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Review

Prevention and Decontamination of Chemical, Biological, Radiological, and Nuclear Contaminants for the Emergency Medical Personnel during Ambulance Services

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This paper will review proper protocol for Emergency Medical Technicians (EMTs) between the ambulance station, scene and hospital. EMTs must know how to protect themselves both inside and outside the ambulance from chemical, biological, radiological, and nuclear (CBRN) contaminants in order to provide the best quality care. EMTs should also know how to remove contamination after taking a patient to the hospital. A CBRN protocol at the scene of exposure is the best defense strategy for protecting both EMTs and the emergency ambulance vehicle from contamination. If EMTs and the emergency ambulance vehicle are exposed to CBRN, neither will be of great service as they both play a critical part in the quality of care given to a patient. In the event of possible exposure, EMTs should dress in high perceptibility personal protective equipment (PPE). Those who have been trained prior should arrive to the scene with an air purifying respirator. Before a patient with possible exposure is placed inside an emergency ambulance vehicle, all patients' compartments should be completely covered and sealed with plastic film. Once the emergency medical crew reaches the hospital and the patient is discharged from the emergency vehicle, all plastic film inside the ambulance, from the cockpit ceiling to the floor, should be removed and properly discarded. The patient's clothing and shoes should be placed into a double layered plastic bag. Adhering to proper protocols, within 10 minutes of arrival at hospital, a contaminated ambulance should undergo pre-washing, decontamination and rinsing operations.

Key Words: Emergency Medical Technicians; CBRN Ambulances; Decontamination

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INTRODUCTION

The first role and responsibility of emergency ambulance service is to provide a resource to save and serve the patient with the highest quality of care. Second, ambulance services are an option to temporarily provide treatment for an injured or exposed patient while removing decontamination. Lastly, rescue the exposed and or injured patient in the most suitable mode of transportation. These roles are all necessary to maintain a high level of confidence in ambulance practices while adhering to proper protocol transfer for a contaminated patient.

Chemical, biological, radiological and nuclear defense (often abbreviated as CBRN defense or CBRND) is the term for protective measures taken in situations in which any of these four hazards are present. To account for improvised devices, the term CBRNe (e for explosives) is also used. CBRN defense consists of CBRN passive protection, contamination avoidance and CBRN mitigation [1].

The Prime Minister, Ministry of Health, Department of Defense and the institutions involved with the protection of very important persons need CBRN ambulances. There are ambulance supply manufactures that specifically make ambulance models to be used in urban and rural areas. The ambulances they manufacture are modified at the highest of quality, per the customer's request. These companies can go so far as to build models with specific brand, body and engine types. Ambulances can even be equipped with air filtration systems that continue running even when the engine is off. Some ambulances have built in decontamination systems to decontaminate not only the vehicle, but the patient and crew members as well. CBRNe Security Systems and Technologies of Deutschland in particular, Total Security Defense, creates their CBRN ambulances according to international standards and all the technical aspects can be modified by the customer [2].

The equipment used in a CBRN case consists of a lower level respiratory systems and level C skin protection gear. This is adequate for radiation event response where other hazards have been determined not to be present. In the event hazards have been identified, they will not be absorbed by or adversely affect, exposed skin. All criteria for using an air purifying respirator should be met, especially for concentrations of all airborne contaminants known. Appropriate filters are available, and oxygen levels become sufficient [3].

Decontamination of ambulances should take place as soon as the patient arrives to the hospital. The ambulance should be cleaned and disinfected according to protocol. Such measures should cover the ambulances exterior, cab, patient compartments, and all medical equipment.

There is no protocol currently in our country that specifically relates to contamination prevention and contamination removal within an ambulance. This paper outlines the steps to be taken by the emergency medical team from the arrival and admittance of a patient into the ambulance, on the scene and arrival at the hospital. Crew members must know how to be protected inside the ambulance from CBRN contaminants as well as know proper decontamination procedures after the patient is discharged from the vehicle.

Transportation and care of highly infectious or biologically contaminated patients pose the risk of ambulance contamination. Following contamination, manual ambulance-cleaning and prevention techniques are required to reduce significant contact time and also prevent the risk of exposure to personnel during the process of cleaning. This review investigated prevention and decontamination of CBRN containments in an ambulance from website MEDLINE®/PubMed® Resources Guide, Biosis, Science Citation Index, USA. Government regulation, Federal Emergency Management Agency (FEMA), Occupational Safety and Health Administration (OSHA), United States (US) Department of Labor, US Department of Homeland Security (DHS), and National Health Service (NHS) evidence in the United Kingdom.

PATIENT ISOLATION AND TRANSPORT EQUIPMENT

In the classification list of CBRN response equipment of DHS, patient isolation equipment is placed in the 'public healthy' division of the 'medical' category. It means the equipment is designed to keep negative or positive pressure conditions normal to isolate pollution in the air or on polluted patients [4].

The air filtration blower system cleans air in two special filtration ways before conveying the air to patients. It provides a cooling effect and maintains negative pressure circumstance in connection with high-efficiency particulate air filter (HEPA) system in order to prevent the secondary pollution made by leakage of pollutants. A particular type of the equipment provides not only negative pressure circumstance, but positive pressure circumstance so that it helps out patients with low immunity, such as burn patients. The filtration system uses rechargeable batteries which can run up to 8-10 hours straight. For full recharging, it takes 4-6 hours. The whole equipment weighs about 10 kg, making it light enough to become portable. Some products can be folded and put into a small bag for easier transport and mobility.

There are also equipment packs that can be integrated into patient transport like stretcher beds and are easily detachable, if necessary. There are separate devices for fixtures. Aside from portability and convenience, the equipment has the ability to collect patient's bodily fluids, such as blood and other secretions. With this equipment, three medical persons are able to treat a patient simultaneously. An equipment pack for adults can be applied to a patient weighing up to 200 kg (Fig. 1)[5].

Fig. 1. CAPSULS™ Patient Isolation Unit (ISOVAC) from [5].

GENERAL PREVENTION AND DECONTAMINATION FOR AN AMBULANCE CONTAINING CBRN CONTAMINANTS

1. CBRN ambulance preparation

The term EMTs refers to all levels of emergency medical service system personnel responsible for incident response (e.g, doctors, nurses, basic EMTs, paramedics, and emergency first responders in Korea). While many EMTs and paramedics are cross-trained with firefighters, these personnel only operate when they are functioning as EMTs. The ambulance should be parked uphill and upwind. Personnel should always remember not to put themselves at risk on the scene. They should not get in place or take care of causalities unless properly trained and protected in NHS standard level C personal protective equipment (PPE), safety helmet, and air purifying respirator (Fig. 2).

On the scene, EMTs should close all ambulance windows and vent holes. Turn off air conditioning unit in ambulance. They should obey all regulations and safety guidelines. When possible, avoid touching contaminated victims. The plastic film should be applied to suggested surface areas with red double-sided adhesive tape. Protocol requires patient compartments and surfaces to be completely covered and sealed in plastic film (Fig. 3). EKG monitors, ambulance stretchers and some hard surfaces do not need to be covered as they are able to be wiped down with liquid and foam disinfectants (Fig. 4).

2. Hospital arrival

In order to activate the emergency decontamination procedure within a hospital, EMT's should send report to emergency doctor on duty as soon as possible before arriving. Emergency personnel must take out plastic films from areas closer to the driver side step by step, slowly (Fig. 5). A large plastic bag will be needed for the contaminated items belonging to the patient (Fig. 6). First put the patient's clothes and shoes in a double layered plastic bag (Fig. 7, 8). Next, notify at the accident site that a patient in transport identifies with signs of contamination. This will allow personnel at the

Fig. 2. NHS standard level C chemical protective PPE from [11].

Fig. 4. EKG monitors and some hard surface equipment do not need plastic film covering from [11].

Fig. 3. Ambulance completely covered and sealed in plastic film from [11].

Fig. 5. Take out plastic films from closer to driver side from [11].

site to carry out proper patient handling and decontamination procedures.

3. Decontaminating the ambulance at the ambulance station

All supplies and tools needed to clean the ambulance should be placed at the ambulance station. There should be several plastic containers of disinfectant, detergent, degreaser, bleach, antiseptic, glass cleaner, and towels. Also, several buckets, brooms, and mops for decontamination purposes should be readily available.

4. Cleaning the outside of the ambulance

Crew should pull the vehicle into the ambulance station. The parking side brake has to be applied for the high-idle neutral gear. Rinse down the entire exterior; both side-view mirrors and four side windows. The windshield must also be free of germs, bugs and other debris. If it is an extremely unclean substance, the ambulance must then be requested for wash. Exterior paint must be washed down. Tires must be free of any dirt, grime and mud. If EMTs wash the vehicle themselves they should spray the cleaning product and degreasing agent on the tires, scrub and then use a refurbish sprayer. This must be done whenever the ambulance is cleaned.

Using Allen-Vanguard's Surface Decontamination Foam (SDF™), proper cleaning can be set up and operational within 10 minutes of arriving at a hospital. A single operator is capable of pre-washing, decontaminating and carrying out post-rinse operations (Fig. 9). According to Allen Vanguard (2010), this is simple to operate and maintain, it is self-contained and carries on-board chemicals, mixing, hoses and nozzles [6]. Emergency response vehicles (2015) recommend that Biofuel's hydrogen peroxide vapor technology allows ambulance personnel to rapidly and effectively eliminate contamination from the ambulance, thereby reducing the risk of cross-infection in subsequent patients [7].

Fig. 6. Large double layered plastic bags from [11].

5. Driver's seat

Scrub the console and dashboard with sterilizing solution. This is best done by spraying the disinfectant products on a clean towel first and then wiping. Do not spray disinfectant products directly onto the audio system, radio microphone, console, dashboard or any other electrical equipment. EMTs should be most aware of this space when disinfecting, as it is one of the most vital areas in

Fig. 7. Verify, remove and seal contaminated items in plastic bags from [11].

Fig. 8. Put it everything into the plastic bags from [11].

Fig. 9. Use Allen-Vanguard's surface decontamination foam from [6].

Fig. 10. Wipe down patient compartments from [8].

the ambulance. Many EMTs will touch audio systems throughout the day while dispatched. At each ambulance station there should be rolls of paper towels for the interior windows and windshield. All interior windows and rearview mirrors should be cleaned using glass cleaner. Floor surfaces, driver and passenger seats should be vacuumed. All trash and waste must be thrown away in decontamination bins [8].

6. Patient compartment

Remove the stretcher from the ambulance and clean all of the ambulance bars and grips. These ambulance stretchers are used on various patients every day. EMTs are familiar with the areas of ambulance stretchers routinely exposed to infection. After each dispatch, put away and remove the sheets from the ambulance stretcher bed. If a stretcher is contaminated, the mattress must be discarded and the frame and undercarriage must be washed using a disinfectant. Make sure all interior lights are working properly and sterilized. Disinfect all interior surfaces and wipe down with a dry towel completely (Fig. 10). Remember to clean up interior door handles, handles for the cabinets, treatment area and the portable radio. Personnel should remember not to spray the cleansing and disinfectant products directly on electrical parts. The EMTs carrying bag must be placed in the patient's compartment above the drug box shelves or connected to the ambulance stretcher or the settee with safety belts.

7. Emergency equipments

Equipment can be cleaned if made of a non-porous material, but decontamination equipment follows a similar protocol to that of skin sterilization, such as flushing thoroughly with water and cleanser, rinsing thoroughly and examining carefully. EMTs must dispose of porous material equipment along with other supplies, rather than trying to disinfect, as the decontamination of such materials is more difficult. Based on an OSHA letter of analysis, it' s recommended to remove or minimize the use of soft plush surfaces where they might need to be decontaminated later [9].

1) Defibrillator/ Monitor: Clean the lead cables, the pulse oximeter and the defibrillator monitor.

2) Oxygen Caddy: Wash down the interior of the oxygen caddy bag and clean the regulator.

3) Immobilization Equipment: Long backboards and head immobilization units should be wiped down on a regular basis. When selecting or replacing short backboard, cervical collar, pediatric immobilizers and other immobilization equipment from the hospital, make sure you clean before placing the equipment back into the ambulance.

4) Stethoscope and Blood Pressure Cuff: Clean the stethoscope such as ear piece and chest piece and gently spray down the surface of the blood pressure cuff if necessary. Certify that the blood pressure cuff is dry before replacing it back in the carrying bag [10].

CONCLUSION

This review illustrates how to properly carry out a contamination emergency response situation by preventing and decontaminating emergency medical personnel and ambulances. It is important to remember the above mentioned safety procedures to prevent the spread of contaminants. In order to minimize exposure, medical teams across all levels should receive proper training. Not only will this raise the standard of care for our country, but it will set an example for future initiatives to be implemented. It is important to understand the level of risk we currently face without

this decontamination protocol implemented. By educating EMT personnel, we can reduce risk significantly within the public. Adopting a CBRN prevention and decontamination protocol will decrease exposure, and maintain the health of our healthcare teams, which is most important to carry out the highest quality of care. Implementing a CBRN protocol is the best strategy for defending ambulance crew and ambulances from contamination.

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