



Personal protective equipment solution for UK military medical personnel working in an Ebola virus disease treatment unit in Sierra Leone

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SUMMARY

The combination of personal protective equipment (PPE) together with donning and doffing protocols was designed to protect British and Canadian military medical personnel in the Kerry Town Ebola Treatment Unit (ETU) in Sierra Leone. The PPE solution was selected to protect medical staff from infectious risks, notably Ebola virus, and chemical (hypochlorite) exposure. PPE maximized dexterity, enabled personnel to work in hot temperatures for periods of up to 2 h, protected mucosal membranes when doffing outer layers, and minimized potential contamination of the doffing area with infectious material by reducing the requirement to spray PPE with hypochlorite.

The ETU was equipped to allow medical personnel to provide a higher level of care than witnessed in many existing ETUs. This assured personnel working as part of the international response that they would receive as close to Western treatment standards as possible if they were to contract Ebola virus disease (EVD). PPE also enabled clinical interventions that are not seen routinely in West African EVD treatment regimens, whilst providing a robust protective barrier. Competency in using PPE was developed during a nine-day pre-deployment training programme. This allowed over 60 clinical personnel per deployment to practice skills in PPE in a simulated ETU and in classrooms. Overall, the training provided: (i) an evidence base underpinning the PPE solution chosen; (ii) skills in donning and doffing of PPE; (iii) personnel confidence in the selected PPE; and (iv) quantifiable testing of each individual's capability to don PPE, perform tasks and doff PPE safely.

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Introduction

Ebola virus is found in body fluids such as blood, sweat, vomit and diarrhoea of patients in the acute phase of infection [1]. Contact with patients presents a high risk of nosocomial infection to the medical staff involved with their treatment. In

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the period from August 2014, when the World Health Organization declared the West African outbreak to be an international public health emergency, through to November 2015, 881 healthcare workers (HCWs) contracted Ebola virus disease (EVD), 531 of whom died [2].

Serious gaps in implementing infection prevention and control (IPC) standards were reported in the settings where transmission likely took place or where infected HCWs were employed. Among these, the most frequently reported were deficiencies in administrative, engineering and environmental controls, inappropriate use or lack of personal protective equipment (PPE), defective IPC practice and behaviour, and poor employment conditions and social determinants [3]. Recent studies have also shown that the baseline skill levels of HCWs in PPE removal are poor, and result in contamination and risk to HCWs [4,5].

The Ministry of Defence (MoD) Kerry Town Ebola Treatment Unit (ETU) was developed to provide the highest possible standards of care, including interventions such as peripheral and central venous catheters, urinary catheters and blood product transfusions. During the period from admission of the first patient in November 2014 to discharge of the last patient in December 2015, the unit admitted 125 patients, 44 of whom had a final diagnosis of EVD. It was important that IPC standard precautions were maintained to reduce the risk of healthcare-associated infections for medical staff and patients.

Rationale for selecting PPE

In September 2014, specialists from Public Health England, the National Ambulance Resilience Unit and the Ministry of Defence (MoD) worked together to identify the combination of PPE and donning and doffing protocols for PPE worn by military medical personnel working in a 12-bedded ETU in Kerry Town, Sierra Leone. PPE comprised both single-use and re-usable items. It needed to be available in a variety of sizes; to be resistant to heat, sweat and chemicals; to minimise loss of dexterity; and to maximize movement. Furthermore, the items needed to be procured during a time when many countries were seeking to stockpile PPE, making development of a sustainable solution critical to allow for continuity and the establishment of reliable supply.

The rationale behind the PPE solution was to allow for care to be delivered whilst protecting those working within the ETU, providing a barrier against nosocomial infection.

PPE was doffed in a designated area, prior to exit into the green zone [6]. A buddy–buddy system where personnel were consistently partnered with the same individual was established. Personnel checked each other's PPE and practices at each stage of all activities from donning PPE, working in the red zone (clinical), and doffing PPE to provide assurance during clinical work.

PPE selected

Scrubs

Cotton scrubs were chosen as the base layer. Consideration was given to disposable scrubs but these were rejected on the basis of comfort, material degradation and additional clinical waste. Cotton scrubs offered a comfortable, absorbent base

that could be bleached, laundered and re-used. Due to the risk of malaria, long-sleeved tops would have been preferred as they offer greater protection against mosquito bites; however, these proved to be significantly more difficult to source within the time frames available.

Footwear

Rubber boots were chosen as the footwear for the clinical zone as they are both chemical and ultraviolet resistant; the boots needed to be decontaminated by soaking in hypochlorite (5000 ppm) for at least 10 min, rinsed in water and left inverted, exposed to direct sunlight, before being transferred to the green zone changing room for re-use. Rubber boots are flexible and comfortable for wearers, and seamless boots were preferred to aid decontamination. White or bright colours (not red) were the preferred option as contamination could be seen easily. The sole and upper area of the boot needed to be resistant to both cuts and punctures. Furthermore, the sole needed to meet EN13287 SRA and SATRA TM144 standards in order to be slip resistant, whilst not having a deep tread which could be difficult to decontaminate. Immersion foot can be caused by wearing damp socks and shoes for less than one day [7]. It was therefore decided that rubber boots would only be worn within the red zone, and removed as soon as the staff were decontaminated.

Coveralls

Despite the final choice of coverall suits, back fastening gowns were initially considered as part of the overall PPE solution due to their established use for infectious work. Gowns can be removed away from the wearer and may assist with temperature regulation in a warm environment. However, in this circumstance, a continuous suit that extends to cover the head, torso, arms and legs of the wearer was preferred. Coveralls are produced to suit a variety of settings, and water-resistant coveralls made of a breathable material with taped seams were selected to reduce the possibility of liquid penetration and contamination of exposed areas under the coverall.

The single-use coveralls chosen and tested were made of polyethylene and polypropylene (both breathable materials). These materials had a lower thermodynamic specification compared with other PPE available on the market, which potentially allowed for a longer working time in the red zone. Coveralls with finger loops were selected as these anchored the sleeve and prevented it from sliding up. Loops were worn on the middle finger as this minimized loss of dexterity. Integrated booties could potentially cause a trip hazard so were not preferred.

Apron

Aprons were included within the PPE solution to increase protection to the front of the wearer, as this area was considered to be at high risk of splashes/spills of contaminated material and, in addition, the coverall zip was set into permeable material. The properties stipulated were: length (below knee), plastic and lightweight design (minimum 16- μ m thickness, so it would stay in place but could be torn off deliberately as part of the removal process), fluid repellent and disposable. The apron chosen was adjustable, and so could

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