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UK's initial operational response and specialist operational response to CBRN and HazMat incidents: a primer on decontamination protocols for healthcare professionals

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ABSTRACT

The UK is currently in the process of implementing a modified response to chemical, biological, radiological and nuclear and hazardous material incidents that combines an initial operational response with a revision of the existing specialist operational response for ambulant casualties. The process is based on scientific evidence and focuses on the needs of casualties rather than the availability of specialist resources such as personal protective equipment, detection and monitoring instruments and bespoke showering (mass casualty decontamination) facilities. Two main features of the revised process are: (1) the introduction of an emergency disrobe and dry decontamination step prior to the arrival of specialist resources and (2) a revised protocol for mass casualty (wet) decontamination that has the potential to double the throughput of casualties and improve the removal of contaminants from the skin surface. Optimised methods for performing dry and wet decontamination are presented that may be of relevance to hospitals, as well as first responders at the scene of a chemical incident.

INTRODUCTION

The deliberate use of toxic materials represents a serious threat to society. In particular, chemical warfare agents are indiscriminate weapons that can have a devastating impact when used on unprotected civilian populations, as recently evidenced in Syria.[1] Any complacency based on the notion that chemical warfare agents are limited to politically unstable regions was recently dispelled by the use of a 'novichok' nerve agent in the UK.[2,3] The current threat level for international terrorism in the UK is classed as 'severe'.[4]

The UK approach for preparing and responding to the threat of terrorism has been developed over the last 15 years as part of the UK Government's 'CONTEST' strategy.[5] One outcome of this strategy was the development of the 'Model Response', which sets out the operational parameters for responding to the deliberate release of chemical, biological or radiological materials.[6] Along with a corresponding investment in equipment and training, the Model Response has provided the UK's emergency services with a range of bespoke resources and procedures for effectively dealing with chemical, biological, radiological and nuclear (CBRN) and hazardous material (HazMat) incidents.

The Model Response was based on delivering specialist assets directly to the scene of an incident. This includes the deployment of trained responders with appropriate protection and detection capability, medical countermeasures and bespoke disrobe and decontamination facilities. Clearly, such an approach is dependent on the timely arrival of assets on-scene. For incidents involving the release of biological or radiological materials, a short delay in the deployment of specialist resources may not have significant health consequences for exposed individuals. However, this may not be the case for chemical agents, particularly those with a rapid onset of action, such as hydrogen cyanide or nerve agents.[7]

A series of research projects were commissioned from 2008 to evaluate various aspects of the Model Response.[8,9] These primarily focused on issues relating to the rapidity of the response and optimisation of the existing mass casualty disrobe and decontamination process. The initial research trials were performed as part of a programme of work known as Optimisation through Research of CHemical Incident Decontamination Systems ('ORCHIDS'). The outcome of the ORCHIDS projects led to a number of recommendations on how the Model Response could be optimised to improve casualty management and has led to the implementation of a revised process that entails an initial and specialist (or strategic) operational response (IOR and SOR, respectively; figure 1).[10] Subsequent work has confirmed the effectiveness of this approach and has extended the scope of evidence to include hair decontamination.[11] A detailed description of the IOR and SOR processes would be outside the scope of this review, which will focus on aspects of disrobe and decontamination.

EVIDENCE BASE

The IOR and SOR build on scientific evidence derived from a series of in vitro, in vivo and human volunteer studies (figure 2). Initial (in vitro) skin absorption studies focused on the effects of individual decontamination parameters, such as the duration of decontamination and the protective effects of normal (civilian) clothing against chemical warfare agents, toxic industrial chemicals and simulants. The outputs of the in vitro studies included a putatively optimised mass casualty decontamination (MCD) protocol and information

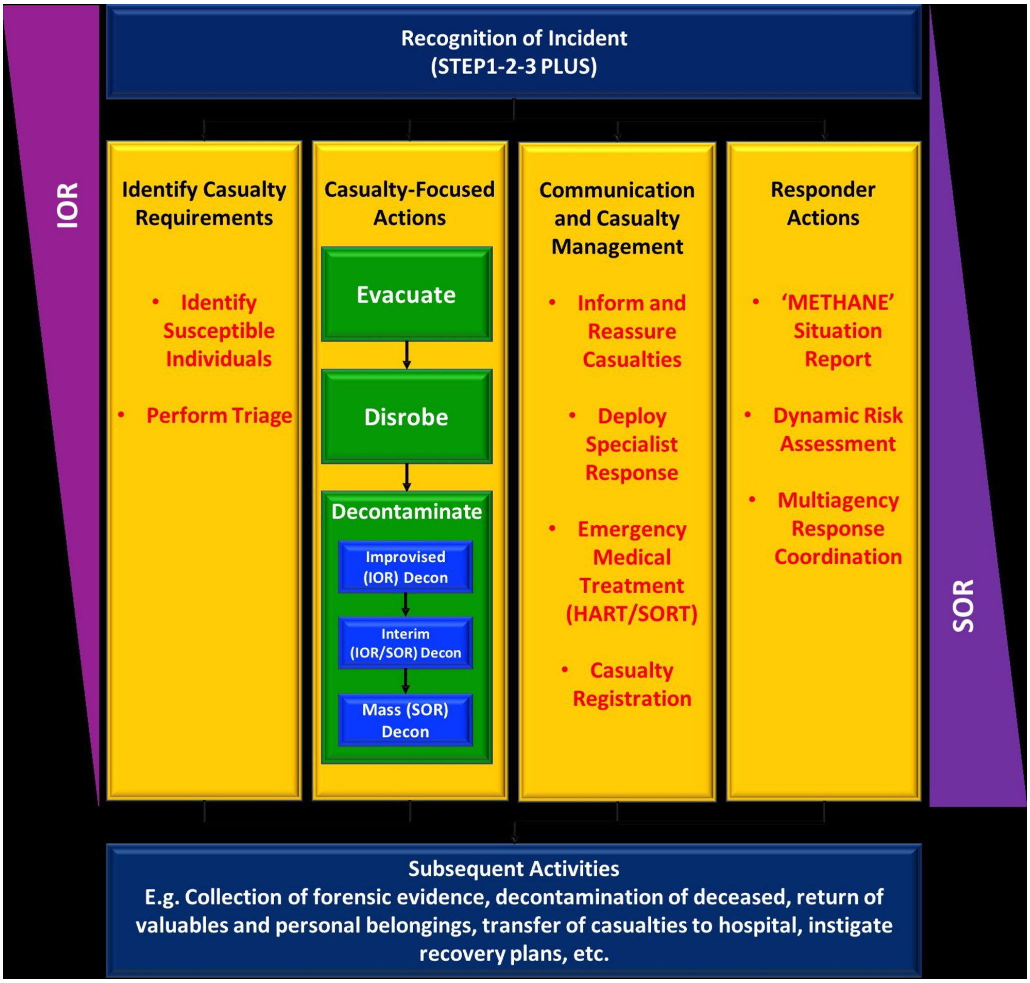

Figure 1 Summary of operational response to chemical or HazMat incidents indicating the tapering elements of the initial operational response (IOR) and specialist operational response (SOR) and main associated tasks. Note that the list of tasks is not exhaustive and is for indication only. HazMat, hazardous material. HART = Hazardous Area Response Team. SORT = Special Operations Response Team.

on the temporal effects of disrobing and decontamination. The combined outputs of the in vitro study were subsequently confirmed in a series of in vivo (animal) studies prior to a final series of human volunteer studies using two relatively non-toxic simulants: fluorescent particles to model a biological or radiological agent[12] and methylsalicylate, previously used as a simulant for chemical warfare agents.[13 14] Collectively, these studies resulted in a number of evidence-based recommendations, including: (1) the need to introduce an 'emergency disrobe and decontamination' stage prior to the arrival of bespoke MCD units and (2) the optimisation of MCD through adoption of the 'ORCHIDS Protocol', namely a shower duration of 90 s with water at a temperature of 35°C and a washing aid such as a face cloth.[7] Overall, the ORCHIDS projects indicated that, while the effectiveness of MCD can be substantially improved by relatively simple and cheap interventions, there is a need to improve the rapidity of the response to make it more patient oriented and to maximise the use of time during the earliest phases of an incident, hence the introduction of the IOR. This approach has since been adopted in the UK[15] and within US Federal Guidance.[16]

The introduction of an early 'emergency disrobe and decontamination' stage requires the use of dry, absorbent materials for decontamination that may be more readily available at the scene of an incident than warm, soapy water. Moreover, there is a growing recognition that dry decontamination may offer other advantages over aqueous (shower based) decontamination. For example, dry decontamination does not lead to the generation of large volumes of contaminated waste, does not cause transfer and spreading of contaminants through clothing and is not associated with the 'wash-in' or 'rinse-in' effect, where the dermal absorption of certain chemicals may be transiently increased by washing with water.[17–20]

Recent work has demonstrated that a variety of absorbent materials (particularly those that are readily available in a clinical environment (such as an ambulance or hospital) could be used for emergency decontamination.[21 22] Such materials include absorbent tissue paper, incontinence pads and absorbent wound dressings, as well as domestic products such as cotton wool, kitchen paper, nappies (diapers) and toilet paper. Above all, the ad hoc nature of disrobe and dry decontamination means that the process can be instigated within seconds or minutes of exposure. This is a critical feature, since the effectiveness of disrobe and decontamination decreases exponentially with time.[7 23] It should be noted that the emergency disrobe and dry decontamination element of the IOR is specific to non-corrosive, liquid contaminants. The efficacy of dry decontamination is substantially reduced if the contaminant is a solid, such as a powder.[21] Moreover, the cooling effects of water may be more appropriate for treating skin contamination with corrosive chemicals, although dry decontamination may

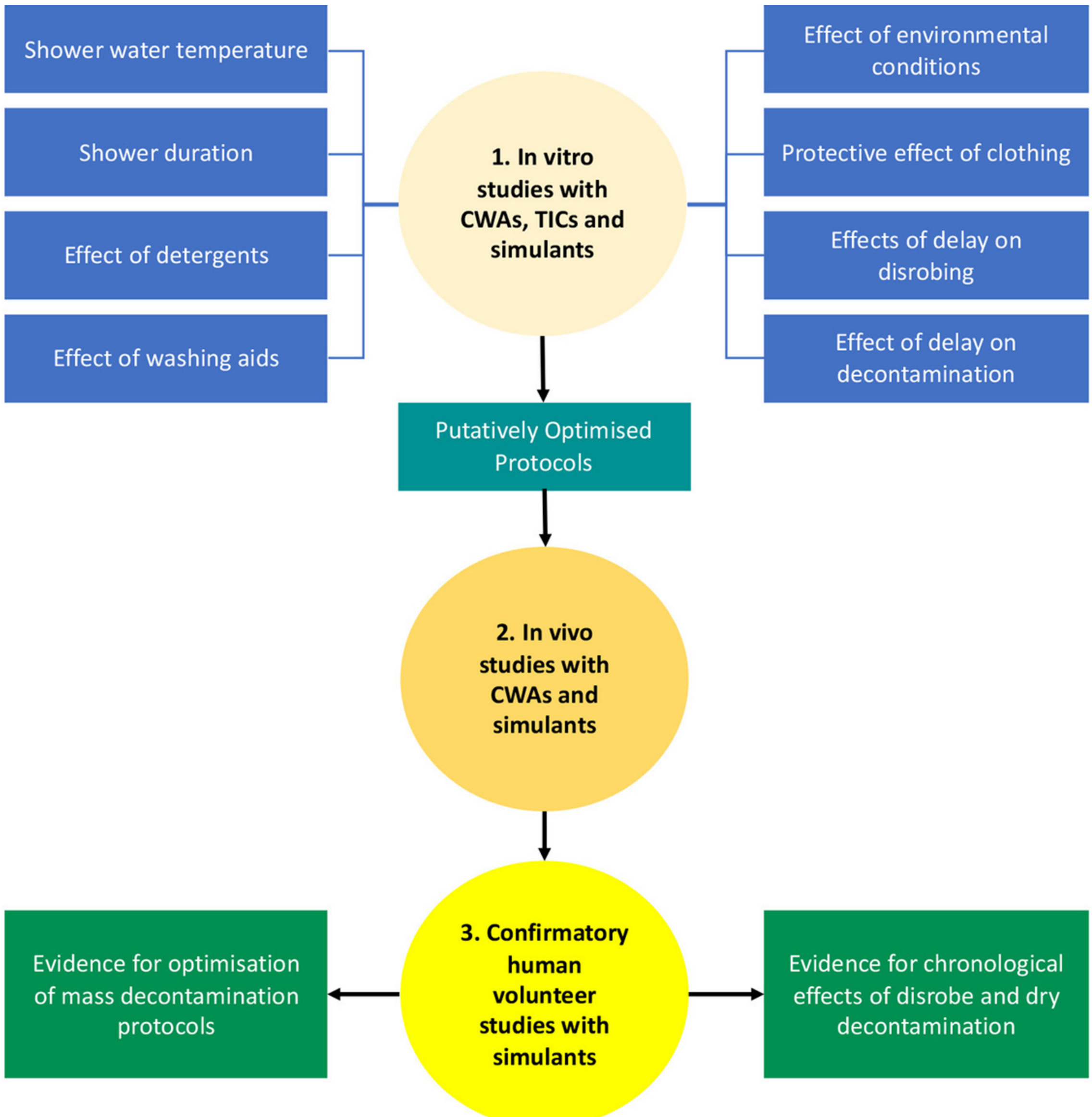

Figure 2 Outline of ORCHIDS projects illustrating a three-tier approach based on in vitro, in vivo and human volunteer studies. Simulants were fluorescent particles and methylsalicylate. CWAs, chemical warfare agents; ORCHIDS, Optimisation through Research of CHemical Incident Decontamination Systems; TICs, toxic industrial chemicals.

be of clinical benefit in reducing exposure until a source of water becomes available.

COMPARISON OF IOR/SOR AND MODEL RESPONSE

The main feature of the new response process is the introduction of an 'emergency disrobe and decontamination' stage at the earliest possible opportunity (figure 3). This new step allows the instigation of these potentially life-saving processes to be performed as soon as readily practicable rather than after the arrival of specialist resources. A second major improvement is the utilisation of the 'ORCHIDS' showering protocol, which may halve the time taken to process casualties through mass decontamination units (MDUs).

The addition of an emergency disrobe and decontamination step necessitates a joint dynamic hazard assessment (JDHA) to ensure the safety of emergency responders when issuing verbal instructions at the scene of the incident.[10] The JDHA is performed by senior members of the emergency services prior to implementing the emergency disrobe and decontamination process. The IOR includes an emphasis on the importance of effective communication for the success of emergency disrobe and decontamination. Responders should seek to foster public trust and confidence by communicating what they know about the incident, why and how casualties need to be disrobed and decontaminated, providing demonstrations of disrobe and decontamination when practical and encouraging mutual assistance. These communication strategies are likely to improve the efficiency and experience of undergoing disrobe and decontamination for affected casualties.[24]

GUIDANCE ASSUMPTIONS AND LIMITATIONS

The following guidance makes the assumption that established procedures for identifying and responding to a chemical incident have been implemented. For example, the 'STEP 1-2-3 PLUS' protocol for determining the appropriate response and the 'METHANE' situation report for communicating

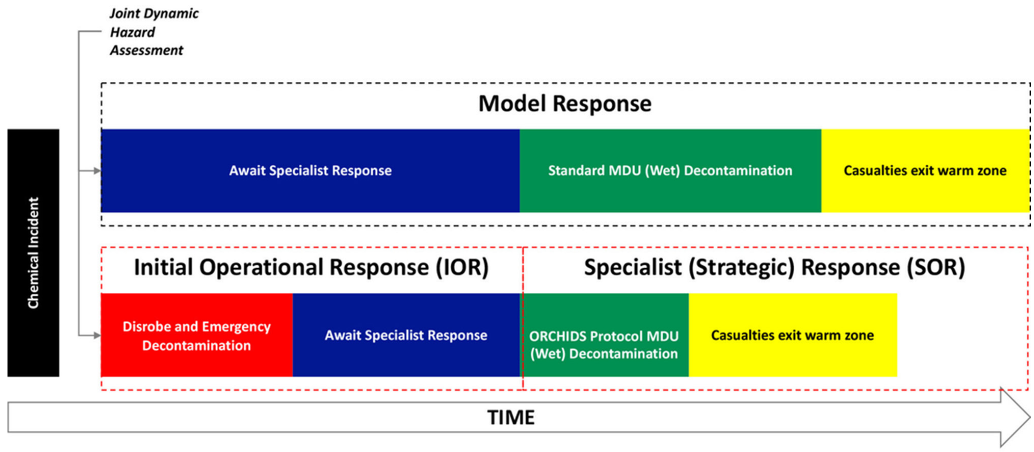

Figure 3 Salient features of the original Model Response in comparison with the new initial operational response (IOR) and specialist operational response (SOR). The IOR, which is essentially a form of first aid, leads into the SOR, where additional resources are made available, such as mass decontamination units (MDU). ORCHIDS, Optimisation through Research of CHemical Incident Decontamination Systems.

information back to control centres.[10] It is imperative that emergency responders maintain an awareness of the situation and do not put their own safety at risk. It is also important to note that the following protocols relate to casualties who are able to understand and perform instructions: guidelines for non-ambulant casualties are currently under development. The IOR guidance reported here is specifically for dealing with non-corrosive, liquid chemical contamination and not powders or biological/radiological contamination.

THE IOR DISROBE AND DRY DECONTAMINATION PROTOCOL

The mnemonic 'EMERGENCY' may provide an *aide-mémoire* for the disrobe and dry decontamination protocol (table 1).

The salient features of the disrobe and dry decontamination process are available in video format produced by the National Ambulance Resilience Unit and NHS England.[25] A pictogram demonstrating the dry decontamination process is presented in figure 4. The dry decontamination stage can be repeated (subject to availability of absorbent material) until MDUs become available. This will help to engage and focus casualties and will further improve decontamination effectiveness.

THE SOR DISROBE AND WET DECONTAMINATION ('ORCHIDS') PROTOCOL

The 'ORCHIDS protocol' is designed for use in MDUs that may be deployed by the fire and rescue service at the scene of an incident or available at designated NHS hospital EDs. Such units generally comprise a three-chamber tent (disrobe, shower and rerobe areas), a boiler pump (to deliver warm shower water), sump pumps (to remove waste water from within the MDU) and may also include warm air blowers (for heating), bund tanks (to collect waste effluent) and the provision of 're-robe' packs.[7 26] It is important to note that MDUs do not normally incorporate air handling units and so adequate steps to maintain good ventilation should be taken to prevent the accumulation of gas, vapours and aerosols during and after use by casualties. It is essential that MDUs and designated operators are regularly exercised to maintain a state of readiness. The ORCHIDS protocol is twice as fast as the previous (Model Response) method but at least as effective.[27]

In the case of exposure to non-caustic liquid contaminants, casualties should undergo disrobe and dry decontamination before proceeding to wet decontamination. This will reduce or eliminate the risk associated with the wash-in effect, where the dermal absorption of certain chemicals may be significantly enhanced by the presence of water, particularly organophosphorus compounds[28] and sulfur mustard.[29]

Following disrobing (if casualties are still clothed), the ORCHIDS showering protocol follows the 'WASHED' mnemonic (table 2).

Table 1: The EMERGENCY mnemonic for key elements of the Initial Operational Response,

E	**Evacuate**: casualties should be instructed to leave the contaminated area if they have not already done so.
M	**Move** the casualties as a group to a safe distance, away from any potential source of contaminant. Ideally, this should be uphill and upwind and preferably in a sheltered (external) area away from strong winds and rain.
E	**Engage** with casualties to explain what is happening and how they can help themselves by following your instructions and advice. Some casualties may not wish to cooperate for cultural, religious or other reasons: focus initial attention on compliant individuals.
R	**Remove** as much clothing as possible. It is important to communicate the benefits of rapid disrobe to the casualties in order to gain their cooperation. The more clothes that are removed the better, but be mindful of modesty concerns. Where possible, do not remove clothing over the head. If available, trauma scissors can be used to cut away clothing.
G	**Give** any available absorbent material to the casualties. Ideal materials include 'blue roll' (absorbent paper tissue), wound dressings, incontinence pads, cotton wool, toilet paper and paper towels. Do not get close to casualties when handing out the decontamination material.
E	**Establish** dry decontamination. Using a blot and rub motion, start with the face, then the hands, then any other exposed skin areas and finally the hair. If availability of material permits, ask casualties to use clean swatches of absorbent material for each body area. Above all, ensure that casualties do not reuse material after decontaminating their hair. Encourage casualties to repeat the entire process several times, paying particular attention to the hair, face and hands.
N	**Note** the development of any signs and symptoms. Begin triage to identify priority casualties.
C	**Communicate** constantly with casualties to encourage cooperation and reassurance that disrobe and decontamination will remove the vast proportion of any contamination. Confirm to the casualties that advanced medical assistance is on its way.
Y	**Yards not inches**: maintain a safe distance from casualties at all times, but close enough so that they can hear instructions.

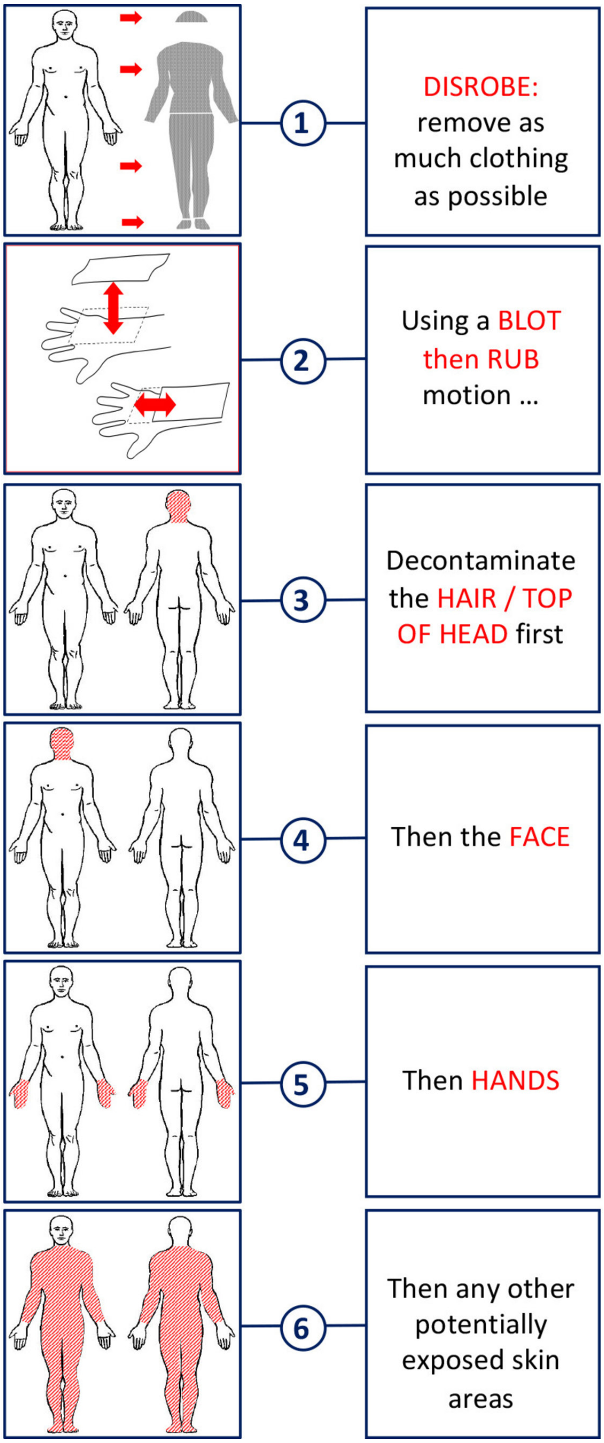

Figure 4 Pictogram demonstrating the blot and rub method for performing dry decontamination on casualties with scalp hair. Following disrobe, use a 'blot then rub' technique to apply the decontamination material. Clean the face first to remove contamination from around the eyes, nose and mouth. The hands should be cleaned next, followed by any other skin areas that may not have been initially protected by clothing. Head hair should be contaminated last, as hair provides a high degree of protection against chemical contaminants. Repeat steps 3–6 as necessary. Use clean decontamination material for each step (if available in sufficient quantity). Used decontamination material should be placed by the casualties into a suitable waste receptacle (eg, clinical waste bag and bin liner) immediately after use. Casualties with no appreciable head hair should be instructed to decontaminate the scalp skin immediately after the face, using clean decontamination material.

Table 2: the WASHED mnemonic for the ORCHIDS mass casualty (wet) decontamination protocol.

W	**Warm water**: the shower water temperature should be at least 35°C (but lower than 40°C) to ensure optimal removal of contaminants.
A	**Aid**: the removal of a chemical contaminant (particularly powders) can be increased by 20% by the use of a washing aid such as a cotton face cloth or sponge during showering. Washing aids should be safely disposed of after single use. Do not reuse washing aids.
S	**Soap**: the use of detergent at a concentration of 0.1%–0.5% (v/v) has been shown to assist decontamination of lipophilic (oily) substances. Most UK mass decontamination units (MDUs) have the capacity to add liquid detergent to the shower water via a metered dosing system.
H	**Head to toe:** casualties should be instructed to start by washing their head and to work their way down to their feet. Casualties should tilt their head backwards when washing their hair to avoid spreading contamination to the face.
E	**Expedited**: in order to avoid the 'wash-in' effect (which may enhance the dermal absorption of certain chemicals), the shower needs to be performed within 90 s. Ideally, 1 min with soapy water and the remaining half minute using water only (rinse). The 90 s timing reflects the optimal shower duration. Longer durations should be avoided.
D	**Drying** with a towel is the critical step for removing many chemical contaminants! Following use, towels must be considered to be heavily contaminated and should be disposed of according to local regulations.

A final consideration is the finite capacity for rerobing within MDUs. Use of the shorter ORCHIDS protocol may cause a 'bottleneck',[30] so plans should be in place to provide additional areas for casualties to rerobe.

DRY OR WET DECONTAMINATION?

To reiterate, dry decontamination of liquid chemicals is at least as effective and is generally safer than wet decontamination. Therefore, dry decontamination should be the default incident response option. However, there are certain circumstances where wet decontamination may be preferable. A decision flowchart (eg, figure 5) can be used to determine the most appropriate course of action. It can be readily ascertained from the flow chart that any non-corrosive liquid contaminant (such as sulfur mustard, all nerve agents or solutions containing pesticides or cyanides and so on) should be treated by dry decontamination. The use of any form of wet decontamination (including the standard NHS 'rinse-wipe-rinse' method) for such materials is contraindicated due to the potential for enhanced dermal absorption. In contrast, solid forms of toxic, radioactive or biological contaminants should be subject to wet (SOR) decontamination. The only scenario that does not follow this simple binary decision process is exposure to corrosive liquids (eg, strong acids or oxidising agents), where disrobe and immediate flushing of affected areas with any available source of water is an urgent requirement. However, if water is not immediately available, disrobing and dry decontamination should be performed to reduce dermal exposure.

Hair contamination

While wet and dry decontamination may reduce or eliminate the risk of a secondary contact hazard, some contaminants may diffuse into the hair fibres. This could potentially limit the effectiveness of decontamination and may provide a reservoir for subsequent evaporation ('off-gassing'). In such instances, removal of contaminated hair should be considered to ensure the safety of casualties and medical staff.

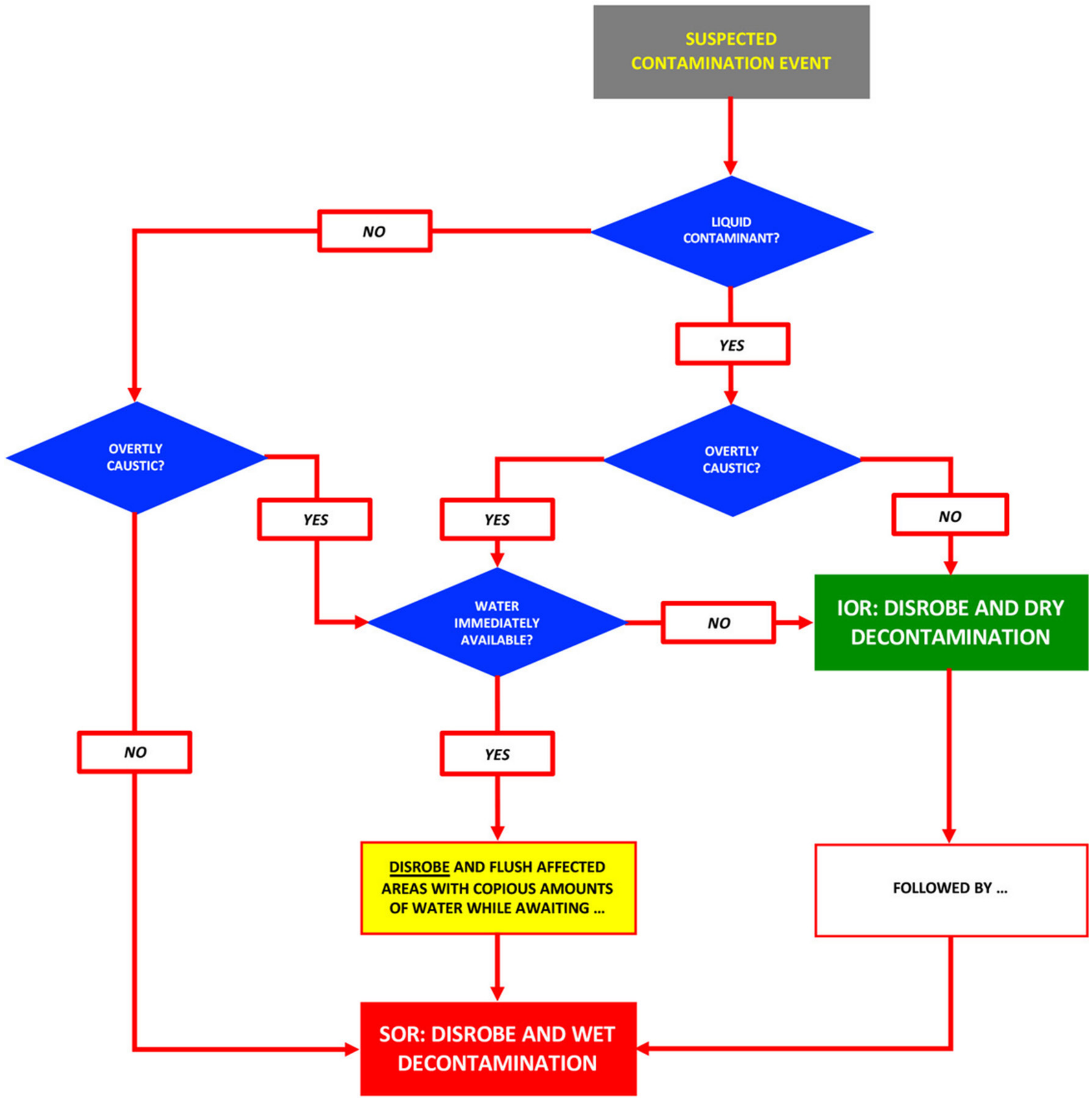

Figure 5 Basic flow chart for determining the appropriate response for managing contaminated casualties. IOR, initial operational response; SOR, specialist operational response.

Non-ambulant decontamination

The new IOR and SOR processes described above have been developed specifically for ambulant casualties, that is, individuals who can both understand instructions and perform self-decontamination with minimal assistance. Work is currently in progress to develop optimised methods for dry and wet decontamination of non-ambulant casualties.[31]

SUMMARY

The UK is in the process of implementing a modified response to CBRN and HazMat incidents that introduces an IOR to complement the SOR. The IOR provides a capability for the rapid disrobe and dry decontamination of chemically contaminated casualties and thus provides an early, practical and effective clinical intervention while the arrival of specialist resources is awaited. For all incidents involving exposure to non-corrosive liquid contaminants, dry decontamination is the default response protocol.

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REFERENCES

1 Note by the Technical Secretariat. Organisation for the Prohibition of Chemical Weapons. Report of the opcw fact-finding mission in syria regarding alleged incidents in ltamenah, the Syrian Arab Republic 24 and 25 March 2017. 2018;1636.
2 The Technical Secretariat, Organisation for the Prohibition of Chemical Weapons. #Summary of the #report on activities carried out in support of a request for technical assistance by the #UK [#Salisbury Incident] (OPCW, Apr. 12 '18). 2018;1612.
3 Vale JA, Marrs TC, Maynard RL. Novichok: a murderous nerve agent attack in the UK. *Clin Toxicol* 2018:1–5.
4 Threat Levels. Security service MI5. https://www.mi5.gov.uk/threat-levels (Accessed 18 Jun 2018).
5 HM Government. *CONTEST: The United Kingdom's Strategy for Countering Terrorism. Version 3*. London: Her Majesty's Stationery Office, 2011. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/97994/contest-summary.pdf. (Accessed 28 Nov 2017).
6 *The United Kingdom's Strategy for Countering Chemical, Biological, Radiological and Nuclear (CBRN) Terrorism*. London: Her Majesty's Stationery Office, 2010. http://webarchive.nationalarchives.gov.uk/20100418065544/http:/security.homeoffice.gov.uk/news-publications/publication-search/cbrn-guidance/strat-countering-use-of-CBRN. (accessed 28 Nov 2017).
7 Chilcott RP. Initial management of mass casualty incidents. In: Arora R, Arora P, eds. *Disaster management: medical preparedness, response and homeland security*. Oxford: CABI Press, 2013:311–24.
8 Chilcott RP. An overview of the Health Protection Agency's research and development programme on decontamination. *Chemical Hazards and Poisons Report* 2009;15:26–8.
9 Amlôt R, Edkins V, Jones DR, *et al*. The ORCHIDS project: evaluation, optimisation, trialling and modelling of procedures for mass casualty decontamination. *Applied Science and Analysis Newsletter* 2010;10-4:16–17.
10 Initial operational response to a cbrn incident. http://www.jesip.org.uk/uploads/media/pdf/CBRN JOPs/IOR_Guidance_V2_July_2015.pdf (Accessed 28 Nov 2017).
11 Chilcott RP, Larner J, Durrant A, *et al*. Evaluation of US Federal Guidelines (Primary Response Incident Scene Management [PRISM]) for Mass Decontamination of Casualties During the Initial Operational Response to a Chemical Incident. *Ann Emerg Med* 2018.
12 Amlot R, Larner J, Matar H, *et al*. Comparative analysis of showering protocols for mass-casualty decontamination. *Prehosp Disaster Med* 2010;25:435–9.
13 Feldman RJ. Chemical agent simulant release from clothing following vapor exposure. *Acad Emerg Med* 2010;17:221–4.
14 Seitzinger AT, Grasso PS, White WE, *et al*. Use of methyl salicylates as a trialing chemical agent simulant. Chemical Research, Development and Engineering Centre Technical Report Number CRDEC-TR-178. *Aberdeen Proving Ground* 1990.
15 Butler D. UK rolls out terror-attack plan. *Nature* 2014;506:139–40.
16 Chilcott RP, Amlôt R. Primary Response Incident Scene Management (PRISM) guidance for chemical incidents. 2015 https://www.medicalcountermeasures.gov/barda/cbrn/prism/ (Accessed 28 Nov 2017).
17 Filon FL, Boeniger M, Maina G, *et al*. Skin absorption of inorganic lead (PbO) and the effect of skin cleansers. *J Occup Environ Med* 2006;48:692–9.
18 Misik J, Pavlikova R, Josse D, *et al*. ***In vitro*** skin permeation and decontamination of the organophosphorus pesticide paraoxon under various physical conditions – evidence for a wash-in effect. *Toxicol Mech Methods* 2012;22:520–5.
19 Moody RP, Maibach HI. Skin decontamination: Importance of the wash-in effect. *Food Chem Toxicol* 2006;44:1783–8.
20 Moody RP, Nadeau B. In vitro dermal absorption of two commercial formulations of 2,4-dichlorophenoxyacetic acid dimethylamine (2,4-D amine) in rat, guinea pig and human skin. *Toxicol In Vitro* 1997;11:251–62.
21 Kassouf N, Syed S, Larner J, *et al*. Evaluation of absorbent materials for use as ad hoc dry decontaminants during mass casualty incidents as part of the UK's Initial Operational Response (IOR). *PLoS One* 2017;12:e0170966.
22 Amlôt R, Carter H, Riddle L, *et al*. Volunteer trials of a novel improvised dry decontamination protocol for use during mass casualty incidents as part of the UK'S Initial Operational Response (IOR). *PLoS One* 2017;12:e0179309.
23 Chilcott RP. Managing mass casualties and decontamination. *Environ Int* 2014;72:37–45.
24 Carter H, Drury J, Amlôt R, *et al*. Effective responder communication improves efficiency and psychological outcomes in a mass decontamination field experiment: implications for public behaviour in the event of a chemical incident. *PLoS One* 2014;9:e89846.
25 NARUaN. Initial Response to a HazMat/CBRN Incident. 2014 https://www.youtube.com/watch?v=9o1lBXrUQUQ (Accessed 13 Feb 2018).
26 Chilcott RP, Wyke SM, Incidents C. In: Sellwood C, Wapling A, eds. *Health emergency preparedness and response*: CABI Publishing, 2016:166–80.
27 Misik J, Pavlik M, Novotny L, *et al*. In vivo decontamination of the nerve agent VX using the domestic swine model. *Clin Toxicol* 2012;50:807–11.
28 Misik J, Pavlikova R, Josse D, *et al*. In vitro skin permeation and decontamination of the organophosphorus pesticide paraoxon under various physical conditions--evidence for a wash-in effect. *Toxicol Mech Methods* 2012;22:520–5.
29 Chilcott RP. Dermal aspects of chemical warfare agents. In: Marrs TC, Maynard RL, Sidell FR, eds. *Chemical Warfare agents: toxicology and treatment*. 2 edn. Chichester: John Wiley and Sons, 2007:409–22.
30 Egan JR, Amlôt R. Modelling mass casualty decontamination systems informed by field exercise data. *Int J Environ Res Public Health* 2012;9:3685–710.
31 Chilcott RP, Mitchell H, Matar H. Optimization of nonambulant mass casualty decontamination protocols as part of an initial or specialist operational response to chemical incidents. *Prehosp Emerg Care* 2018:1–12.