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REVIEW ARTICLE

The Role of Technology Advancement in Improving the Current Practice of Ambulance Decontamination in Malaysia: A Scoping Review

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Abstract

In Malaysia, the current methodology for decontaminating ambulances is by manually cleaning surfaces with Environmental Protection Agency (EPA) approved disinfecting solutions as contrast to previous practice using water and soap. The solutions used are registered with National Pharmaceutical Regulatory Agency (NPRA) Ministry of Health Malaysia (NPRA) to ensure adherence to international standard of practice. The manual decontamination practices are effective if strictly conducted following guidelines. However, the proper cleaning and decontamination of an ambulance is an important task that frequently overlooked. It creates a risk to healthcare providers and their patients for subsequent ambulance trip. To ensure the patient compartment is absent from multitudes of infectious pathogen especially Covid-19, is not only an escalating challenge for healthcare providers as it is an unseen, but also poses a real threat to them and their patient. The healthcare managers should consider technologies that can provide a safer, effective and more efficient cleaning and decontamination of an ambulances. We proposed to adapt a new approach of decontamination by using a vapour based disinfection method coupled with germicidal enhancement using ultra violet. It utilizes an EPA-approved hospital disinfectant to decontaminate surfaces in the patient care compartment after every patient transport. A nozzle, placed inside the patient care compartment, disperses a mist of disinfectant solution that designed to meet standard requirement. The enhancement of germicidal effect using an ultra violet ray will disinfect and ensure a free patient compartment from an infectious organism. This decontamination system directly integrated into a new or existing ambulance. It is convenient, timesaving, hands-off solution for decontaminating of an ambulance and importantly creates a safer practice.

Keywords: Ambulance Service, Decontamination, Vapour-Based, Safe Practice

Introduction

Ministry of Health Malaysia is the main provider of ambulance services in Malaysia supported by university hospitals and other non-governmental organisations such as Malaysian Red Crescent Society, Malaysian Civil Defence, St John Ambulance of Malaysia and other private hospitals. Unfortunately, there is no single body or organisation given the responsibility to coordinate and manage not only the overall comprehensive running of the services but also the ambulance specification, importantly the maintenance as well as decontamination aspect of an ambulances. One of the reasons for the lack of integration between the various agencies is due to the lack of interest for administrative coordination from various agencies (Hisamuddin et al., 2007).

There were 793 functioning ambulances in Malaysia which equals to 0.28 per 10,000 populations in reference to developed countries which was 1 per 10,000 populations (Arunah C. et. al., 2010). From National Healthcare Establishments & Workforce Statistics 2010 Hospitals report, it was mentioned that Selangor and WP Putrajaya had the least ambulances to population ratio of 0.14 per 10,000 populations. In terms of ambulance runs for emergency response, there were a total of 169,129 runs which translates to 59.69 runs per 10,000 populations. Out of this, six states surpassed the national average of ambulance runs, with Pulau Pinang being the highest (130.16), followed by Perak (112.79), Melaka (111.47), Negeri Sembilan (95.23), Kedah & Perlis (63.24) and Pahang (61.83). In comparison, only Melaka had a small number of ambulances per 10,000 populations (0.24) with an above average ambulance runs. Only 6 states had interfacility transfers above the national average (57.58 per 10,000 population), and these were Negeri Sembilan (109.43), Kelantan (108.32), Pulau Pinang (98.69), Perak (80.84), Pahang (69.52) and WPKL (63.32). This information showed that, the number of ambulances in Malaysia is not at par with the developed country standards thus a heavy used of an ambulances are certainly unavoidable. Therefore, the need for effective decontamination is mandatory as to ensure safety and prevent healthcare associated infection due to ambulance trip services.

Ambulance decontamination: The current standard practices

Decontamination means a removing a contaminant not only microorganism but also any hazardous materials such as chemicals and radioactive substances. Whereas, disinfection is a process of killing microorganism on inanimate objects except bacterial spores. It may be divided into three levels based on amount and which type of microorganism is susceptible or killed and known as high disinfection (HDL), intermediate disinfection (IDL) and low disinfection (LDL) levels (World Health Organization, 1999) .

The main purpose of ambulance decontamination is to ensure a proper cleaning and disinfection of an ambulance and equipment in order to reduce the bioburden of disease and prevent secondary transmission of a known or unknown contagious disease. The decontamination need to be provide a clean and free environment from microorganism prior to its return to service following the transport of a patient either known or suspected infectious patient.

In Malaysia, the current methodology for cleaning and decontaminating ambulances is by manually cleaning surfaces with EPA-approved disinfecting solutions (KKM, 2020). which is regulated by NPRA to meet the international standard (NPRA, 2022; ECHA, 2015). The common disinfectant used is sodium hypochlorite 0.5 – 1% with minimum recommended contact time of one minute for surface disinfection and up to twenty minutes for liquid waste disinfection. Sodium hypochlorite is effective against viruses, bacteria, fungi, and mycobacterium but is not effective for bacterial spores and prions. The manual decontamination practices are proven to be an effective method if it is done strictly according to protocols. Otherwise the disinfection is not effective thus provides an unnecessary risk to subsequent passengers of subsequent ambulance trip. No doubt, the decontamination procedures of an ambulance is an important task that frequently overlooked.

The average time taken for a standard practice of decontamination an ambulance is three to four hours. This is because more time taken to rinse the interior of an ambulance and partly due to separated area for ambulance decontamination place which is far from emergency department. To ensure the patient compartment is absent from multitudes of infectious pathogen especially Covid-19, is an escalating challenge for healthcare providers as it is an unseen, but poses a real threat to them and their patient they managed. The healthcare managers should consider technologies that can provide a safer, effective and more efficient cleaning procedures for ambulance decontaminations.

Ambulance: A safe vehicle?

Ambulance is commonly used for referral and transportation of critically ill patient. Patient will be in the ambulance of a confined space during the transportation. In Malaysia, the response time for an emergency case is fifteen to thirty minutes depending on the traffic conditions. Whereas for the referral either step-up or step-down care is variable depending on the distance of the destined hospitals. It may vary and ranging from one to eight hours as an example, the referral from Hospital Sultanah Nur Zahirah to Hospital Hulu Terengganu or Institut Jantung Negara respectively. The more time spent in a confined space of an ambulance the more risk of acquired infection. The risk is significant if the ambulance is not maintained or decontaminate appropriately.

Healthcare associated infection is an alarming issues. It affects millions of patients annually (Valdez MK et. al., 2015). It was found that, about 70 percent of advanced life support ambulances sampled throughout the metropolitan Chicago area yielded at least one isolate of Staphylococcus aureus (Rago JV et. al., 2012). Another study, revealed high microbial contamination (bacterial and fungal) in ambulance air during services and higher bacterial contamination on medical instrument surfaces and allocated areas after ambulance services compared to the start of ambulance runs (Luksamijarulkul P & Pipitsangjan S, 2015). There was a direct association between the number of microbial count in the ambulance air and surface contamination.

In Europe, a regional study examined the levels of bacterial contamination in Welsh ambulances over a 12-month period on a monthly schedule. The results showed a variety of microbes were present in the samples before cleaning the emergency vehicles **(Table 1).** Surprisingly, it was discovered that the steering wheel had a higher percentage of contamination after the cleaning. It is possibly due to improper cleaning method. In general, the highly significant percentage of microbes were found after the cleaning re-emphasizing the need for more stringent infection control methods or practice (Nigam Y & Cutter J, 2003).

Table 1. Percentage Of sites contaminated before and after traditional cleaning

Site	% Of sites contaminated before traditional cleaning	% Of sites contaminated after traditional cleaning
Folds in stretcher mattress	66.7	50.0
Off side wall near stretcher mattress	66.7	8.4
Inside cupboard/drawers	33.4	16.7
Steering wheel	33.4	41.7
Inside mask-Entonox	58.4	41.7
Inside suction bottle	70.0	20.0
Rails of grid/track or floor	91.7	66.7

Adapted from Nigam Y. & Cutter J., 2003.

Technology for practice enhancement

Manual cleaning an ambulance using a detergent is not enough as it only removes residues (dirt, dust, protein, skin cells etc.) to ensure the surface is visually free from any physical materials and not the microorganism. It may remove and dilute the microorganism numbers and help a disinfectant to work effectively with the microbial cells. Never the less, sterilization process will kill and deactivate all forms of life (viruses, bacteria, fungi, spores,) including biological agents such as prions (WHO,1999).

The use of vapour based disinfection had been successful in many larger area as compared to a confine space of an ambulance. Previous study found that, the hydrogen peroxide dry-mist disinfection system is significantly more effective than 0.5% sodium hypochlorite solution at eradicating C. difficile spores and might represent a new alternative for disinfecting the rooms of patients with C. difficile infection (Barbut F, et. al., 2009). In another study of different setting using vapour paracetic acid (PAA), the calculated effectiveness of disinfection was 99.7% in kindergartens and 99.3% in schools that indicate a highly effective method of surface disinfection (Kruszewska E et. al., 2021). Hydrogen peroxide and paracetic acid are highly effective and non-toxic fumigants that can be safely used for fogging laboratory and medical equipment, pharmaceutical facilities, hospital rooms, and animal breeding rooms (Bukłaha A et. al., 2022).

A study conducted to evaluate the fumigation techniques of disinfection in an ambulance involving nine ambulances. A sampling of an organism was conducted and the most common organisms isolated include Bacillus species (sps), coagulase negative Staphylococci, and Enteric bacteria. A similar density of growth and types of microbes was found in samples collected both during the day and night. The prevalence rates of growth observed from the 3 different sampling sites were in the range of 80-100% before fumigation. In post-fumigation, there was approximately a 60-90% decrease in the incidence of microbes. The tested fumigation technique was successful in reducing most of the bacterial contamination. This indicates the significance of disinfection and sterilization techniques in prevention of disease transmission (Daifallah Alrazeeni et. al., 2014). A hydrogen peroxide dry fumigation system, run in three cycles, proof to have an excellent sporicidal effect when used in rooms, ambulances, and external and internal parts of ventilated equipment (Andersen BM et. al., 2006). Similar study also proposed that, vapour based hydrogen peroxide is more suitable for enclosure with limited volume and aerosol hydrogen peroxide is more suitable for no-tight environments, not crowded with objects or equipment, such as lab rooms appropriately prepared.

The effectiveness of vapour based disinfection was also proven in many healthcare settings. The outcomes are greatest when coupled with ultra violet-c. Previous comparison study by Yosra Sedaghan et. al., 2019, on the effectiveness of disinfection in intensive care unit (ICU) using the three methods such as manual cleaning, hydrogen peroxide vapour (HPV) and ultra violet-c (UVC) revealed a 66.67%, 100% and 50%, respectively. Similar study also found that, the effectiveness of otoscope disinfection in the ICU and blood pressure meter in the operating room (OR) with three methods of MC, HPV and UVC has been 0%, 50% and 100%, respectively. Therefore, it is confirmed that disinfection using HPV followed by UVC method has proven to be the best for surface area and equipment decontamination.

The enhancement of germicidal effect using an ultra violet ray will disinfect and ensure a free patient compartment from an infectious organism (Yosra Sedaghan et al., 2019). However, to ensure effectiveness the ray must reach the area concerned. It was found that, the location of ultra violet and the addition of reflective surfaces increases the chance of effective irradiation and sterilization thus reduced the time for disinfection. This technology able to disinfection in 16 seconds (William GL et. al., 2018).

Therefore, we proposed to adapt a new approach of decontamination by using a vapour based disinfection method coupled with germicidal enhancement using ultra violet. It may utilize hydrogen peroxide disinfection, an EPA-approved hospital disinfectant to decontaminate surfaces in the patient care compartment after every patient transport. When

used correctly, they offer a complementary technology to manual cleaning that increases the probability of an effective reduction in viability and provides a comparatively uniform distribution of disinfectant (William GL et., al., 2018; Kyle Wolber, 2020).

Conclusion

In Malaysia, the ambulances are heavily used. It was found to harbour significant number of microorganism that carry a high risk of healthcare associated infection. This risk mandates a high-level disinfection ambulance program to ensure safety to the healthcare staff and patients. Therefore, continued efforts to improve traditional manual disinfection of surfaces are needed preferably a no-touch decontamination technology to improve disinfection of surfaces in healthcare. A nozzle, placed inside the patient care compartment, disperses a mist of disinfectant solution for three cycles will ensure a complete area reached and gain optimum disinfection effects. The proposed addition of decontamination method can directly be integrated into a new or an existing ambulance. It is convenient, timesaving, hands-off solution for decontaminating of an ambulance and importantly creates a safer practice.

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