The Constant Gardener

Professor Robert Chilcott, Principal Toxicologist, and Dr Richard Amlôt, Scientific Program Leader, at the UK's Health Protection Agency (HPA), tells Gwyn Winfield about their Orchids

There are some fields where you feel that no matter how much you learned there would still be a lot left to go – detection, identification and modelling, for example – while others start with a shallow learning curve and then plateau. An example of the latter would be mass decontamination; it is exceptionally rare that you will go to an exercise and say, "Wow! I have never seen that before!" It does happen, but usually in the concept of operations – such as the Israeli decision to do mass decontamination at the hospital, or the Singaporean decontamination buses – rather than the technology; in terms of the mass decon itself, dirty queue goes in, water comes down, 'clean' queue goes out the other side: so it was, and so it will be, from time immemorial.

Hence it is surprising then to realise that it is not all classified, and that there is actually very little published scientific data available on the best way to carry out mass decontamination. Civilian decontamination has been grafted from a cutting from the military tree, and the military decon tree has always been science strong! From agent fate through to collection of run off, everything has been tested, trialled and evaluated. Yet mass decontamination is the first flowering from this military-civil graft, and as such it does not have the deep roots in the scientific community – much is extrapolated from military tactics, techniques and procedures... and, well, how difficult can having a shower be?

One of the last times Professor Chilcott collided with the editor – albeit in a glancing way – was as one of the scientific advisors on the Exercise Milo article (*CBRNe World* Autumn 2010). Milo itself was an interesting exercise, looking at the decontamination of physically disabled people - the evaluation of this DH exercise was part of the Orchids program, as Professor Chilcott explained, "Orchids is an acronym for Optimisation through Research of Chemical Incident Decon systems. The original remit of Orchids was to evaluate what we currently have and identify areas that we can improve to make the whole process more efficient. We tackled some very basic problems, as there was very little in the literature on the efficacy of water-based mass decon systems to allow us to rationally optimise mass decon procedures: we came up with a list of simple parameters that we wanted to look at. For example, how hot should the water be, how long should you be in, what detergent is best for a generic capability and is there anything that a user can do to improve showering such as using a wash cloth or loofah? The water temperature issue was interesting to work on as there were two conflicting schools of thought: one is that if the water is too hot it will open "pores" of the skin and allow more contaminant to go through; there is an element of truth to that although it doesn't actually involve opening pores per se. The other side of the coin is that if the water is too cold it won't dissolve and hence remove contaminants from the skin surface. There was nothing in the literature to say where that balance was. We did some lab studies first with a simple skin test system, where we looked at all those parameters individually. We also performed an initial human volunteer trial, where we looked at extending the duration of showering and found that it had no influence on the outcome of decon, it was just as good at three minutes as it was at six, so that made us think that we could go the opposite way and reduce time, and the obvious operational advantage is that a shorter shower can get more people through."

The lab tests, for example, showed that the optimum time for a shower is 30 seconds, a trade-off between maximum cleanliness and the minimum shower duration. The trials were inspired by the next potential procurement cycle for the UK civilian mass decontamination capability – enshrined within New Dimensions – and it had been questions such as 'So how long do they need to be in the shower?' that had prompted the research. Professor Chilcott said that it was propitious that this process coincided with a mass decontamination call from the European Commission, which meant that when they won the contract the EC would provide 70% of the funds, and the UK, through the Department of Health and other Government Departments, would fund the rest. As Government technical advisors, the HPA were asked whether they could improve the current system, starting with the fundamentals. "The HPA Emergency Response Department had already done a field exercise with children, called Young Neptune," said Professor Chilcott, "which had established what any parent could have told you - that if you put dirt on Little Johnny and put him in a shower he will come out as dirty as he went in! It was not a surprise - but there was now qualitative evidence that an improvement could be made. That became a project called ORCHIS, where we conducted a large-scale volunteer trial, including children, put them through mass decon following pictorial washing instructions, flannels and/or extended duration showering [for more information see results in the *Journal of Pre-Hospital and Disaster Medicine**]. The outcome was interesting – people think about decon and showering as a simple process; go in, water on, come out clean. But it is actually very complicated, involving a lot of steps and trying to optimise each one needs rigorous study. It may seem obvious that if you give someone a flannel they come out cleaner." Dr Richard

Orchids used a combination of classic CWA and TICs to organise new decon protocols for first responders ©HRW

Amlôt was able to shed light on this and other effects through evaluation performed during the trials, "The reason that flannelling worked was because if you put someone in a decon shower then they'll stand there and not do anything," he said, "but if you give them a flannel then they see the shower, they see the flannel and think 'I am in the shower I might as well have a wash'. So the flannel is a good 'cue to action' - it may seem obvious in retrospect, but there was previously no data to support it. On the other hand, some things that you would equally assume to be obvious were actually counter-productive. People washing longer didn't necessarily become cleaner- three minutes was sufficient to get what you are going to get off. The other thing was giving people instructions; logic dictated that if you train someone, by giving them instructions, they should come out cleaner, it worked with children but had the opposite reaction with adults – give them instructions and they come out dirtier. My team investigated this effect and identified two reasons. One was that people said that when they got in the decon unit they forgot what the instructions were, and 'needed to think about what you had told us to do and by the time I had remembered the water had stopped and I was asked to leave!' The other reason was based on a misinterpretation of the relatively simple pictorial washing instructions: some volunteers said that 'on the instructions there were bubbles coming out of the shower nozzles and the pictures said that when bubbly water comes out I am to wash, but no bubbles came out so I didn't wash and then the water stopped.' It was really surprising that something as simple as a picture could make things worse! Bubbles had been added to the picture to indicate that the water would contain detergent, but in reality there were no bubbles, it was just soapy water coming out of the shower unit. Subsequent trials and exercises have shown us the importance of communicating about the process of decontamination as a whole, but we learnt that you don't need to teach people how to wash, just as long as we can get them started."

The field tests were based on the simple parameters that had been identified during the laboratory phase of the studies, which had been done with classic CWAs - VX, GD, Sulphur mustard; Toxic Industrial Chemicals, such as parathion; simulants, such as methyl salicylate; and fluorescent particles. Professor Chilcott stated the data from the latest round of tests, which finished in July, should be published shortly.

Without trying to give away too much personal information, hair – or the lack thereof – and decontamination have always been of interest. Again militarily it has never been much of an issue; military hair does not tend to be worn long – though that has changed since the Cold War! – and if it needs to be cut... well it gets cut. But hair can absorb some chemicals, which if you have enough of it can represent a potential off-gassing hazard. Did Orchids – and I forgive any blushes reader! – study the impact of the absorption of agent into body hair – chest or back – did that make a significant impact? Admittedly unless you are truly children of the wolves then most body hair should not be impacted, since the clothes take the brunt of it, which are then removed – but if the hair pushes against the clothes, and absorbs it in a way that skin does not... Professor Chilcott put my mind partly at ease, "Hair generally is a double edged sword, in absorbing agent it can trap or sequester it, preventing it from reaching the skin – which is a good thing – but it makes it more difficult to decon, as agents trapped within the protein of the hair can be difficult to extract back out into the decon solution. There are some ways of getting around that, the most simple being the Swedish method –you get a pair of clippers and remove it [Surely the Brazilian method! Ed.]"

"Other parameters we have looked at included the effect of chirality or

"handedness,"' said Professor Chilcott, "in preliminary studies, there was a hint that right handed people washed the left hand side of their body better – that effect disappeared in more recent studies and we think that is because we are decontaminating people better than we were at the start, because we are using the optimised "ORCHIDS" method rather than the original. We did find that there is a correlation between BMI (Body Mass Index) and the degree of cleanliness after decon, and it is probably to do with the degree of flexibility, so if you are carrying extra weight then you may be less likely to clean those difficult to reach places: we will publish that finding shortly.

Most of the human testing was performed by their MIAU – Mobile Imaging Analysis Unit – or 'the horsebox' as it is lovingly called. Here the subjects were taken into a dark room, front lit with UV lights, so that cameras could pick up the fluorescent spots that the subjects had been "contaminated" with to ascertain and quantify decon efficacy. "They go into the box, explained Professor Chilcott, "and stand within an inner frame which has a number of spatial and fluorescent calibration disks. The facing wall is full of UV tubes – the Mk1 version used sunbeds, but the Mk2 version used narrow bandwidth tubes which, whilst producing less UV radiation, emit substantially less visible light and so improves sensitivity. We also put an IR camera in there, which allowed us to look out for hypothermia after showering as we always seemed to perform our studies in mid-winter! We also project a raster grid onto each volunteer, to help account for the fact that not all parts of the body are perpendicular to the camera so you get a loss of fluorescent intensity because of the shape of the body. So we look at the before and after pictures, plus the raster grid, and then can calculate a figure to say that you are X% decontaminated."

Yet for all the fact that it was a civilian mass decontamination exercise, which could cover a number of contingencies, not just counter-terrorist/CBRN, the choice of agents was very military. Was this due to the fact that the military have a lot of data sets on these classic CWA, which means there is a body of work that can be cross-pollinated, or is it purely down to the fact that government agencies can at least agree on CWA, while TICs depends on who's threat list you are using... Professor Chilcott replied "we chose the three CW agents as they are the standard challenge for development of medical countermeasures and there is correspondingly previous data we can compare and contrast with. We have some follow up work planned and are hoping for continuation funding from UK and US governments. This next phase of proposed work will seek to investigate a broader range of contaminants. What we need to achieve is a database of chemicals with differing physicochemical properties so that in the future we can say if a contaminant has a volatility greater than this or a solubility less than that we can predict how well it will be removed from the skin by decontamination. This will require some clever maths and a better understanding of skin physiology if we are to model the behaviour of chemicals during wet decontamination."

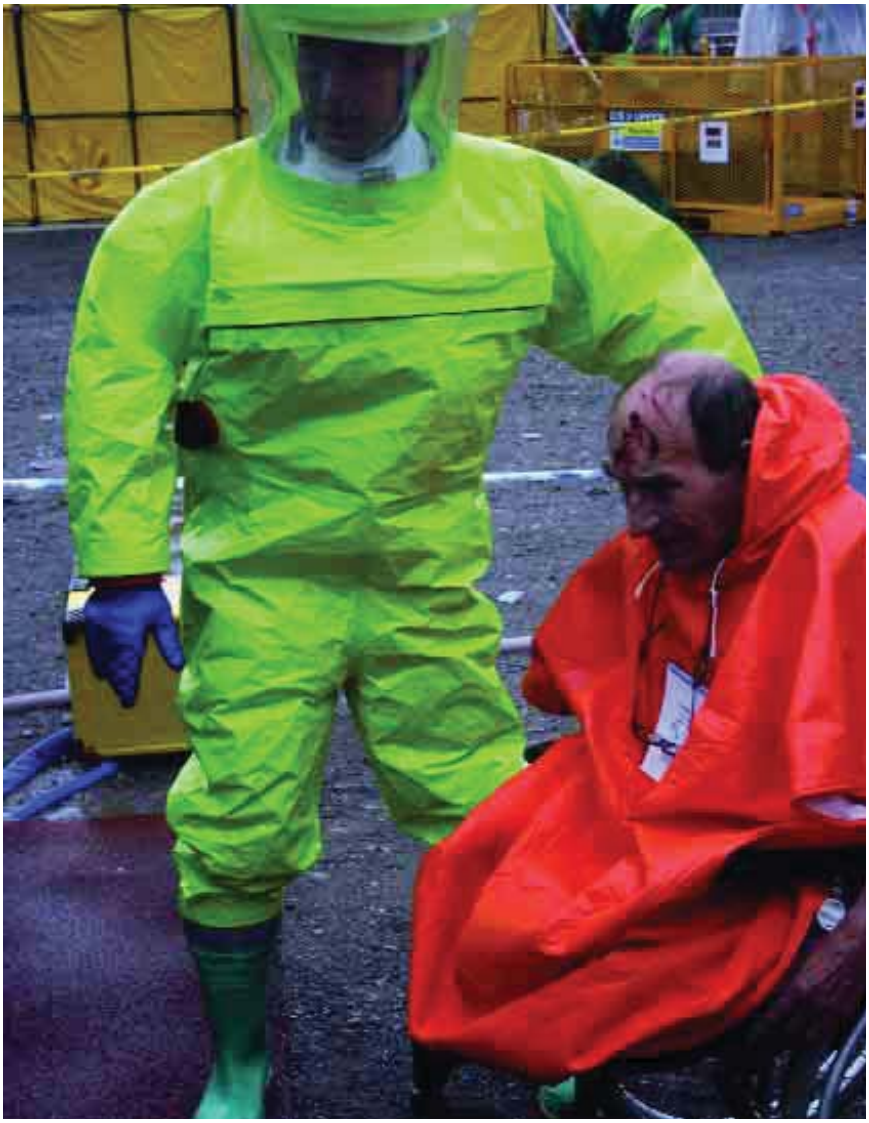
Yet one of the advantages of Orchids was the fact that it was so cookie cutter, it required little to no thought – people go in with flannel for thirty seconds, come out clean. Once you start having to think about adjusting the temperature of the water, changing the soap concentration, providing a rougher flannel, you start moving away from mass decontamination into something more clinical and also require a high degree of faith in the identification of the agent. Professor Chilcott confirmed that the project had sought to identify a generic procedure through evaluating a broad range of experimental parameters. Yet one of the elements of Orchids that had concerned me was the issue of flannels. Conventional, non-flannel, mass decon manages to collect nearly all of the contamination by bunding the water for later disposal. Once you start introducing a cloth that is going to wipe the contaminant off, then you provide yourself with a large amount of contaminated cloths, that can't be so easily contained and will, if I know decon

lines, be kicked into a large pile by the entrance to the tent – conveniently where people will be queuing for entrance. While the flannels will be wet, and therefore less likely to off-gas, the temperature of the tent, combined with the concentration of chemicals, will provide an interesting challenge. Professor Chilcott suggested that I was being overly concerned, "No, when it is operational there will be people in the middle aisle, in PRPS or gas tight suits, and it would be their job in between cohorts of casualties to bag and remove such waste to the warm zone where it would be treated accordingly. I don't see it as a big issue, especially given the advantage a flannel confers over the standard method."

One issue that Orchids has had to deal with is the vulnerable, or disabled population. Exercise Milo dealt with the handicapped – and the sporting handicapped at that – but what of the other elements? Those with autism or cognitive disabilities? "We have done some exercise and field trials for people who are deemed to be vulnerable," explained Professor Chilcott. "The thing to remember is that even if people have varying disabilities it doesn't mean they can't wash themselves. In an incident what you would need to do is take a functional needs approach, so whilst they may have special requirements, if they can wash then it doesn't make them special for decon. Clearly, someone who has a physical disability that would prevent self-washing or movement through the decon unit could potentially pose a problem, so they would be treated in the same way as a non-ambulant casualties for which there is a specific mass decon provision. Dr Amlôt's team has done a review on the needs of vulnerable populations during mass decontamination such as pregnant women, physical impairments, cognitive impairments, the elderly, chronic illness and tourists! Why is a tourist vulnerable? Chances are, in central London a proportion of people may not understand English."

While we are seeing the beginnings of civilian mass decontamination flowering, will there be another season, maybe even the fruit of their efforts? Professor Chilcott suggested that while it is too early to say that the 'Orchids Protocol' will become standard UK procedure, it has been recommended as such in the preliminary findings. Follow on work, if funded, will look at more contaminants such as TICs but also the concepts of use, deployment and operations. "The Orchids project as you call it is actually Orchids 1, and there is also an Orchids 2 which has looked at personal decon," stated Professor Chilcott, "we have also worked on a wound decontamination project. There may be lots of things flying round a contaminated environment such as debris, or payload, from a "dirty bomb." The current school of thought is that if you have a nerve agent-contaminated wound, then there will be an extremely rapid onset of intoxication which may precede the practical administration of a medical countermeasure. What we have found is that if you apply an absorbent dressing, like a haemostat, in a timely manner to a contaminated wound, then you can stop agents such as VX from having any effect - it sequesters the agent and is as good as decon. The reason we looked at this is that the current military treatment, for example, for non-compressible haemorrhaging injury is the application of licensed haemostatic products. By using an experimental wound model we have demonstrated that certain commercial haemostats are effective wound decontaminants. So overall, our research programme has been fairly comprehensive in that it has addressed facets of mass, personal and wound decontamination."

This sudden germination of decon is a new thing, not only in the HPA but within the UK CBRN defence capability generally – traditionally, militarily the UK always relied on allies – and it is interesting to see this sudden blossom. Already it has resulted in a new generation of civil thought and discussion (the last time I saw Professor Chilcott was at a decon symposium in Tokyo) questioning whether the old ways – which were never for civilian decontamination, never mind mass – are the right method for home soil. It will be interesting to see, as the cuttings from Orchids 1 are grafted onto Orchids 2, what the final plant will look like – but hopefully we will never need to taste the fruit of this research. **HRW**



Amputees in Action, allowing realistic decontamination of the disabled, allowed greater definition of TTPs ©HRW

*Amlôt R, Larner J, Matar H, Jones DR, Carter H, Turner EA, Price SC and Chilcott RP. Comparative Analysis of Showering Protocols for Mass Casualty Decontamination. Prehospital and Disaster Medicine, 25(5), p437 – 441 (2010).