); 2005. p. 7.1-7.7.
- 7- Pita R, Anadón A, Martínez-Larrañaga MR. Actualización de las intoxicaciones por agentes neurotóxicos de guerra: efectos fisiopatológicos (1). *Aten Farm* 2002;4:98-116.
- 8- Newmark J. The birth of nerve agent warfare: lessons from Syed Abbas Foroutan. *Neurology* 2004;62:1590-6.
- 9- Tu AT. Chemical terrorism: horrors in Tokyo subway and Matsumoto city. Fort Collins, Colorado: Alaken Inc.; 2002.
- 10- Okumura T, Suzuki K, Fukuda A, Kohama A, Takasu N, Ishimatsu S, et al. The Tokyo subway sarin attack: disaster management, part 2: hospital response. *Acad Emerg Med* 1998;5:618-24.
- 11- Esbitt D. The Strategic National Stockpile: roles and responsibilities of health care professionals for receiving the stockpile assets. *Disaster Manag Response* 2003;1:68-70.
- 12- Nolan R, Hamilton M. Establishing a stockpile of essential medical supplies: actions and issues. *The ASA Newsletter* 2004;(101):20-4.
- 13- Bhanot KK. What defines a public health emergency? An analysis of the strategic national stockpile and the national childhood vaccine injury act: the need for prevention of nonterror national medical emergencies. *J Contemp Health Law Policy* 2004;21:137-67.
- 14- Rendin RW, Welch NM, Kaplowitz LG. Leveraging bioterrorism preparedness for nonbioterrorism events: a public health example. *Biosecur Bioterror* 2005;3:309-15.
- 15- Banner G. The Rhode Island Medical Emergency Distribution System (MEDS). *Disaster Manag Response* 2004;2:53-7.
- 16- Giovachino M, Calhoun T, Carey N, Coleman B, Gonzalez G, Harde-man B, et al. Optimizing a district of Columbia Strategic National Stockpile Dispensing Center. *J Public Health Manag Pract* 2005;11:282-90.
- 17- Olson D, Leitheiser A, Atchison C, Larson S, Homzik C. Public health and terrorism preparedness: cross-border issues. *Public Health Rep* 2005;120(Suppl 1):76-83.
- 18- Young D. Iowa pharmacists dispense from Strategic National Stockpile during drill. *Am J Health Syst Pharm* 2003;60:1304-6.
- 19- Young D. States, hospitals learn emergency-preparedness lessons in TO-POFF 3. *Am J Health Syst Pharm* 2005;62:1000-9.
- 20- Cohen V. Organization of a health-system pharmacy team to respond to episodes of terrorism. *Am J Health Syst Pharm* 2003;60:1257-63.
- 21- Kozak RJ, Siegel S, Kuzma J. Rapid atropine synthesis for the treatment of massive nerve agent exposure. *Ann Emerg Med* 2003;41:685-8.
- 22- Baca E, Cabanas ML, Pérez-Rodríguez MM, Baca-García E. Trastornos mentales en las víctimas de atentados terroristas y sus familiares. *Med Clin (Barc)* 2004;122:681-5.
- 23- Lemyre L, Clément M, Corneil W, Craig L, Boutette P, Tyshenko M, et al. A psychosocial risk assessment and management framework to enhance response to CBRN terrorism threats and attacks. *Biosecur Bioterror* 2005;3:316-30.
- 24- Rodríguez J. Análisis de la intervención psicológica realizada con los familiares de los afectados por el atentado de Madrid 11-M: errores que se repiten. *Puesta al Día en Urgencias, Emergencias y Catástrofes* 2004;5:127-31.
- 25- Smith DW, Christiansen EH, Vincent R, Hann NE. Population effects of the bombing of Oklahoma City. *J Okla State Med Assoc* 1999;92:193-8.
- 26- Baum A, Fleming I. Implications of the psychological research on stress and technological accidents. *Am Psychol* 1993;48:665-72.
- 27- Bowler RM, Mergler D, Huel G, Cone JE. Psychological, psychosocial, and psychophysiological sequelae in a community affected by a railroad chemical disaster. *J Trauma Stress* 1994;7:601-24.
- 28- Dayal HH, Baranowski T, Li Y, Morris R. Hazardous chemicals: psychological dimensions of the health sequelae of a community exposure in Texas. *J Epidemiol Community Health* 1994;48:560-8.
- 29- Markowitz JS. Long-term psychological distress among chemically exposed firefighters. *Behav Med* 1989;15:75-83.
- 30- Yehuda R. Post-traumatic stress disorder. *N Engl J Med* 2002;346:108-14.
- 31- Kovalchick DF, Burgess JL, Kyes KB, Lymp JF, Russo JE, Roy-Byrne PP, et al. Psychological effects of hazardous materials exposures. *Psychosom Med* 2002;64:841-6.
- 32- McLeod WR. Merphos poisoning or mass panic? *Aust N Z J Psychiatry* 1975;9:225-9.
- 33- Woodall JW. Tokyo subway gas attack. *Lancet* 1997;350:296.
- 34- Kawana N, Ishimatsu S, Kanda K. Psycho-physiological effects of the terrorist sarin attack on the Tokyo subway system. *Mil Med* 2001;166 (Suppl 2):23-6.
- 35- Hiss J, Arensburg B. Suffocation from misuse of gas masks during the Gulf War. En: Danon YL, Shemer J, editores. *Chemical warfare medicine: aspects and perspectives from the Persian Gulf War*. Jerusalem: Gefen Publishing House Ltd.; 1994. p. 106-12.
- 36- Karsenty E, Shemer J, Alshech I, Cojocar B, Moscovitz M, Shapiro Y, et al. Medical aspects of the Iraqi missile attacks on Israel. En: Danon YL, Shemer J, editores. *Chemical warfare medicine: aspects and perspectives from the Persian Gulf War*. Jerusalem: Gefen Publishing House Ltd.; 1994. p. 38-44.
- 37- Claborn DM. Environmental mimics of chemical warfare agents. *Mil Med* 2004;12:958-61.
- 38- Ahern J, Galea S, Resnick HS, Kilpatrick DG, Bucuvalas M, Gold J, et al. Television images and psychological symptoms after the September 11 terrorist attacks. *Psychiatry* 2002;65:289-300.
- 39- Cragin CL. The role of the Department of Defense in domestic weapons of mass destruction consequence management. *Mil Med* 2001;166(Suppl 2):1-3.
- 40- Nacos LB. Mediated terror: teaching terrorism through publicity and propaganda. En: Forest JF, editor. *The making of a terrorist: recruitment, training, and root causes*. Volume two: Training. Westport (CT): Praeger Security International; 2006. p. 98-115.
- 41- Norwood AE, Holloway HC, Ursano RJ. Psychological effects of biological warfare. *Mil Med* 2001;166(Suppl 2):27-8.
- 42- Henderson JN, Henderson LC, Raskob GE, Boatright DT. Chemical (VX) terrorist threat: public knowledge, attitudes, and responses. *Biosecur Bioterror* 2004;2:224-8.
- 43- "New Zealand fire sparks mustard gas scare". *Global Security Newswire*, 22 de junio de 2005. Disponible en http://www.nti.org/d_newswire/issues/2005/6/22/6c05fff1-6907-42dd-b164-509da53b5442.html (consultado el 26 de mayo de 2006).
- 44- Blendon RJ, Benson JM, Desroches CM, Weldon KJ. Using opinion surveys to track the public's response to a bioterrorist attack. *J Health Commun* 2003;8:83-92.
- 45- Kirk MA, Cisek J, Rose SR. Emergency department response to hazardous materials incidents. *Emerg Med Clin North Am* 1994;12:461-8.
- 46- Pollard WE. Public perceptions of information sources concerning bioterrorism before and after anthrax attacks: an analysis of national survey data. *J Health Commun* 2003;8:93-103.
- 47- Mullin S. The anthrax attacks in New York City: the "Giuliani press conference model" and other communication strategies that helped. *J Health Commun* 2003;8:15-6.
- 48- Levitin HW, Siegelson HJ, Dickinson S, Halpern P, Haraguchi Y, Noce-ra A, et al. Decontamination of mass casualties - re-evaluating existing dogma. *Prehospital Disaster Med* 2003;18:200-7.
- 49- Masuda N, Takatsu M, Morinari H, Ozawa T. Sarin poisoning in Tokyo subway. *Lancet* 1995;345:1446.
- 50- Morita H, Yanagisawa N, Nakajima T, Shimizu M, Hirabayashi H, Oku-dera H, et al. Sarin poisoning in Matsumoto, Japan. *Lancet* 1995;346:290-3.
- 51- Nakajima T, Sato S, Morita H, Yanagisawa N. Sarin poisoning of a res-



- cue team in the Matsumoto sarin incident in Japan. *Occup Environ Med* 1997;54:697-701.
- 52- Nishiwaki Y, Maekawa K, Ogawa Y, Asukai N, Minami M, Omae K, et al. Effects of sarin on the nervous system in rescue team staff members and police officers 3 years after the Tokyo subway sarin attack. *Environ Health Perspect* 2001;109:1169-73.
- 53- Okudera H, Morita H, Iwashita T, Shibata T, Otagiri T, Kobayashi S, et al. Unexpected nerve gas exposure in the city of Matsumoto: report of rescue activity in the first sarin gas terrorism. *Am J Emerg Med* 1997;15:527-8.
- 54- Okumura T, Suzuki K, Fukuda A, Kohama A, Takasu N, Ishimatsu S, et al. The Tokyo subway sarin attack: disaster management, part I: community emergency response. *Acad Emerg Med* 1998;5:613-7.
- 55- Nozaki H, Hori S, Shinozawa Y, Fujishima S, Takuma K, Sagoh M, et al. Secondary exposure of medical staff to sarin vapor in the emergency room. *Intensive Care Med* 1995;21:1032-5.
- 56- Ohbu S, Yamashina A, Takasu N, Yamaguchi T, Murai T, Nakano K, et al. Sarin poisoning on Tokyo subway. *South Med J* 1997;90:587-93.
- 57- Okumura T, Takasu N, Ishimatsu S, Miyanoki S, Mitsuhashi A, Kumada K, et al. Report on 640 victims of the Tokyo subway sarin attack. *Ann Emerg Med* 1996;28:129-35.
- 58- Ando H. Analyses of sarin and related compounds used in the Tokyo subway incident. International Symposium on NBC Terrorism Defense in Commemoration of the 10th Anniversary of the Tokyo Subway Attack; 2005 June 16-19; Chiba Institute of Science, Choshi City, Chiba, Japan.
- 59- Nozaki H, Aikawa N, Fujishima S, Suzuki M, Shinozawa Y, Hori S, et al. A case of VX poisoning and the difference from sarin. *Lancet* 1995; 346:698-9.
- 60- Törngren S, Persson S-Å, Ljungquist Å, Berglund T, Nordstrand M, Hägglund L, et al. Personal decontamination after exposure to simulated liquid phase contaminants: functional assessment of a new unit. *J Toxicol Clin Toxicol* 1998;36:567-73.
- 61- Somani SM. Toxicokinetics and toxicodynamics of mustard. En: Somani SM, editor. *Chemical warfare agents*. San Diego (CA): Academic Press, Inc.; 1992. p. 13-50.
- 62- Laurent JF, Richter F, Michel A. Management of victims of urban chemical attack: the French approach. *Resuscitation* 1999;42:141-9.
- 63- Newmark J. Nerve agents: pathophysiology and treatment of poisoning. *Semin Neurol* 2004;24:185-96.
- 64- Van Hooiendonk C, Ceulen BI, Bock J, van Generen J. Chemical warfare agents and the skin: penetration and decontamination. En: Proceedings of the International Symposium on Protection Against Chemical Warfare Agents; 1983 June 6-9; Stockholm, Sweden; 1983. p. 153-60.
- 65- Raber E, Jin A, Noonan K, McGuire R, Kirvel RD. Decontamination issues for chemical and biological warfare agents: how clean is clean enough? *Int J Environ Health Res* 2001;11:128-48.
- 66- Houston M, Hendrickson RG. Decontamination. *Crit Care Clin* 2005; 21:653-72.
- 67- Cox R. Decontamination and management of hazardous materials exposure victims in the emergency department. *Ann Emerg Med* 1994;23:761-70.
- 68- Levitin HW, Siegelson HJ. Hazardous materials: disaster medical planning and response. *Emerg Med Clin North Am* 1996;14:327-48.
- 69- Macintyre AG, Christopher GW, Eitzen E, Gum R, Weir S, DeAtley C, et al. Weapons of mass destruction events with contaminated casualties: effective planning for health care facilities. *JAMA* 2000;283:242-9.
- 70- Sullivan F, Wang R, Jenouri I. Principles and protocols for prevention, evaluation, and management of exposure to hazardous materials. *Emerg Med Rep* 1998;19:21-32.
- 71- Lawson JR, Jarboe TL. NIST Special Publication 981: Aid for decontamination of fire and rescue service protective clothing and equipment after chemical, biological and radiological exposures. Gaithersburg (MD): National Institute of Standards and Technology (NIST); 2002.
- 72- Occupational Safety and Health Administration (OSHA). OSHA best practices for hospital-based first receivers of victims from mass casualty incidents involving the release of hazardous substances. Washington, D.C.: OSHA; 2005.
- 73- Goldman M, Dacre JC. Lewisite: its chemistry, toxicology, and biological effects. *Rev Environ Contam Toxicol* 1989;110:75-115.
- 74- Munro NB, Talmage SS, Griffin GD, Waters LC, Watson AP, King JF, et al. The sources, fate, and toxicity of chemical warfare agent degradation products. *Environ Health Perspect* 1999;107:933-74.
- 75- Pedersen B, Røen BT, Fullu L. Detoxification of sulphur mustard using commercially available decontaminants. En: Proceedings of the Seventh International Symposium on Protection Against Chemical and Biological Warfare Agents; 2001 June 15-19; Stockholm, Sweden; 2001. p. 44.
- 76- Lavoie FE, Coomes T, Cisek JE, Fulkerson L. Emergency department external decontamination for hazardous chemical exposure. *Vet Hum Toxicol* 1992;34:61-4.
- 77- Gordon RK, Feaster SR, Russell AJ, LeJeune KE, Maxwell DM, Lenz DE, et al. Organophosphate skin decontamination using immobilized enzymes. *Chem Biol Interact* 1999;119-120:463-70.
- 78- Cooper GJ, Ryan JM, Galbraith KA. The surgical management in war of penetrating wounds contaminated with chemical warfare agents. *J R Army Med Corps* 1994;140:113-8.
- 79- Bradley RN. All-hazards approach to decontamination. En: Burstein JL, Schwartz RB, Swienton RE, editors. *Medical response to terrorism: preparedness and clinical practice*. Philadelphia: Lippincott Williams & Wilkins; 2005. p. 293-300.
- 80- Agency for Toxic Substances and Disease Registry (ATSDR). *Managing hazardous materials incidents. Vol. I. Emergency medical services: a planning guide for the management of contaminated patients*. Atlanta (GA): U.S. Department of Health and Human Services; 2000.
- 81- Keim ME, Pesik N, Twum-Danso NAY. Lack of hospital preparedness for chemical terrorism in a major US city: 1996-2000. *Prehospital Disaster Med* 2003;18:193-9.
- 82- Tokuda Y, Kikuchi M, Takahashi O, Stein GH. Prehospital management of sarin nerve gas terrorism in urban settings: 10 years of progress after the Tokyo subway sarin attack. *Resuscitation* 2006;68:193-202.
- 83- Okumura T, Hisaoka T, Naito T, Isonuma H, Okumura S, Miura K, et al. Acute and chronic effects of sarin exposure from the Tokyo subway incident. *Environ Toxicol Pharmacol* 2005;19:447-50.
- 84- Abraham RB, Weinbroum AA. Resuscitative challenges in nerve agent poisoning. *Eur J Emerg Med* 2003;10:169-75.
- 85- Agency for Toxic Substances and Disease Registry (ATSDR). *Managing hazardous materials incidents. Vol. II. Hospital emergency departments: a planning guide for the management of contaminated patients*. Atlanta (GA): U.S. Department of Health and Human Services; 2000.
- 86- Cone DC, Davidson SJ. Hazardous materials preparedness in the emergency department. *Prehosp Emerg Care* 1997;1:85-90.
- 87- Moles TM. Emergency medical services systems and HAZMAT major incidents. *Resuscitation* 1999;42:103-16.
- 88- Rodríguez P, Serra JA. Coordinación general de las actuaciones en el hospital. *Med Clin (Barc)* 2005;124(Suppl 1):3-7.
- 89- Tan GA, Fitzgerald MCB. Chemical-biological-radiological (CBR) response: a template for hospital emergency departments. *Med J Aust* 2002; 177:196-9.
- 90- Tur-Kaspa I, Lev EI, Hendlar I, Siebner R, Shapira Y, Shemer J. Preparing hospitals for toxicological mass casualties events. *Crit Care Med* 1999; 27:1004-8.
- 91- Burgess JL. Hospital evacuations due to hazardous materials incidents. *Am J Emerg Med* 1999;17:50-2.
- 92- Burgess JL, Blackmon GM, Brodtkin A, Robertson WO. Hospital preparedness for hazardous materials incidents and treatment of contaminated patients. *West J Med* 1997;167:387-91.
- 93- Cooper D, Souther L, Hanlon D, Fischer P, Leiker R, Tsongas T, et al. Public health consequences among first responders to emergency events associated with illicit methamphetamine laboratories—selected states, 1996-1999. *MMWR Morb Mortal Wkly Rep* 2000;49:1021-4.
- 94- Cooper D, Souther L, Hanlon D, Fischer P, Leiker R, Tsongas T, et al. Public health consequences among first responders to emergency events associated with illicit methamphetamine laboratories—selected states, 1996-1999. *JAMA* 2000;284:2715-6.
- 95- Geller RJ, Singleton KL, Tarantino ML, Drenzek CL, Toomey KE. Nosocomial poisoning associated with emergency department treatment of organophosphate toxicity—Georgia, 2000. *MMWR Morb Mortal Wkly Rep* 2001;49:1156-8.
- 96- Geller RJ, Singleton KL, Tarantino ML, Drenzek CL, Toomey KE. Nosocomial poisoning associated with emergency department treatment of organophosphate toxicity—Georgia, 2000. *J Toxicol Clin Toxicol* 2001;39:109-11.
- 97- Hick JL, Hanfling D, Burstein JL, Markham J, Macintyre AG, Barbera JA. Protective equipment for health care facility decontamination personnel:

regulations, risks, and recommendations. *Ann Emerg Med* 2003;42:370-80.

98- Horton DK, Berkowitz Z, Kaye WE. Secondary contamination of ED personnel from hazardous materials events, 1995-2001. *Am J Emerg Med* 2003;21:199-204.

99- Horton DK, Burgess P, Rossiter S, Kaye WE. Secondary contamination of emergency department personnel from o-chlorobenzylidene malonitrile exposure, 2002. *Ann Emerg Med* 2005;45:655-8.

100- Kinoshita H, Hirose Y, Tanaka T, Yamazaki Y. Oral arsenic trioxide poisoning and secondary hazard from gastric content. *Ann Emerg Med* 2004;44:625-7.

101- Merrit N. Malathion overdose: when one patient creates a departmental hazard. *J Emerg Nurs* 1989;15:463-5.

102- Nocera A, Levitin HW, Hilton JMN. Dangerous bodies: a case of fatal aluminium phosphide poisoning. *Med J Aust* 2000;173:133-5.

103- Roberts D, Senarathna L. Secondary contamination in organophosphate poisoning. *Q J Med* 2004;97:697-8.

104- Stacey R, Morfey D, Payne S. Secondary contamination in organophosphate poisoning. *Q J Med* 2004;97:75-80.

105- Thanabalasingham T, Beckett MW, Murray V. Hospital response to a chemical incident: report on casualties of an ethyldichlorosilane spill. *BMJ* 1991;302:101-2.

106- Georgopoulos PG, Fedele P, Shade P, Lioy PJ, Hodgson M, Longmire A, et al. Hospital response to chemical terrorism: personal protective equipment, training, and operations planning. *Am J Ind Med* 2004;46:432-45.

107- Schultz M, Cisek J, Wabeke R. Simulated exposure of hospital emergency personnel to solvent vapors and respirable dust during decontamination of chemically exposed patients. *Ann Emerg Med* 1995;26:324-9.

108- Schier JG, Hoffman RS. Personal protective equipment. En: Burstein JL, Schwartz RB, Swienton RE, editores. *Medical response to terrorism: preparedness and clinical practice*. Philadelphia: Lippincott Williams & Wilkins; 2005. p. 284-9.

109- Baker D. The problem of secondary contamination following chemical agent release. *Critical Care* 2005;9:323-4.

110- Pita R. Al-Qa`ida and the chemical threat. *The ASA Newsletter* 2005; (108):19-23.

111- Koenig KL. Strip and shower: the duck and cover for the 21st century. *Ann Emerg Med* 2003;42:391-4.

112- Okumura T, Hisaoka T, Yamada A, Naito T, Isonuma H, Okumura S, et al. The Tokyo subway sarin attack – lessons learned. *Toxicol Appl Pharmacol* 2005;207:S471-6.

113- Hick JL, Penn P, Hanfling D, Lappe MA, O'Laughlin D, Burstein JL. Establishing and training health care facility decontamination teams. *Ann Emerg Med* 2003;42:381-90.

114- DiMaggio C, Markenson D, Loo GT, Redlener I. The willingness of U.S. Emergency Medical Technicians to respond to terrorist incidents. *Bio-secur Bioterror* 2005;3:331-7.

115- Al-Damouk M, Bleetman A. Impact of the Department of Health initiative to equip and train acute trusts to manage chemically contaminated casualties. *Emerg Med J* 2005;22:347-50.

116- Murata K, Araki S, Yokoyama K, Okumura T, Ishimatsu S, Takasu N, et al. Asymptomatic sequelae of acute sarin poisoning in the central and autonomic nervous system 6 months after the Tokyo subway attack. *J Neurol* 1997;244:601-6.

117- Nakajima T, Ohta S, Fukushima Y, Yanagisawa N. Sequelae of sarin toxicity at one and three years after exposure in Matsumoto, Japan. *J Epidemiol* 1999;9:337-43.

118- Nakajima T, Ohta S, Morita H, Midorikawa Y, Mimura S, Yanagisawa N. Epidemiological study of sarin poisoning in Matsumoto City, Japan. *J Epidemiol* 1998;8:33-41.

119- Okudera H. Clinical features on nerve gas terrorism in Matsumoto. *J Clin Neurosci* 2002;9:17-21.

120- Sekijima Y, Morita H, Yanagisawa N. Follow-up of sarin poisoning in Matsumoto. *Ann Intern Med* 1997;127:1042.

121- Yokoyama K, Araki S, Murata K, Nishikitani M, Okumura T, Ishimatsu S, et al. Chronic neurobehavioral effects of Tokyo subway sarin poisoning in relation to posttraumatic stress disorder. *Arch Environ Health* 1998; 53:249-56.

122- Yokoyama K, Araki S, Murata K, Nishikitani M, Okumura T, Ishimatsu S, et al. A preliminary study on delayed vestibulo-cerebellar effects of Tokyo subway sarin poisoning in relation to gender difference: frequency analysis of postural sway. *J Occup Environ Med* 1998;40:17-21

123- Yokoyama K, Araki S, Murata K, Nishikitani M, Okumura T, Ishimatsu S, et al. Chronic neurobehavioral and central and autonomic nervous system effects of Tokyo subway sarin poisoning. *J Physiol Paris* 1998;92:317-23.