



# EMS Disease Exposure, Transmission, and Prevention: a Review Article

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Published online: 11 October 2019

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## Abstract

**Purpose of Review** This article aims to review recent literature regarding the risks of disease exposure to pre-hospital providers and the patients they serve, as well as the challenges they face in minimizing transmission and exposure.

**Recent Findings** Many studies continue to show poor compliance with consistent universal precautions, as well as proper hand hygiene. Vaccination rates are suboptimal despite attempts to encourage compliance. With the spread of multi-drug resistant organisms, new techniques of decontamination need to be investigated.

**Summary** There remains a general lack of information and studies regarding the risks of disease exposure and transmission to EMS providers despite the significance hazards their profession can pose. However, there remains a continued theme throughout the majority of EMS and pre-hospital studies, demonstrating that hand washing and consistent use of personal protective equipment remains a persistent, preventable means of disease exposure and transmission.

**Keywords** Emergency medical services · Exposure · Transmission · PPE · Contamination · Decontamination · Infectious disease

## Introduction

EMS and pre-hospital providers face special challenges when it comes to disease exposure, which not only puts them at risk, but also poses additional threat to patients under their care. These providers are at several disadvantages when compared with in-hospital providers. Given their initial patient exposure, there is a general lack of information as regards diagnosis and past medical history. They are also at increased risk of exposure with the possibility of insufficient personal protective equipment given certain clinical scenarios. Frequently, hand washing is either limited or altogether unavailable based on circumstances, and thorough cleaning of equipment can be

challenging, making the providers and equipment potential vectors for disease transmission. In addition, outbreaks of new viruses and resistant pathogens pose new challenges in specific identification and in protecting providers and patients alike. Further complicating matters is the lack of available research and difficulty performing studies given the inherent nature of these limitations.

## Needle-Stick Injuries and Vaccinations

Among healthcare workers, EMS providers are known to have relatively high risk of sustaining needle-stick injuries (NSI). This is logically related to the emergency nature of their work, the mobile nature of their work environment, ambient lighting or space limitations, and the speed at which their procedures need to be done. More recently though, several case studies have been reported which identify a specific medical condition that is uniquely associated with needle sticks: hypoglycemia. An unconscious diabetic patient predisposes the healthcare worker to increased risk of a NSI. The lancets on a glucometer have a very small needle that can be hidden, and sometimes patients do not dispose of these used items properly. The Huber needles on insulin pumps have also been described to have increased risk [1].

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This article is part of the Topical Collection on *Infectious Disease*

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Hepatitis B, C, and HIV are the most dreaded viral infections, and constitute the most realistic concerns for disease transmission in needle-stick injuries. Familiarity with local disease reporting is crucial to ensuring EMS providers are aware when exposures requiring prophylaxis or additional testing occur. See Fig. 1 for a list of reportable diseases in

Ohio; these can vary from state to state. The universal precautions published by the CDC are not necessarily different for EMS compared with other healthcare workers; however, the compliance can be more challenging. Considering the risk and prevalence of these types of exposures, a protocol for such exposures should be in place in EMS systems as well as health

### Know Your ABCs: A Quick Guide to Reportable Infectious Diseases in Ohio

From the Ohio Administrative Code Chapter 3701-3; Effective May 1, 2015

#### Class A:

Diseases of major public health concern because of the severity of disease or potential for epidemic spread – report immediately via telephone upon recognition that a case, a suspected case, or a positive laboratory result exists.

- Anthrax
- Botulism, foodborne
- Cholera
- Diphtheria
- Influenza A – novel virus infection
- Measles
- Meningococcal disease
- Middle East Respiratory Syndrome (MERS)
- Plague
- Rabies, human
- Rubella (not congenital)
- Severe acute respiratory syndrome (SARS)
- Smallpox
- Tularemia
- Viral hemorrhagic fever (VHF), including Ebola virus disease, Lassa fever, Marburg hemorrhagic fever, and Crimean-Congo hemorrhagic fever
- Yellow fever

Any unexpected pattern of cases, suspected cases, deaths or increased incidence of any other disease of major public health concern, because of the severity of disease or potential for epidemic spread, which may indicate a newly recognized infectious agent, outbreak, epidemic, related public health hazard or act of bioterrorism.

#### Class B:

Disease of public health concern needing timely response because of potential for epidemic spread – report by the end of the next business day after the existence of a case, a suspected case, or a positive laboratory result is known.

- Amebiasis
- Arboviral neuroinvasive and non-neuroinvasive disease:
  - Chikungunya virus infection
  - Eastern equine encephalitis virus disease
  - LaCrosse virus disease (other California serogroup virus disease)
  - Powassan virus disease
  - St. Louis encephalitis virus disease
  - West Nile virus infection
  - Western equine encephalitis virus disease
  - Other arthropod-borne diseases
- Babesiosis
- Botulism
  - infant
  - wound
- Brucellosis
- Campylobacteriosis
- Chancroid
- *Chlamydia trachomatis* infections
- Coccidioidomycosis
- Creutzfeldt-Jakob disease (CJD)
- Cryptosporidiosis
- Cyclosporiasis
- Dengue
- *E. coli* O157:H7 and Shiga toxin-producing *E. coli* (STEC)
- Ehrlichiosis/anaplasmosis
- Giardiasis
- Gonorrhea (*Neisseria gonorrhoeae*)
- *Haemophilus influenzae* (invasive disease)
- Hantavirus
- Hemolytic uremic syndrome (HUS)
- Hepatitis A
- Hepatitis B (non-perinatal)
- Hepatitis B (perinatal)
- Hepatitis C
- Hepatitis D (delta hepatitis)
- Hepatitis E
- Influenza-associated hospitalization
- Influenza-associated pediatric mortality
- Legionnaires' disease
- Leprosy (Hansen disease)
- Leptospirosis
- Listeriosis
- Lyme disease
- Malaria
- Meningitis:
  - Aseptic (viral)
  - Bacterial
- Mumps
- Mycobacterial disease, other than tuberculosis (MOTT)
- Pertussis
- Poliomyelitis (including vaccine-associated cases)
- Psittacosis
- Q fever
- Rubella (congenital)
- Salmonellosis
- Shigellosis
- Spotted Fever Rickettsiosis, including Rocky Mountain spotted fever (RMSF)
- *Staphylococcus aureus*, with resistance or intermediate resistance to vancomycin (VRSA, VISA)
- Streptococcal disease, group A, invasive (IGAS)
- Streptococcal disease, group B, in newborn
- Streptococcal toxic shock syndrome (STSS)
- *Streptococcus pneumoniae*, invasive disease (ISP)
- Syphilis
- Tetanus
- Toxic shock syndrome (TSS)
- Trichinellosis
- Tuberculosis (TB), including multi-drug resistant tuberculosis (MDR-TB)
- Typhoid fever
- Typhus fever
- Varicella
- Vibriosis
- Yersiniosis

#### Class C:

Report an outbreak, unusual incident or epidemic of other diseases (e.g. histoplasmosis, pediculosis, scabies, staphylococcal infections) by the end of the next business day.

##### Outbreaks:

- Community
- Foodborne
- Healthcare-associated
- Institutional
- Waterborne
- Zoonotic

#### NOTE:

Cases of AIDS (acquired immune deficiency syndrome), AIDS-related conditions, HIV (human immunodeficiency virus) infection, perinatal exposure to HIV, all CD4 T-lymphocyte counts and all tests used to diagnose HIV must be reported on forms and in a manner prescribed by the Director.



Fig. 1 Reportable diseases and the conditions under which they should be reported for the state of Ohio, USA

systems. An example of our own institution’s protocol regarding HIV testing and response is seen in Fig. 2 (see figure), although screening for other diseases such as hepatitis are included in these protocols. In general, wearing gloves has high compliance, while correct use and disposal of needles has a higher failure rate. Specifically, recapping used needles is a practice that is commonly done despite safety designs incorporated in the needle/syringe system. There is high

correlation between certification level and knowledge of the recommended universal precautions: advanced life support (ALS) providers understand and apply the recommendations more consistently than basic life support (BLS) providers. Ironically, the ALS providers report a higher rate of NSI and blood exposures, but are more likely to use needles during their care, and to engage in more intense resuscitation techniques. Forgetfulness, impaired dexterity and vision, and the

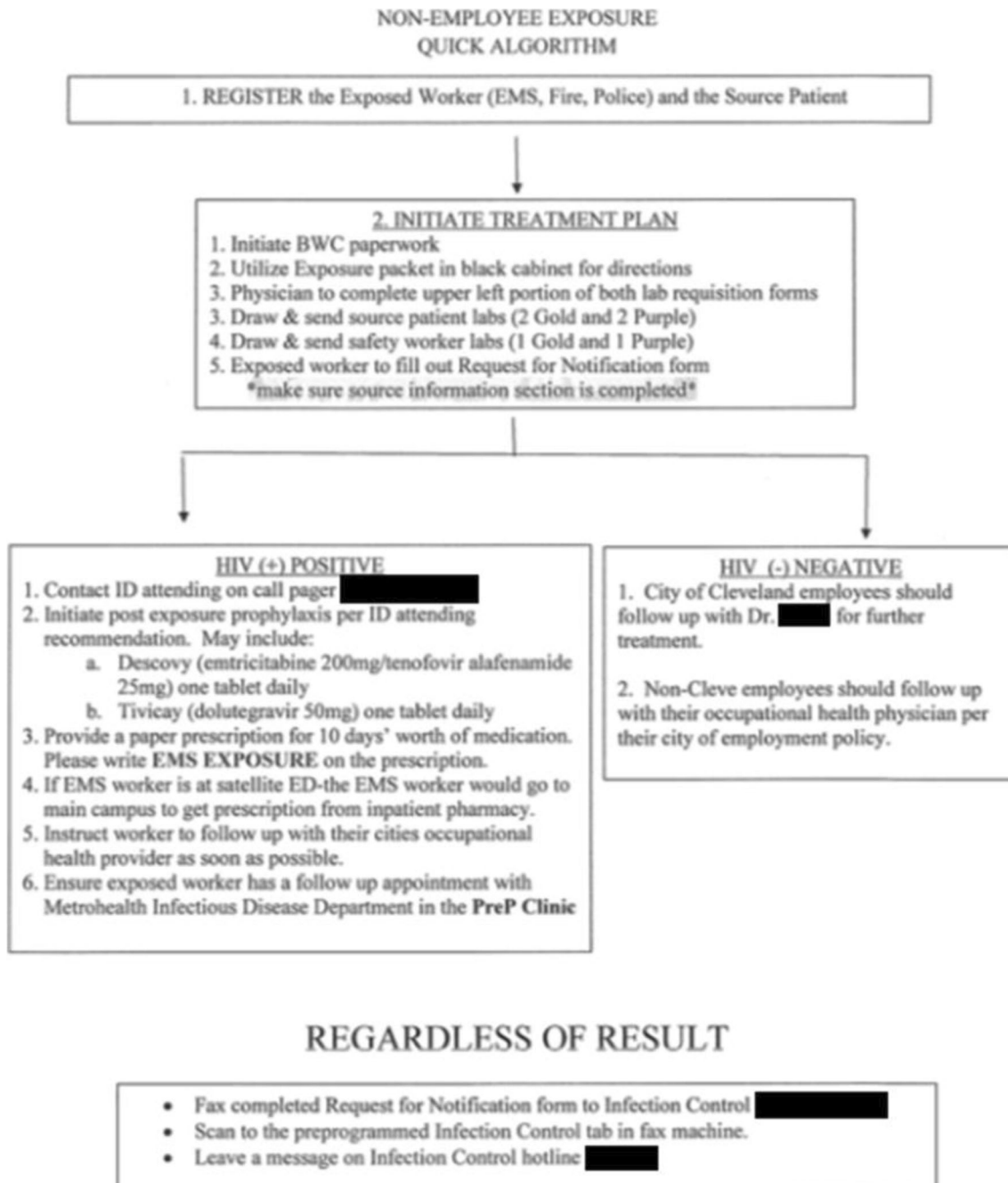


Fig. 2 Protocol for EMS workers with disease exposure and process regarding HIV results

time required for correct application are three reasons cited by EMS workers for non-compliance with universal precautions. Treating a patient who is at “low risk for transmission of disease” was a reason cited for failure to wear gloves, a recommendation that had 83% compliance in a large survey. Published results of this survey made valuable conclusions in its summary. EMS providers are prone to unintentional NSI due to movement (vehicles and patients), lack of convenient access to sharps containers, and the presence of multiple rescuers. Emphasis on compliance with known universal precautions should be increased among EMS providers [2]. While this likely poses one of the greatest threats to EMS workers, there are not an abundance of updated studies regarding the risk of disease transmission to workers in this setting.

Immunizations in the healthcare setting are an important means of preventing disease burden. It has been shown that despite education and awareness of the risks of disease transmission, healthcare workers, including pre-hospital providers frequently have low compliance rates with vaccines [3]. Identifying the barriers to vaccinations is imperative. Influenza is one area of focus that has potential for significant reduction in transmission and overall prevention with vaccination. Rates of vaccination are consistently low in the general population as well as in health care providers, with many reasons cited for acceptance or refusal [4, 5]. Finding motivators for and identifying obstacles that prevent vaccination, as well as increasing education among providers could be a simple way to help prevent disease transmission both to patients and providers during outbreaks of influenza [6•].

## Hand Hygiene, Universal Precautions, and Decontamination

EMS providers primarily work in small, enclosed spaces, and these spaces are subject to exposure to many pathogens and bodily fluids that makes them prominent vectors for disease exposure and transmission. A large part of recent research focuses on hygiene and sanitation efforts, as well as the training and education needed to implement it. Efforts are made to keep workspaces clean; however, the demanding and fast-paced nature, lack of time, resources, or even dedicated cleaning time and staff (such as is available in the hospital setting) makes it more difficult to achieve a more sterile environment. This lack of sterility, along with the worsening prevalence of multi-drug-resistant organisms (MDRO), puts both the health care providers and other patients at increased risk. Provider compliance with standard hygiene and use of PPE, as well as proper disinfection techniques can help decrease the disease transmission and exposure risk of such harmful pathogens [7–9]. The increasing prevalence of MDRO also increases the need for pre-hospital provider awareness and knowledge regarding actions needed to combat transmission

of not only methicillin-resistant *Staphylococcus aureus* (MRSA), but also other increasingly common pathogens such as vancomycin-resistant Enterococcus (VRE) and *Clostridium difficile*. Basic life support (BLS) and advanced life support (ALS) providers alike have been shown to lack education regarding the risks of these pathogens and the steps needed to limit their exposure and transmission. In one study, fewer than half of providers had even heard of some pathogens, and reported that increased awareness would prompt increased compliance with PPE and proper decontamination [10].

Proving and studying the transmission of such pathogens is difficult during actual transport with real patients and actual organisms. However, there have been efforts in attempting to document this, as well as in implementing new cleaning strategies to counteract disease transmission. One such study looked at standard protocol versus an updated protocol using a surrogate bacteriophage to represent bacteria and viruses [11••]. The authors found that in addition to decreased transmission with updated cleaning protocols, providers' hands were the primary vectors for pathogen transmission. This further illustrates the importance of basic hand hygiene and compliance with PPE. They also found that promotion of decontamination habits and formal training in updated techniques was needed. Another study again emphasized that pre-hospital providers are again major vectors of pathogens [12]. This also reiterated the fact that despite well-known recommendations from the Centers for Disease Control and Prevention, some EMS providers still do not practice appropriate hand washing techniques during patient care, increasing their potential for disease exposure and spread. This was again demonstrated in a study with self-reported compliance with hand hygiene and use of PPE. It, like many studies, showed that even with an understanding of the importance of hand washing and using personal protective equipment properly, there was a distinct lack of compliance among many providers, leaving significant room for improvement [13]. Alternatively, while proper hand hygiene is crucial, the surrounding environment still requires attention [14]. While there remains the constant need to decontaminate between patients as much as possible, improved techniques should be investigated. While decontamination techniques can be improved, it has been suggested that more intense practices and protocols may decrease the risk of persistent contamination in areas where standard cleaning techniques may not be applicable [15]. There is usually a short period of time between the transport of one patient and the next, especially in busy metropolitan and inner-city areas. This, among other complicating factors, is one of the many reasons cited by pre-hospital providers for decreased use of personal protective equipment, which subsequently leads to increased risk of injury or transmission [16]. It has also been shown that even with awareness of the need to disinfect contaminated surfaces, the lack of time, and sometimes

equipment frequently poses significant challenge to ensuring a clean workspace [17].

## Ebola and MERS

EMS providers are faced with transport of many different types of patients. They often have limited history, which may limit their ability to prepare for and protect themselves against dangerous communicable pathogens. Ebola virus and Middle Eastern Respiratory Syndrome are two of the most recent outbreaks of highly communicable diseases that heightened awareness for disease transmission, which warrant mention. Events such as Ebola virus outbreaks, as well as other highly communicable diseases like MERS, raise new concerns and highlight the need for updated protocols, as well as the increased need for education and training and preparation for such situations. This not only applies to the EMS workers, but to the entire emergency response system. This highlights an important need in the emergency medical response system for adaptability, rapid implementation of new protocols, and ability to widely disseminate information to workers to help prevent the transmission of these dangerous, easily transmissible diseases [18, 19]. Similar to other infectious diseases, the lack of provider compliance, for several reasons, remains a significant issue in disease prevention. The recent MERS outbreak prompted reassessment of reasons for PPE failure. One study revealed multiple reasons, including poor fit, especially for women, anxiety about the donning of PPE, and even low confidence in the PPE efficacy to protect from disease [20]. This is important due to the fact that health care providers are often a significant proportion of infected patients and risk further spread to patients [21]. Proper fitting PPE is especially important in respiratory illnesses like MERS, and providers should undergo proper fitting. It has been shown that there has been poor understanding of the appropriate use of PPE—requiring appropriate use of N95 masks—and isolation of patients in well-established diseases such as tuberculosis [22], so it is imperative to provide adequate information and training for these emerging illnesses and the infection control challenges they pose. While there are similarities between SARS and MERS, the latter has generally shown little human-human transmission. It does, however, have a very high mortality rate and pandemic potential, and travelers pose great risk for the spread of the virus [23], making recognition of suspicious symptom complexes and identification of recent travel a priority for EMS providers.

## Conclusion

Pre-hospital providers and the patients they serve are at heightened risk for disease exposure and transmission. They

face unique challenges with regard to prevention of transmission and decontamination of their workspace environment. There is an ever-growing prevalence of multi-drug resistant organisms that further complicates the process, and brings to light the need for investigation of improved cleaning and decontamination protocols. While some of the challenges are unique to the environment in which prehospital personnel practice, there remains an overwhelming abundance of studies revealing that following simple universal precautions, such as proper hand hygiene and improved compliance with the use of personal protective equipment, there remains a great deal of room for improvement. There also remains a considerable amount of need for improved education regarding the various pathogens, the dangers they pose not only to the patients but the providers as well, and the techniques available to help decrease the spread and transmission of aforementioned pathogens.

**Acknowledgments** The authors would like to thank Dr. Thomas Collins for reviewing their article.

## Compliance with Ethical Standards

**Conflict of Interest** Colton Bitley, Brian Miller, and Jonathan Glauser declare no conflict of interest.

**Human and Animal Rights and Informed Consent** This article does not contain any studies with human or animal subjects performed by any of the authors.

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