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“Work as Done in the Emergency Department response to CBRN events: A comparative study”

Saydia Razak [0000-0003-3306-7191]

Sue Hignett [0000-0002-3025-7451], Jo Barnes [0000-0002-3291-8006], and Graham Hancox [0000-0001-7301-6001]

Loughborough University, Loughborough, LE11 3TU, UK
s.razak@lboro.ac.uk

Abstract.

The Emergency Department (ED) is the highest risk area in healthcare. Chemical, Biological, Radiological, and Nuclear (CBRN) events are multi-faceted emergencies which could result in an influx of casualties to arrive in the ED. Responding to a CBRN event presents major challenges to ED staff (first receivers).

This study aimed to understand the actions of first receivers in response to CBRN presentations by mapping Work as Done (WAD) in the event of a CBRN incident, using Hierarchical Task Analysis (HTA) to capture and compare the CBRN responses in two NHS Trusts in the UK. WAD was established by presenting first receivers with CBRN scenario cards. Field notes were made, converted to HTAs, and analyzed using thematic analyses.

The results found similarities between the 2 Trusts, for example, in isolation and containment. The differences highlighted that although first receivers were adhering to clinical recommendations and governmental guidance for treatment and investigation of CBRN presentations, variation still existed. CBRN events are time critical situations in which the clinical and organizational skills of first receivers should be prioritized. This variation between NHS Trusts can be overcome by standardizing the NHS CBRN response.

Keywords: Emergency Department, CBRN, Human Factors

1 Introduction

CBRN events are responded to as emergencies. In the UK, the Civil Contingencies Act [1] lays out responsibilities on NHS organizations to uphold civil protection. Guidance for the NHS on Emergency Preparedness Resilience (EPRR) is governed by NHS England and provides a strategic national framework of core principles which NHS organizations must meet [2].

The ED is highly pressured, overcrowded, short-staffed, and has variable patient demands [3]. This combined with a multi-faceted task such as responding to a CBRN event presents numerous challenges to first receivers. First receivers are underprepared to respond to CBRN events [4] because CBRN events overwhelm the capabilities of the ED [5].

HF/E *“is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system”* [6]. Hierarchical Task Analysis (HTA) is the most central task analysis framework used within the HF/E discipline. HTA describes a task as a higher-level goal with a hierarchy of superordinate and subordinate tasks [7].

Responding to CBRN emergencies requires adherence to clinical recommendations and governmental guidelines that inform Trust policies and plans, representing Work as Imagined (WAI). In Contrast, Work as Done (WAD) describes the reality of the work place [8].

Based on the complexity of the ED, the demands of a CBRN event, and the under preparedness of first receivers to CBRN events, this study aimed to 1) better understand the actions of first receivers in response to CBRN scenario presentations by using WAD as captured and represented using HTAs and 2) compare WAD in CBRN events in two NHS hospitals in the UK.

2 Method

The method is described in two phases to explain firstly how the scenario cards were developed and secondly how they were used to investigate first receivers' response to CBRN events.

In this study, scenario cards were used to create a hypothetical CBRN situation in which first responders could give verbal representations of how they would respond, representing WAD. This method was chosen because of the infrequency of real CBRN events occurring in the ED, so an observation methodology couldn't be used. Additionally, CBRN events could not ethically be anticipated or created due to their life endangering nature. Nonetheless, it was endeavored to form a realistic representation of WAD. This was achieved by having realistic scenario cards based on Health Protection Agency CBRN clinical guidance [9]. The Scenario cards were reviewed by a Hazardous Area Response Team (HART) specialist to ensure that they were realistic.

2.1 Formation of scenario cards

Scenario cards were chosen because they have been used to test incident command systems in hospital based disaster simulation exercises [10]. Scenario cards were used to create a hypothetical CBRN situation and were developed through a six staged process: 1) exercise observation, 2) implementing clinical guidance, 3) scenario card drafting, 4) HART specialist review, 5) evaluation and revision, and 6) pilot study, resulting in three scenario cards for Chemical, Biological (Figure 1), and Radiological. The scenario cards were then piloted on two participants, an ex ED nurse and an ED consultant.

Figure 1: Final version of biological scenario card (SARS)

2.2 Presentation of scenario cards

Purposive sampling was used to identify and select individuals who were especially knowledgeable about or experienced with a topic of interest [11]. A representative sample was ensured by calculating the percentage distributions of first receivers on a typical shift.

The study recruited 57 first receivers (nurses, $n = 21$; doctors, $n = 12$; Healthcare Assistants, $n = 9$; receptionists, $n = 8$; security officers, $n = 4$; porters, $n = 2$; and medical physicist, $n = 1$). The sample comprised of 30 females and 27 males who were recruited from two NHS Trusts in the UK. The inclusion criteria required participants to be 18 years and over and employed in the ED for a minimum of three months on a substantial contract; this was to ensure that all participants had the opportunity to be provided with a Trust induction. Participants were employed in a different role or department for an average of 12 years (SD: 8). The length of employment in the ED ranged from 3 months to 20 years (mean: 8 years, SD: 5).

2.3 Ethical approval, good practice, and recruitment.

Ethical approval was provided by Loughborough University sub-committee (C17-22). NHS Health Research Authority (HRA) ethical approval was granted through the Integrated Research Application (IRAS) (219968). Trust specific Research and Development (R&D) department approval was also given. Data collection methods

anonymized responses and participants' details were strictly kept confidential in accordance with the Data Protection Act (1998) [12]. First receivers were recruited by placing posters in staff only areas in the ED and with the researcher attending staff handovers. Participants were consented with accordance to NHS consent for research guidance.

2.4 Data collection

Scenario cards were presented across a range of shifts in the ED, at a convenient time when the identified first receiver was available. They were presented with the scenario card, given time to read it, and then asked to describe their actions when faced with the scenario. Field notes were made which were later transcribed and converted into HTAs. A verification interview was carried out on a separate occasion as a means of ensuring rigor in the HTAs [7]. This began by providing the scenario card as a memory aid and then showing each participant the HTA from their interview. They were asked if the HTA was a true representation of what they would do in a CBRN event and given an opportunity to discuss and make amendments to the HTA.

2.5 Analysis

The field notes were transcribed, and each transcript was read and reread for familiarisation. Thematic analysis was applied to the field notes to systematically identify, organize, and provide insight into patterns of meaning (themes) across a data set [13], and applied to the HTAs. The HTA results were 1) thematically represented by color, 2) tabulated by first receiver group, and 3) first receiver specific HTAs' formed (Figure 4). First receiver specific HTAs were then combined to form Trust specific standardized WAD top level HTAs to represent the ED response to CBRN events (**Error! Reference source not found.** and Figure 4).

3 Results

The field notes were used to develop the themes. A total of 15 common (inter-Trust) themes were identified (Isolate and contain, treat/provide patient care, capacity, escalate (clinical), escalate (organizational), recognize, decontaminate, liaise and communicate, assist, implement PPE, take lead, protect staff, take notification, clinically assess, and investigate (symptoms/presentation)).

There were 13 Trust specific themes for Trust A (Conform to guidance, diagnose, protect self/environment, cross contamination, practice based on environment, communicate, access relevant equipment, patient awareness/sensitivity, provide access, liaise and support, secure, monitoring, and manage influx of patients) and Trust B had 4 Trust specific themes (Assess/treat, document, make decisions, and protect patient/staff). The themes are applied in **bold** text.

The themes developed from the field notes were applied to the HTAs, for example, Trust A receptionist (A009) demonstrated acknowledging **capacity** by booking the

patients in for **treatment** (Figure 4; 1). **Clinical escalation** was implemented as a means of highlighting concerns about a patient presentation to a clinician by stating: “*patient has difficulty in breathing; if she was really struggling, I’d Tannoy the NIC*”. A009 further demonstrated the theme of **accessing relevant equipment** (Figure 4; 2) by saying “*if she was really bad I’d call for a trolley*”, and finally the theme of **isolate and contain** (Figure 4; 3) was a result the receptionist being suspicious on the presentation by stating “*husband has the same, something is going on*”.

The level of analyses exemplified with the Trust A receptionist was repeated with all first receivers at both Trusts. Common themes were grouped and informed the top-level tasks (**Error! Reference source not found.** and Figure 4).

Figure 2: Trust A: Standardized WAD in the ED response to CBRN events

Inter-Trust similarities existed in **isolate and contain**, **liaise and communicate**, and **escalate**. Differences existed in the prioritization of **PPE**, **treat**, **decontaminate**, and **investigate**.

Figure 3: Trust B: Standardized WAD in the ED response to CBRN events

Figure 4: Trust A receptionist process of analyses and example of results

4 Discussion

It is known that first receivers are under prepared for CBRN events and that the level of preparedness is crucial for an effective CBRN response [14]. This study unpacked the actions of first receivers when responding to a CBRN event in the ED to describe and understand behaviors (and variance) using HTA for a systematic comparison of WAD between Trust A and Trust B.

The results showed similarities between the Trusts when responding to CBRN events for example, to prioritize **isolate and contain** the contaminant. This is important because CBRN contaminated self presenters pose the risk of secondary contamination to healthcare staff and facilities [15]. **Liaising** (with external agencies/specialties) and **communicating** (with patients and colleagues) were common actions at both Trusts; both are key in the response to CBRN events [5]. EPRR guidance emphasizes the importance of communication in critical CBRN response tasks such as, communicating with the patient, communicating for security, and communicating for casualty assessment [16]. As shown in Figures 3 and 4, first receivers at both Trusts liaise and communicate before they implement the action of **escalate** in the ED CBRN response.

There were some key differences between the 2 Trusts with respect to the order (and possibly importance) for the use of general **PPE** (gloves, apron, and a mask), decontamination PPE (Powered Respirator Protective Suits; PRPS) and decontamination. At Trust A, first receivers considered general PPE to be vital to prevent cross contamination; whereas at Trust B more first receivers discussed decontamination PPE, which disagrees with literature suggesting problems associated with PPE [17]. For **decontamination**, Trust B included a higher level goal to emphasize the importance of decontamination in a CBRN situation; this is vital because research suggests that although it is a requirement for all casualties to be decontaminated before arriving at the ED, some may be transported before decontamination has occurred as well as the ED being open to self-presenting patients [18].

The second difference was the order (and possibly priority) for **treat and investigate**. The treatment of patients primarily used the ABCDE (Airway, Breathing, Circulation, Disability, Exposure) [19] approach which reinforces the suggestion that treatment of CBRN casualties should reflect the conventional casualty management paradigms with additional safety considerations [20]. At Trust B, the first receivers discussed relevant clinical investigations which were in adherence to current governmental guidance.

5 Conclusions

This study systematically unpacked the ED first receiver response to CBRN events using HTA to explore WAD. There were many similarities (particularly at the higher-level goals) but also some differences between the first receivers at each Trust, for example with **clinical investigation, decontamination, and PPE**. CBRN events are time critical situations in which the clinical and organizational skills of first receivers

should be prioritized to deliver concise patient care. A means of achieving this would be to standardize the CBRN response in NHS Trust [21].

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