Bridging the chemical and medical gaps for mass casualty decontamination[1]

美軍化學兵與軍醫單位共同執行大量傷患除污作業之研究

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本文

The threat of chemical, biological, radiological, nuclear, and explosives (CBRNE) incidents perpetrated by rogue states or terrorist organizations presents a clear and present danger to the security of the United States and allied nations around the world. CBRNE materials are inherently hazardous, and they have the potential to produce significant injuries and a large number of casualties in a short timeframe. This operational environment can stretch standard rescue and health care providers beyond their capacity to provide effective care and treatment. A mass casualty scenario often requires the assistance of Army consequence mitigation response units to surge military personnel and supplies to the incident area. However, due to the inherent nature and complexity of these scenarios, friction points may develop. This can slow down the response, generate confusion among response assets, and reduce the overall effect of the response strategy.

流氓國家或恐怖組織利用化生放核及高爆性武器事件影響美國及世界各盟國安全甚鉅。其運用之物質本質上具危害性大且能在短時間造成相當程度人員傷亡。在此作業環境下，不利於人員搜救與醫療人員遂行有效之照顧與醫療作業。在執行大量傷患作業情況下，通常須要許多支援人力與物資，然而，對各參謀與救災單位而言，此複雜之救災場景在作業中將產生許多摩擦，致影響救援進度，且在混亂中執行救護作業，將影響整體救災成效。

To ensure the effectiveness and efficiency of CBRNE consequence management response strategies, innovative Army leaders design realistic and challenging training plans that ensure unit proficiency in CBRNE consequence management techniques and procedures. One unit engaged in such efforts is the 71st Chemical Company, 8th Military Police Brigade, 8th Theater Sustainment Command, Schofeld Barracks, Hawaii. The 71st Chemical Company forward deployed to Camp Arifjan, Kuwait, and conducted a joint mass casualty decontamination (MCD) exercise with the 581st Area Support Medical Company, 61st Multifunctional Medical Battalion, 1st Medical

1 本文取材自《Army Chemical Review 美國陸軍化學兵期刊》, Winter 2015，(Missouri：U.S. Army Chemical, Biological, Radiological, and Nuclear School, USACBRNS), PP.21-24.

Brigade, 13th Sustainment Command, Fort Hood, Texas. Chemical units often cross-train with military police and explosive ordnance disposal units to execute an all-hazards[2] approach to consequence management operations. However, medical units are not normally included in training partnerships beyond basic medical support.

為擬定化生放核及高爆性武器災後復原應變計畫，美國陸軍官員研擬出仿真且具挑戰之訓練，以磨練各單位處置技術與作業程序。參與單位為駐地於夏威夷史考菲基地、隸屬第八支援指揮部、受第 87 憲兵旅管制之化學兵第 71 連，該連現正移地至科威特實施訓練，與駐地於德州滬得基地、隸屬第 13 支援指揮部、第 1 衛生營、61 衛生營下轄之地 581 衛生連進行聯合大量傷患除污演習。化學兵單位經常與憲兵與未爆彈處理單位遂行全威脅災後復原作業，惟不常與軍醫單位共同演練。

Both companies dedicated a week to exchanging information and conducting demonstrations of tactics, techniques, and procedures for responding to an MCD event. During the first 3 days of execution, the companies conducted chemical- and medical-specific training, the 71st Chemical Company demonstrated CBRNE decontamination procedures, and the 581st Medical Company demonstrated medical triage and evaluation procedures. Teams from both companies executed tasks at their respective stations to further improve their training methods. The week-long event culminated in a situational training scenario derived from recent reports of chemical agents employed in the Middle East. The units were challenged with 75 simulated ambulatory and nonambulatory casualties who presented with a variety of medical issues and symptoms induced by exposure to a simulated, unknown, persistent, CBRNE agent during a 3-hour timeframe. The MCD exercise was executed with 145 Soldiers contributing to mission accomplishment from the joint company effort. The 71st Chemical Company leadership briefed Area Support Group– Kuwait and U.S. Army Central Command senior leaders, including Brigadier General Timothy M. McKeithen, to provide a comprehensive overview of U.S. Army Central Command MCD capabilities. The exercise was fast-paced and specifically designed to challenge the units to determine the limits of their respective and synergistic capabilities. The commander’ s intent for the training exercise was met, and the units incorporated lessons learned into a comprehensive standard operating procedure to enhance the U.S. Army Central Command theater all-hazards consequence response plan.

化學兵與軍醫部隊執行為期 1 週之觀摩與經驗交換，雙方就大量傷患消除作業進行戰術、技術與程序(TTPs)交流，前 3 天展示不同之訓練方式，化學兵第 71 連演練消除作業，581 衛生連則演練檢傷分類與評估程序，雙方於各設置地

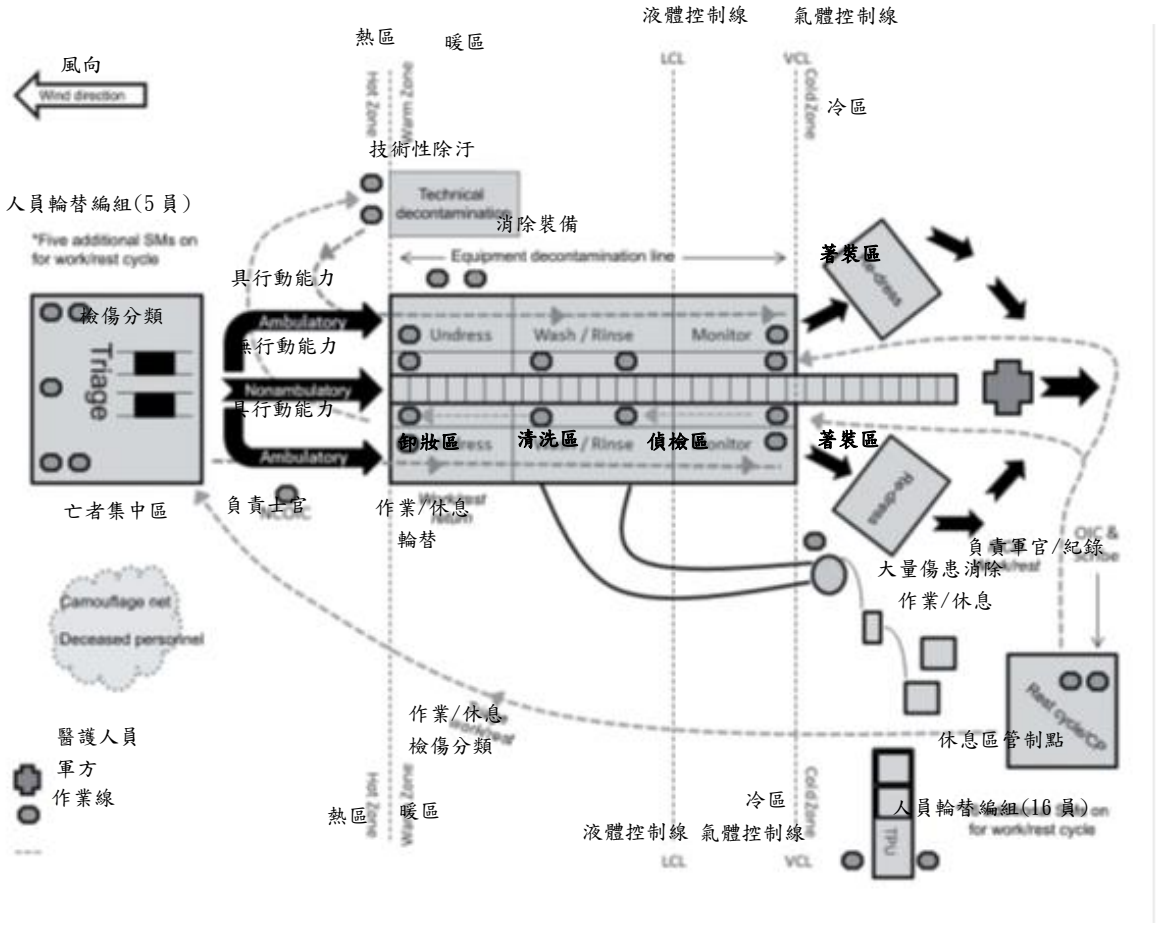
2 美陸軍 TM3-11.42 技術手冊說明各基地指揮官負責全威脅(All-Hazards)之緊急應變處置，亦包含化生放核暨高爆性武器威脅.Field Manual (FM) 3-11.42 Multi-Service Tactics, Techniques, and Procedures for Installation Emergency Managemente Operations, 23 JUN, 2014.

點示範訓練方法。演練之高潮則採近期源自中東之化學戰劑作為想定，由 145 員官兵參演演習，模擬 75 員傷患受化生放核及高爆性武器污染之情況，區分具行動能力及無行動能力之人員。化學兵第 71 連連長對科威特軍官與美軍中央指揮部高階幹部提摩太進行任務與能力簡報。本次想定設計目的，期能發現雙方作業限制與聯合作業能量，最後，演習結果符合指揮官期待，經驗獲得亦納入作業標準，可作為爾後全威脅復原應變計畫參用。

A mass casualty incident is defined as any incident that exceeds the emergency disaster response capabilities of an area. Due to the abrupt, immediate nature of a CBRNE incident, initial responders are commonly composed of local emergency responders (police, fire department officials). Effective mass casualty response is founded on the principle of triage—the system of sorting and prioritizing casualties based on the tactical situation, mission, and available resources. The goal is to provide the highest level of assistance to the greatest number of casualties within the limitations of time, distance, and capability. Contaminated casualty management is complicated; casualties must be evaluated and possibly treated and evacuated while contaminated with a deadly CBRNE agent. Decontamination must be conducted quickly to save lives. Chemical, biological, radiological, and nuclear (CBRN) units should use resources that are immediately available to facilitate a rapid response.

大量傷患事故定義為一種超出一地區能力所能處置之災害，因係屬突發性事故且遭化生放核污染，第一線應變人員應包含地方應變單位(警察、消防)。有效之大量傷患處置作業乃基於檢傷分類方式(如圖 1)，人員分類與優先處置順序則基於狀況、任務與可用資源。期能於有限之時間、距離與能力，提供高專業性之大量傷患處置。處理受污染之傷患過程複雜，傷患必須經評估後儘可能的接受治療，另對遭受化生放核污染之傷患則須實施隔離。除污作業必須快速，以搶救生命。化生放核應變單位應運用立即可獲得之資源，以達快速反應之效。

圖 1　大量傷患消除作業開設示意圖



Following triage operations, the rapid physical removal of the CBRNE agent from the victim is the most important action associated with effective decontamination. Physical removal includes wiping or blotting visible agents from the victim’s skin, disrobing the victim, using adsorbents to soak up the agent, and showering or with large quantities of water. After a CBRNE agent attack, vapor or aerosol hazards may still be present—especially if the agent was disseminated within an enclosed structure. After casualties are moved through the wash and rinse stations of the decontamination line, they are monitored with detection equipment, which varies based on the type of CBRNE agent present. This ensures thorough decontamination by reducing contamination to levels as low as reasonably achievable. The casualties then proceed to medical personnel for thorough diagnosis and treatment of medical issues and injuries.

為利除污作業遂行，人員檢傷分類後，須儘速清除傷患污染之化生放核物質。清除方式包含擦拭與吸附人員皮膚上之感染，並脫去人員衣服以吸附物浸泡污染之物質，另以大量清水進行淋浴與沖洗(如圖 2)。化生放核攻擊後蒸氣與浮質污染仍存在，尤其在一密閉之建築物，污染人員在通過清洗與擦拭區等消

除站後，應依各類型之污染運用偵檢器進行複偵，亦須由細部消除作業將污染程度降至最低，隨後傷患經醫護人員實施診斷與治療。

圖 2　化學兵第 71 連開設除污站情形

A successful mass casualty response heavily depends on many factors, including—

- The size of the incident in terms of the physical area and the number of casualties.
- The level of care provided by the first responders.
- The type of CBRNE agent employed.
- The proximity of the response assets to the incident area.
- The number of personnel available for the response.

Unit leaders specifically designed the training event to determine which of these operational factors were integral to the successful execution of a consequence management response strategy. In addition, they investigated whether the time required to move a response unit into position, set up, and become fully capable of executing a specific mission.

制定周延的應變作為應考量許多因素，包含以下各點：

1.污染區域與傷患污染範圍

2.第一線應變人員可獲得支援之程度

3.化生放核污染種類

4.各應變單位至事故現場之距離

5.可用人力之多寡

各單位指揮官設計想定時，決定上述任一因素都將對災後復原執行產生影響，同時，各級指揮官亦須考量應變單位進入事故現場、開設作業點與執行各項任務之時間。

Several important discoveries were made through this joint training exercise. It was determined that the time needed to execute a CBRNE mass casualty response may be too great to be effective against most CBRNE agents. When the lethality rate of certain chemical warfare agents (G and V series nerve agents, chlorine gas) is taken into account, the life-saving benefit from an MCD response may be extremely low. Due to significant time and logistics requirements for moving response assets into position, setting up decontamination and medical stations, and achieving a ready status to begin treating casualties, many of the casualties requiring decontamination may be deceased. The MCD capability may be more useful when agents with a slower mechanism of action (persistent blister agents) are employed. To achieve the desired level of theater response capability, senior leaders must assess the likelihood of a particular event and position CBRNE assets accordingly.

本演習發現許多重點，瞭解針對遭受化生放核及高爆武器污染之傷患處置，須大量作業時間方能遂行除污作業，若將致死率高之化學戰劑(G 系、V 系與氯氣)納入想定設計，雖經大量傷患除污作業後，仍降低受上述污染之人員存活率。由於應變人員機動、消除站及救護站之開設等所需時間長與後勤支援龐大，部分傷患人員亦遭受致命污染，故採用反應較慢之毒劑(持久型糜爛性戰劑)，以提升應變能力，高階幹部須評估各種災害產生之可能性與事故場址。

The results of this exercise called the effects of the CBRNE MCD response into question in terms of execution time. The perception of, and expectation for, an MCD operation involves a large number of ambulatory casualties with low to moderate degrees of injury, and many MCD training exercises are developed for this scenario. For non-ambulatory casualties, a litter must be processed through the decontamination line. This requires more time, personnel, and space. The decontamination of non-ambulatory casualties is labor-intensive, and it requires significant numbers of augmentation personnel and additional equipment. Non-ambulatory casualty decontamination slows the process of casualty evaluation and treatment, and it is physically demanding for response personnel. These factors must be taken into account when determining the number of Soldiers assigned to support an MCD operation.

演習結果對大量傷患除污作業所需時間產生不確定性，重點在於演習想定設計假設大量輕、中度受傷人員遭受污染，對無行動能力之傷者而言，僅少數人必須通過各消除站，對時間花費、人力與空間影響甚鉅，受污染且無行動能力之人員消除作業對耗損人力大且須要採用額外裝備，並加長傷患人員醫療評估與治療時間，對作業人員將是一大考驗，故須將此因素納入考量，以作為兵力派遣之參考。

對受污染之傷患張貼個人受污染資訊小卡

Asymmetric warfare may further complicate the mass casualty event if combatant, noncombatant, or third-world country nationals are included among the injured. A CBRNE incident demands a rapid transition from routine to contingency operations, triggered by the earliest recognition of this threat within a unit area of responsibility. This transition can be made more efficiently and effectively by a thoroughly developed MCD response plan that is routinely rehearsed, assessed, and validated.

平、戰時或涉及第三世界國家之不對稱作戰將使大量傷患除污作業更加複雜，於責任區導發之化生放核及高爆性武器事故須快速由平時轉換至應急作業階段，有鑑於此，有效率的發展完備之應變計畫則仰賴平時之演練、評估與驗證。

Decontamination by removing clothing and/or showering or flushing with water is the most expedient and practical method for MCD. Showering is recommended when liquid transfer from clothing to skin is suspected. Disrobing should occur before showering for CBRNE agents; however, the decision to disrobe should be made by the incident commander based on the situation. When large numbers of potential casualties are involved and queued for decontamination or when a limited volume of water is available, it may be necessary to significantly reduce shower times. Water alone is an excellent means of decontamination; showering or with water physically removes the CBRNE agent from skin by dilution. By adding soap, a marginal improvement can be achieved by ionic degradation of the chemical agent. Soap aids in dissolving oily substances such as mustard or other blister agents. The most important reason for decontaminating exposed victims is to remove the agent from the victim’s skin and clothing, reducing further possible agent exposure and further effects among victims. Protecting emergency responders and medical personnel from secondary transfer exposures is also a concern.

脫卸衣物、淋浴與沖洗程序為大量傷患除污作業最有效與實際之方式，淋浴為去除由衣物移轉至皮膚所殘留之污染最有效之方式，故於淋浴作業前須進行衣物脫卸，然而，衣物脫卸時機必須由現場指揮官依據事故現場狀況決定。若大量受染人員等待除污或水源不足狀況下，淋浴時間須受限制。倘若在獨立水源情況下則有利遂行消除作業，淋浴或以水沖洗可去除化生放核及高爆性武器之污染，肥皂則可溶解糜爛性與芥氣毒劑之污染。除污的重要原則乃去除人員皮膚與衣物之沾染毒劑，以減少可能之曝露與對人員產生之影響，此外，緊急應變與醫療人員再次感染可能性亦須考量。

Commanders at all levels should consider the lessons learned from joint training exercises when determining which CBRNE incidents would benefit from an MCD response. It is critical for leaders to understand the limits of the MCD capability so that CBRN units can be used most effectively. The partnership between medical and CBRN assets is critical for effectively and efficiently treating large numbers of CBRNE incident casualties. Opportunities that exercise interoperability between these skill sets serve not only to greatly enhance the Chemical and Medical Corps,but also the Army’s posture to successfully engage in an all-hazards consequence management operational environment.

指揮官應利用各層級聯合演習之教訓與經驗，獲致更有效之大量傷患消除作業成效，並瞭解大量傷患消除作業能力與限制。受化生放核及高爆性污染之人員消除作業須仰賴醫療作業單位與化生放核應變單位。醫療作業與化生放核應變單位可透過演習，提升大量傷患消除作業效能與雙方互通能力，亦可提升部隊全威脅災後復原作業整備能力。