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Planning and Facilitating the Training of Emergency Medical Services on the Safe Transport of Patients with Highly Infectious Diseases

By

Mohammed A. Alhallaf

A THESIS

Presented to the Faculty of

The University of Nebraska Graduate College

In Partial Fulfillment of the Requirments

for the Degree of Master of Science

Emergency Prepardeness

Graduate Program

Under the Supervision of Professor Sharon J. Medcalf

University of Nebraska Medical center
Omaha, Nebraska

April, 2020

Advisory Committee:

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To my mother and father, I can only write thank you and I love you dearly. Last, I want to write how lucky I am to have the support of my loving wife, Maha. You encouraged me to pursue my dreams. The degree awarded me belongs as much to you. To my daughter Haya and son Omar, you have given my life a new meaning. This, and all that I do is for you.

Planning and Facilitating the Training of Emergency Medical Services on the Safe Transport of Patients with Highly Infectious Diseases

Mohammed A. Alhallaf, M.S.

University of Nebraska, 2020

Advisor: Sharon J. Medcalf, Ph.D.

Emergency Medical Services (*EMS*) personnel are the first line of treatment and are the first exposed health care workers to infectious diseases (*IDs*). Consequently, the EMS setting is a relatively vulnerable environment for disease transmission and cross-contamination. Also, serious and emerging IDs, such as highly pathogenic viral hemorrhagic fevers and novel Coronaviruses, in a time of increased globalization, require comprehensive EMS training and preparedness. This project had the objective of identifying best practices for the EMS transport of patients with IDs. The methods for this project were done in two phases. In the first stage, we conducted a literature review to outline current practices. In the second, we convened an EMS-ID Workgroup Meeting (held in Baltimore, MD, January 2020). The purpose of this meeting was to gather national and international experts to provide input to the University of Nebraska Medical Center to facilitate the development of an EMS-ID training curriculum. A total of 25 national and international EMS-ID organizations, along with CDC and ASPR officials, gathered to discuss best practices and work on answering common EMS-ID problematic areas. Topics were grouped into seven categories: equipment preparation, vehicle preparation, patient management, PPE selection, team configuration, decontamination, and post-mission surveillance. We report here the results of those discussions, highlighting the EMS Workgroup perspectives and noting areas where agreement could not be reached.

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List of Abbreviations

ASPR	Assistant Secretary for Preparendness and Response
CBRNE	Chemical, Biological, Radiological And Nuclear
CDC	Centers for Disease Control and Prevention
DOH	Pennsylvania Department of Health
EMS	Emergency Medical Services
EMT	Emergency Medical Technician
ER	Emergency Room
EVD	Ebola Virus Disease
HART	Hazardous Area Response Team
HCW	Health Care Worker
HEPA	High-Efficiency Particulate Air
HID	Highly Infectious Disease
IDART	Infectious Disease Ambulance Response Team
IP	Infection Prevention
IPC	Infection Prevention and Control
NBU	Nebraska Biocontainment Unit
NHTSA	The National Highway Traffic Safety Administration
NIOSH	The National Institute for Occupational Safety and Health
NSRI	National Strategic Research Institute
OSHA	The Occupational Safety and Health Administration
PIU	Patient Isolation Unit
PPE	Personal Protective Equipment
SARS	Severe Acute Respiratory Syndrome
UNMC	University of Nebraska Medical Center
WHO	World Health Organization

CHAPTER 1: INTRODUCTION

Emergency Medical Services (*EMS*) personnel are the first line of treatment and are the first exposed health care workers to infectious diseases (*IDs*). Consequently, the EMS setting is a relatively vulnerable environment for disease transmission and cross-contamination, keeping in mind that EMS providers may not have the sufficient training and knowledge for managing infectious patients and their transport. After the 2014-2016 Ebola Virus Disease (EVD) outbreak in West Africa, and the first transmission of EVD to health care workers in the United States, the EMS community understandably experienced anxiety about the appropriate education and training, as well as procedures to best handle patients with IDs (Isakov et al., 2015). In fact, due to the increase in frequency and transmission of IDs with high consequence, such as EVD, two counties in California, Sacramento and Contra Costa, have developed a specialized infectious disease response team called the Infectious Disease Ambulance Response Team (IDART), which is capable of managing and transporting patients with communicable/infectious diseases, much like a Hazardous Material Team (HAZMAT) would respond to a scene of a toxic spill (Murdock, 2014).

Serious and emerging IDs, such as highly pathogenic viral hemorrhagic fevers and novel Coronaviruses, in a time of increased globalization and travel, require comprehensive EMS training and preparedness for efficient infection control practices. In addition to treating the increasingly mobile populations, who potentially have a higher likelihood of contracting an infectious or emerging disease,

EMS personnel must decontaminate/disinfect their work equipment and ambulances, increasing their exposure to infectious pathogens (Woodside, 2013).

The extended amount of time EMS workers spend while wearing their personal protective equipment (*PPE*), can lead to fatigue, psychological stress, and possibly tears and degradation of the PPE, which places providers at a greater risk for contamination (Le et al., 2018). Ambulance workers must also consider what resources they have, develop a contingency plan for isolation and/or quarantine, manage medical waste, decide how many medics will be in the patient compartment, choose who will provide medications, and coordinate with state officials before transporting ID patients (CDC, Guidance for Developing a Plan for Interfacility Transport of Persons with EVD, 2017). To effectively answer these questions, a demanding amount of training and preparation must be done together with an intensive program of practice in the four infection control domains: hand hygiene, PPE selection and use, safe injections, and point of care testing prior to the decision to transport communicable/infectious disease patients.

The National Institute for Occupational Safety and Health (NIOSH) collaborated with the National Highway Traffic Safety Administration (NHTSA) to conduct a study to explore the rates of EMS injuries and illnesses. Unfortunately, the study showed that EMS providers have higher rates of fatalities and work-related injuries than the general workforce, and that approximately 6,000 paramedics and Emergency Medical Technicians (EMTs) are annually exposed to harmful substances, such as blood and respiratory secretions (Reichard, Marsh, Tonozzi, Konda, & Gormley, 2017). The study concluded that new and enhanced efforts are

needed to prevent the exposure of EMS personnel to harmful substances. Additionally, the Centers for Disease Control and Prevention (CDC) listed "treating patients with infectious illnesses" as one of the major job hazards EMS workers face as part of their duties (CDC, EMS Workers, 2018).

These exposures not only put paramedics and EMTs at serious risk for infections, but the general public as well; due to cross-contamination. Therefore, to enhance EMS workforce safety, and to protect the public's health, it is important to develop, plan, identify, and facilitate the components and competencies for a comprehensive EMS infectious disease training program. A well-defined training program can also enhance the existing infection control practices performed by EMS providers. For example, one study found that medics' hands were the primary vehicle of microbial transfer during actual EMS 911 calls, and that current practices of decontamination minimally reduced quantity and prevalence of viral loads, suggesting that the use of H_2O_2 wipes significantly reduced the concentration of viruses on EMS surfaces (Valdes, Sexton, Lutz, & Reynolds, 2015). Such recommendations can benefit the EMS community in implementing new and effective strategies of infection control and equipment decontamination.

To prepare professionals, the competency based training approach has attracted the interest of many educators around the world and became dominant in many medical and non-medical fields over the last four decades (Frank, 2010). The concept of competency based practice originated from paraller movements in professional training in a number of countries, such as the National Training Board in Australia, the National Skills Standards in the United States, and the National

Vocational Qualifications in England (Leung, 2002). If appropriately applied, competency frameworks can address the gap between the theory of competency based education and the practice of clinical teaching (Cate & Scheele, 2007).

Statement of the Problem/Context

Infection control and prevention practices of EMS providers are ongoing issues (Jackson, Lowton, & Griffiths, 2014). Yet despite efforts and strategies to reduce the burden of IDs, EMS workers' practice in dealing with communicable diseases is still reported as suboptimal due to poor knowledge of fundamental principles of infection control and disease transmission, as well as decreased compliance with *standard precautions* and equipment disinfection recommendations (Thomas, O'Meara, & Spelten, 2017; Bledsoe et al., 2014; Harris & Nicolai, 2010; Shaban, 2006; Shaban, Creedy, & Clark, 2003).

An infection control training module, specific to EMS, needs to be developed together with a competency set for IDs and infection control procedures for the EMS community in the prehospital field (Lowe et al., 2015; Mahomed, Jinabhai, Taylor, & Yancey, 2007). Strengthening EMS training and education on Highly Infectious Diseases (HIDs) could improve patient outcomes, responders' safety, and the community's health (Le et al., 2018).

Significance of Study/Project

To our knowledge, no study has yet developed a training set specific to the EMS community for transporting HID patients. The purpose of this project is to describe the process of identifying the need for an EMS-HID transport training program and to gather best practices on procedures for the EMS transport of patients with HID.

The results of this project will be valuable to: practitioners in the field of EMS, public health agencies, hospitals, and training facilities in developing better practices and tools for EMS-HID training programs. The outcomes of this work can enhance the occupational safety of EMS personnel by minimizing their exposure to infectious agents through a well-defined EMS-HID training set; improve patient outcomes; and eventually improve the community's health.

Research Question

This project investigates the components of an EMS-HID training program that can increase the knowledge and practice of paramedics and EMTs who may respond to patients with highly communicable/infectious illnesses. The overall objective of the project is to gather current practices, identify best practices, and finally develop an EMS-HID training set for the prehospital community.

Specific Aims

1. The overall objective for this project is to gather best practices on procedures for the transport of patients with HID.
2. Identify areas of consensus and gaps in EMS-HID practice.
3. Develop broad program educational skills to train prehospital providers who may potentially transport a HID patient.

To achieve the overall aim, the author will be providing a comprehensive review of sources related to HID training for EMS providers. And specify best practices, from national and international EMS-HID experts, in regards to transporting patients with communicable/infectious diseases.

Definitions of Terms

The term being defined is in **Bold**:

1. **Competency:** The knowledge, skills, and abilities demonstrated by organization or system members needed to perform specific functions within organizations or professional practice (Birkhead, Davies, Miner, Lemmings & Koo, 2008).
2. **Emergency Medical Services (EMS):** The NHTSA's Office of EMS defines EMS as a system that provides emergency medical care. Once it is activated by an incident that causes serious illness or injury, the focus of EMS is emergency medical care of the patient(s) (2019).

3. **Emergency Medical Technician (EMT):** Stanford Medicine, EMT Program defines EMT as an emergency responder trained to provide medical care. "EMTs may be solely responsible for the treatment and transportation of their patients or assist a paramedic, nurse, physician or other advanced life support provider" (2019).
4. **Infectious Disease (ID):** According to the World Health Organization (WHO), infectious diseases are caused by pathogenic microorganisms, such as bacteria, viruses, parasites, or fungi. The diseases can spread directly or indirectly from one person to another (2019). In this document, HIDs refer to highly hazardous communicable disease, high consequence infectious diseases, and/or high consequence communicable diseases.
5. **Paramedic:** The Department of Labor defines a paramedic as a person who responds to emergency calls, performing medical services, and transporting patients to medical facilities (2019).
6. **Personal Protective Equipment (PPE):** According to the Occupational Safety and Health Administration (OSHA), PPE include equipment for eyes, face, head, extremities, respiratory devices, and protective shields; depending on the nature of the incident (2019).
7. **Standard precautions:** Standard precautions are disease transmission prevention strategies recommended by both the CDC & WHO, and are available online for public access. https://www.cdc.gov/infectioncontrol/basics/standard-precautions.html

Assumptions

1. The EMS workgroup participating organizations are willing to engage and share their experiences that are related to the training of EMS and the safe transport of HID patients.
2. The participating organizations have experienced, or will experience, training EMS on transporting patients with highly communicable/infectious illnesses.
3. The EMS Workgroup participants are willing to share resources, such as data, recommendations, past experiences, that are beneficial to training EMS providers on handling and transporting HID patients.
4. The EMS Workgroup participants are EMS representatives from national and internation organizations.

CHAPTER 2: LITERATURE REVIEW:

This section will be divided into: literature of EMS transport of HIDs and literature of educational competency development.

1. Literature of EMS Transport of Patients with HIDs:

Prehospital personnel may be exposed to infections and body fluids of their patients due to the unpredictable nature of their job and the uncontrolled environment, as it is not always possible to predict which patient has a communicable disease (Speers, 2014). In fact, the effects of the stressful nature of EMS work has led to paramedicine being among the most dangerous careers (Thomas, O'Meara, & Spelten, 2017). However, to minimize the risk of contamination, standard precautions and PPE must be practiced, and PPE worn, at all times, together with appropriate immunization, continued education, and post exposure counselling of EMS staff (Speers, 2014).

Prehospital providers experience significant exposure to blood and body fluids, but at the same time, EMS workers are not consistently utilizing standard precautions and equipment disinfection recommendations, which is due to poor knowledge of fundamental principles of infection control and disease transmission (Thomas, O'Meara, & Spelten, 2017; Bledsoe et al., 2014; Harris & Nicolai, 2010; Shaban, 2006; Shaban, Creedy, & Clark, 2003); including failure to wear gloves (17%) and the inappropriate disposal of contaminated materials (79%) (Harris & Nicolai, 2010).

Despite these shortcomings, two studies reported the exposure rates to IDs in the U.S. among paramedics who work in a similar ambulance service company.

Both showed a decrease from 4.4 exposures per 1,000 EMS calls to 1.2 exposures per 1,000 EMS calls between 1993 and 2011, which is attributed to continued education and training on the appropriate use of PPE and infection control measures (Sayed, Kue, McNeil, & Dyer, 2011; Reed, Daya, Jui, Grellman, & Loveless, 1993).

During the 2003 Severe Acute Respiratory Syndrome (SARS) outbreak in Canada, 68 paramedics developed SARS, and 292 medics were placed on either home quarantine or work quarantine, which was due to the medics' unprotected exposure (not wearing the appropriate PPE) to health care facilities that experienced a SARS outbreak (Verbeek, McClelland, Silverman, & Burgess, 2004). Those who developed SARS did not use appropriate PPE, and four out of five paramedics initiated patient contact before being directed to wear their PPE (Verbeek et al., 2004).

Another study examined paramedics' exposure to various infectious disease hazards and found that they were most commonly exposed to meningitis (32.9%), followed by tuberculosis, viral respiratory infections, and body fluid splashes to skin and eyes; suggesting the use of protective eyewear to minimize the risk of body fluid splashes (Sayed, Kue, McNeil, & Dyer, 2011).

A qualitative study assessed the retention of donning and doffing of Level C (chemical-resistant coverall, butyl gloves, boots, and an air-purifying respirator) PPE skills among paramedics who received Level C PPE training six months ago at the University of Pittsburg. The study found that only 14.3% of medics successfully donned and doffed (suggesting that the current training is inadequate) without

committing a critical error, such as early removal of the respirator, with the most common non-critical error involving the removal of boots before other parts of the PPE ensemble (Northington, Mahoney, Hahn, Suyama, & Hostler, 2007). This study used a standardized training module and checklist adopted from a disaster medicine course taught at the University of Pittsburg as an evaluation tool for the paramedic's performance.

A survey by Visentin et al., assessed the use of PPE among EMS personnel during ID outbreak and non-outbreak situations, and found that the most common reasons for inconsistent donning of PPE were: judgment of non-necessity by the medics, and technical difficulties wearing the PPE (e.g., visual impairment while wearing protective eyewear) (2009). Another survey conducted on the EMS personnel in Summit County, Ohio indicated that medics need continued education focusing on the routes of transmission of IDs, their risk of contamination, and the effective use of protective gear. These results were due to the medics' lack of knowledge of diseases' routes of transmission, and the non-compliance with standard precautions (Mencl, Birkle, Blanda, & Gerson, 2000).

A most recent qualitative study examining EMS providers perspectives at one of the designated U.S. Ebola Centers showed that current EMS-ID training sessions were mostly focused on PPE, but neglected the basic knowledge of HID transmission, resulting in lack of confidence and feeling of danger among EMS practitioners during actual responses (Alexander, Masters, & Warren, 2020). The study concluded by stating that some of these concerns may be mitigated by providing continuous pandemic preparedness and training to EMS personnel.

A gap analysis survey of EMS practitioners' assessment of needs when transporting patients with HIDs highlighted the lack of consistent guidelines and training for prehospital personnel, and that EMS workers have limited time in their national curricula devoted to the identification of IDs and infection control practices (Le et al., 2018). At the end of this survey, respondents were asked to provide opinions. These included the need for a more quality training of IDs and not feeling confident enough to respond to HID patients.

Lowe et al., (2015) identified several considerations for the safe EMS transport of patients infected with EVD. Based on their analysis, they recommend: ambulance preparation (including stripping the ambulance patient care cabin of all equipment that is not required for transport, draping the patient compartment with 6-mm plastic sheeting secured with duct tape, and isolating the driver's compartment from the patient's), appropriate selection of PPE, and post transport/environmental decontamination.

Isakov et al., (2015) identified collaboration between EMS and the receiving hospitals as one component to fill educational and training gaps related to transporting patients with EVD, as well as teaching medics how to prepare the ambulance in advance to facilitate cleaning and decontamination. Isakov et al., (2015) also recommended that the ventilation system in the driver's compartment to be turned on with the fan set to high, without recirculation, to create a positive pressure area and to prevent from aerosols entering the compartment. They also noted that the Tyvek suit and hooded, powered, air-purifying respirator provided suitable splash protection, prevented medics from incautious touching of the face,

and did not cause eyewear fogging. As to ambulance waste after the transport of an ID patient, EMS staff PPE and any other waste from the ambulances transporting EVD patients at the Nebraska Biocontainment Unit (NBU) were bagged, secured, and passed to health care workers at the NBU to be placed in an autoclave (Lowe et al., 2015).

The United States Fire Administration listed the components of an infection control training program, which included: epidemiology, proper use of PPE, standard operating procedures for safe work practices, proper disposal of medical waste, cleaning and decontamination, exposure management, and vehicle/supply preparation (Guide to Managing an Emergency Service Infection Control Program, 2002).

Additionally, the Washington State Department of Health's Manual*, Infectious Disease Prevention for EMS Providers,* gives a detailed explanation on the proper techniques of managing an ID patient in the field (2009). The CDC, together with the Assistant Secretary for Preparedness and Response (ASPR), also created guidance for developing a plan for interfacility transport of persons under investigation or confirmed patients with EVD in the United States (2017).

Another study demonstrated the spread of microbes during actual EMS calls. The study found that medics' hands were the primary vehicle of microbial transfer (Valdes, Sexton, Lutz, & Reynolds, 2015). The study also found that current practices of decontamination minimally reduced quantity and prevalence of viral loads, suggesting that the use of H_2O_2 wipes significantly reduced the concentration of viruses on EMS surfaces, and that additional training on decontamination and hand

hygiene must be provided to the EMS personnel. The Pennsylvania Department of Health (DOH) recently recommended that ambulances be taken out of service for at least two hours after transporting measles patients - because measles virus can contaminate surfaces or hang in the air for up to two hours (DOH, 2019).

One observational study highlighted the use of standard precautions by EMS providers arriving at a large emergency department (ER). The study indicated the following: only 56.9% of medics arrived wearing gloves; hand washing was observed in only 27.8% of providers; equipment disinfection was noted in 31.6%, with the most commonly disinfected item being the patient stretcher (Bledsoe et al., 2014). Another observational study examined EMS personnel commitment to the four infection control domains: hand hygiene, PPE selection and use, safe injections, and point of care testing. The study found that only 50% of the EMS providers performed hand hygiene (County of Los Angeles Public Health, Communicable Disease Control, 2016).

The risk of communicable disease is not as obvious as other physical risks to the EMS personnel, such as road traffic and power line accidents, and therefore, EMS providers must receive a training that enables them to identify at-risk patients and the appropriate level of PPE (MacDonald, 2014). The risk assessment begins with screening questions and information obtained from the dispatch communication center, prior to making patient contact (MacDonald, 2014). These screening questions can include asking the caller for their present symptoms or if there is anyone else who is also sick at the callers' location (EMS Infectious Disease Playbook, 2017).

In some parts of Europe, there are specifically designed ambulances for the transport of patients with infectious diseases and are operated by the Hazardous Area Response Team (HART) paramedics (Schilling et al., 2013). The specific technical features on board these vehicles include controlled ventilation, negative pressure, HEPA filtration, aerosol tight systems, fixed equipment and walls that can be easily disinfected, and separation of driver's from patient's cabin (Schilling et al., 2013).

To conclude this section:

A preliminary literature review shows that past studies are primarily focused on the weaknesses of EMS management of patients with HIDs. What is missing from the past studies is a comprehensive and structured approach for developing competencies to train EMS providers on the safe transport of patients with IDs. Specifically, prehospital personnel need a training module that focuses on: identifying at-risk patients before making patient contact, compliance with standard precautions, modes of transmission of IDs, appropriate selection of PPE, donning and doffing procedures, ambulance preparation, decontamination of the vehicle and its equipment, and medical waste management.

2. Literature on Educational Competency Development

There are eight competency areas included in the Core Competencies for public health professionals developed by the Public Health Foundation (PHF) and Council on Linkages between Academia and Public Health Practice (COL), which apply to all public health specialists including paramedics (Birkhead, Davies, Miner,

Lemmings & Koo, 2008). The competency domains of public health practice are: analytic/assessment, policy development and program planning, communication, cultural competency, community dimensions of practice, public health sciences, financial planning and management, and leadership and systems thinking, with each domain having at least one primary competency statement (PHF, 2014). The competencies can serve to define knowledge gaps that can lead to the development of a specific training plan (Birkhead, Davies, Miner, Lemmings & Koo, 2008). The COL's competencies have served as a framework to build public health-relevant competency sets, such as public health preparedness and applied epidemiology (Koo & Miner, 2010).

Koo & Miner (2010) recommended a framework for workforce education in public health by targeting three conceptual approaches: adult learning theory, competency-based education, and the Dreyfus model in public health. Adult learning theory includes letting the adult learner know why they are learning, what the goal is, and whether they can achieve it, and is useful in preparation of the learning environment and engaging the learner in the appropriate types of learning activities. The theory of competency-based education as explained by Koo & Miner (2010) is based on the eight competency domains of the PHF, COL. The Dreyfus model in public health provides key guidance for selecting the suitable skill level for the different learners and focuses on longer-term career outcomes (Koo & Miner, 2010). The integration of the three concepts can produce high-quality workforce education.

The National Center for Environmental Health, within the CDC, has published recommendations for local environmental health practitioners; these include 14 core competencies grouped into three primary functions: assessment, management, and communication (2001). Assessment involves conducting a literature search and consulting with experts in the field. Management involves clearly articulating a problem and taking appropriate measures to resolve it. Communication involves effectively identifying "teaching moments" and emphasizing prevention (National Center for Environmental Health, CDC, 2001).

The Association for Professionals in Infection Control (APIC) and Epidemiology developed a conceptual model of Infection Prevention (IP) Competency that could be applicable in all practice settings (Murphy et al., 2012). The four domains identified by APIC represent a future-oriented competency development: leadership, infection prevention and control, technology, and performance improvement, which are described in detail in this reference (Murphy et al., 2012). The Certification Board of Infection Control and Epidemiology (CBIC) has also identified core competencies for IP, which included the identification of ID processes, controlling the transmission of infectious agents, and education and research (2012). The Journal of Infection Prevention has also published 17 competencies to design a well-structured education and training program specific to IP, which includes: clinical practice, education, research, and leadership and management (Burnett, 2011).

CHAPTER 3: DATA COLLECTION METHODS:

The methods for this project were done in two phases. In the first stage we conducted a literature review to outline current practices. In the second stage, we convened an EMS-ID Workgroup Meeting that included national experts from ASPR, NDMS, and CDC, as well as international HID experts, with an overall objective of identifying best practices. Finally, inputs and comments were collected using the Sphere Software.

The overall objective of the literature search was to identify agreement/disagreement areas between what is available from the literature and was discussed in the EMS-ID Workgroup Meeting. We reviewed the EMS ID literature available on Google Scholar and PubMed online databases using the search queries: EMS, paramedic, EMT, prehospital, MEDEVAC, ambulance, prevention, PPE, infectious disease, communicable disease, contagious, outbreak, containment of biohazards, and infection control, limited to the English language. These queries yielded 18 unique citations, which were imported into an electronic database (RefWorks).

Additionally, manually reviewed citations from related articles generated seven more sources. We included original, peer-reviewed articles evaluating EMS capability, weaknesses, and recommendations for the transport of patients with IDs. Articles were excluded if the sample population did not include paramedics, EMTs, or prehospital physicians and/or nurses, which required full-text review.

In the second stage of this project, we convened an EMS-ID Workgroup Meeting (held in Baltimore, MD, January 2020). The purpose of this meeting was to

gather national and international experts to provide input to the University of Nebraska Medical Center (UNMC) to facilitate the development of an EMS-ID training curriculum. A total of 25 national and international EMS-ID organizations, along with CDC and ASPR officials, gathered to discuss best practices and work on answering common EMS-HID problematic areas. The meeting was organized by UNMC and the National Strategic Research Institute (NSRI). No attempt was made to identify the credentials of the attendees nor their professional backgrounds. This strategy was used to ensure that each member was equally represented and to promote open discussion among all participants. Discussion was open to achieve an overall objective of sharing knowledge and identifying consensus around the following pre-identified content areas:

Content Areas:

1- Special equipment preparation
2- Vehicle preparation for ground transportation
3- Patient management
4- Infection Prevention and Control (IPC) practice, including PPE-related processes
5- Team configuration and communication
6- Hygiene, decontamination, and waste management
7- Post-transportation personnel management and monitoring

Finally, we solicited inputs and comments from practicing ID experts and 25 national and international organizations representing EMS using the Sphere Software. It is a platform designed for this type of collaboration meetings where data can be gathered simultaneously from multiple parties without disrupting the process. Participants were able to type their thoughts and questions without interrupting the presenter. The presenter (or any of the attendees) can then answer the questions and respond to the typed comments. Participants were introduced to the system before the start of the workshop.

Verbal comments and questions (that were not typed) were entered into the system by two notetakers. Here, we present the results of those discussions, highlighting the EMS Workgroup perspectives and noting areas where agreement could not be reached, followed by a summary of what should be incorporated into an EMS-ID training program ('Table 1: What to Incorporate into an EMS-ID Training Curriculum").

Sample Population:

The primary research method for this project is literature review and conceptual modeling. One EMS-HID expert workshop in Baltimore, MD will be assembled to identify current and best practices to transport patients with HIDs. The workshop participants (the EMS Workgroup) are national and international experts in the field of EMS and IDs. Inputs and comments will be solicited from participating organizations representing EMS and the transport of HID patients. The number of participating organizations is approximately 25 agencies from Korea, Japan, Singapore, Germany, Italy, Norway, and the United Kingdom, as well as

representatives from the CDC, ASPR, John Hopkins, NIH, Emory University, Indiana University, UNMC, and Omaha Fire Department.

Timelines:

Date	Task
October 10th	Final proposal submission
October 21st	Schedualing comprehensive exam on Seguidor
Week of October 21st	Start writing the first section of the Thesis
January of 2020)	Collecting data from the EMS-HID Workgroup participants together with conducting a literature/resource search to gather and determine best EMS-HID practices
January-March	Completing all sections of the thesis project Finish the reference page Proofread, refine, edit, before submission
March 20th	Submission of the final paper to Dr. Sharon Medcalf
April 6th	Submission of the paper to the Thesis committee
April 15th	Final Thesis presentation

Data Analysis:

The author analyzed data generated internally using simple statistics (e.g., percentages, averages, and frequency). Also, because the project's data is mainly composed of current observations, knowledge, recommendations, there was no need for complex numerical data analysis.

CHAPTER 4: RESULTS AND DISCUSSION

Content Area #1: Special Equipment Preparation:

As noted earlier, patient movement and biocontainment are among the most challenging tasks prehospital providers encounter when transporting patients with HIDs. It is crucial for EMS providers to plan and exercise the types of patient isolation systems used to transport special patients. The two isolation transport units discussed as measures to implement infection control were the ISOPOD and the EpiShuttle (developed after the 2014 EVD outbreak). Both units share the same indications of use - to contain the pathogens and decrease the risk of cross-contamination.

In this section of the workshop, we discussed the similarities and differences between the two isolators. Both Patient Isolation Units (PIUs) provide a negative pressure environment but require training prior to usage. The two PIUs provide access to the patient through the incorporated access ports (e.g., glove ports and ventilation ports), and thus, both are vulnerable to damage and, possibly, leakage of fluids. Also, fogging and decreased visibility through the transparent surface of the EpiShuttle was a special issue noted by the workgroup. Nevertheless, few participants encouraged the idea of using anti-fog products to enhance visibility. Our working group highlighted one major difference between the two PIUs - the adjustable internal stretcher of the EpiShuttle - which could improve patient experience and comfort during transport.

The EpiShuttle was also noted to have protective outer layers, allowing the unit to be re-used for up to five years or 20 uses (whichever comes first). Additionally, the EpiShuttle was acknowledged because it allowed for a reduction in the level of PPE required to implement IPC (since the patient is fully encapsulated), and therefore, lowered the risk of generated hazardous waste and offered an opportunity for a longer duration of travel (without change of caregivers).

A significant limitation of the EpiShuttle was the size configuration. Larger/taller patients would not fit into the unit, and thus, the EpiShuttle was not seen by the workgroup as practical as the ISOPOD. It also required individual adapters to be secured to the ambulance stretcher, which may not always be available for rapid deployment. Because there were many differences between the two, using an ISOPOD versus the Epishuttle was one area where participants could not reach an agreement. However, we all stressed the need for EMS agencies to clearly define when/when not to use a PIU in their protocols and Standard Operating Procedures (SOPs). If there is a risk for exposure to bodily fluids, the workgroup recommended using a PIU. But if the patient is “dry” or “stable”, he/she may not need to be placed in a PIU.

Many of our working group emphasized the importance of pre-positioning several patient care items inside the PIU for potential use during transport. These items included emesis bags; a marker board to ease communication or disposable walkie-talkies utilized for patient communication; ventilation devices; and a dedicated intravenous medication line to push medications as needed (e.g., sedatives, antiemetics, etc.). Further discussion on patient management techniques

will be outlined in the next sections. In addition to the ambulance's medical equipment, it was acknowledged that having additional hazardous waste bags, leak-proof containers, and impermeable sheets inside the patient care area may be useful for unstable patients who may produce excessive bodily fluids.

In addition to using a Bluetooth earpiece with a push-to-talk button or hands-free radios, a few of the group members proposed the idea of providing cooling vests for the EMS crew to provide comfort while performing patient transport in full PPE. Lastly, wearing external rubber boots was recognized by the workgroup to minimize slip hazards, especially during severe weather conditions.

Content Area #2: Vehicle Preparation for Ground Transportation:

The discussion started by acknowledging that, in case the patient's condition deteriorates (i.e., loss of consciousness) diversion from the receiving facility is not an option because the receiving hospital is prepared for the patient, whereas any other receiving facility may not be prepared with high level infection prevention mitigation processes or environments. Therefore, the transport unit must be sufficiently equipped and ready to provide safe, acute patient care (i.e., ventilatory support, cardiac monitoring, and medication infusion) until reaching its final destination.

The participants concurred with Lowe et al (2014) that the patient cabin should be draped with 6-mm plastic sheeting cut in a "U" shape and secured with Gorilla or duct tape. The process of draping an ambulance takes approximately one hour for two experienced personnel, and therefore, early notification should be practiced. Our working group also encouraged the use of the commercially available 6-mm plastic tarp designed for ambulance protection, which minimizes installation time to approximately 20 minutes.

While others still draped the back of the ambulance when using a PIU, many of the workgroup participants felt that draping the back of the ambulance when using a PIU is not necessary. The idea behind draping the patient compartment when using a PIU is to guard against unrecognized external contamination of the PIU. Nevertheless, the considerable majority agreed that the team who installed the

tarp/plastic draping should be the same team to remove and decontaminate the draping. That is because the installation team knows where the seams and tabs on tape and tarp/plastic draping are, thus minimizing the risk of potential unrecognized hazards.

As to the environmental modifications and HVAC control, the workgroup perspectives concurred with previous studies that the patient cabin must be isolated from the driver compartment; vent system in the driver compartment should be set to high without recirculation; and exhaust fan in the patient cabin is set to high (Kumar & Isakov, 2018). It was also acknowledged that lowering the cabin temperature for febrile patients may be helpful.

The participants discussed safety considerations for draping a standard ambulance and noted that including the following safety features may be necessary for future transports: seatbelt access; positive pressure air vents uncovered; painter's drop cloth or impermeable sheets to minimize slip hazard; and communication devices with external personnel. Using impermeable/impervious drapes over plastic was noted to be not as slippery as plastic and provided extra traction for the caregivers when wearing external rubber boots. Also, impermeable/impervious drapes did not require scissors or sharps when removed from the back of the ambulance and was semi-absorbent for patients experiencing diarrhea or vomiting. It is advised that applying these environmental modifications be supervised and conducted with the presence of a safety officer.

Some of our working group participants agreed that all medical equipment (e.g., cardiac monitor and suction unit) should be inside the patient cabin and

accessible but not exposed to contamination. Others felt for the need to remove all unessential equipment to a secondary transport/chase vehicle. Some participants felt that having pre-drawn medications secured/taped to the inside wall of the patient cabin may be helpful and can ease treatment procedures during transport (e.g., nausea), but the majority preferred to pre-treat patients before transport.

Many of our international participants did not express interest in conducting the above mentioned environmental modifications to a standard ambulance. Instead, they preferred using a dedicated Chemical, Biological, Radiological, Nuclear (CBRN) ambulance equipped with controlled ventilation; negative pressure; HEPA filtration; separated driver compartment; and intercommunication systems. Nonetheless, we all agreed that it is a preferred practice to arrange with nearby EMS agencies to stage additional ambulances as backup units, loaded with extra supplies and a PPE-capable team. A summary of additional special equipment considerations has been published elsewhere (EMS Infectious Disease Playbook, 2017).

Content Area #3: Patient Management:

This section highlights two goals: 1. Patient safety 2. Protection of EMS crew. The overall objective is to provide quality patient care while balancing the needs of the patient with the safety of the crew.

1. Patient Preparation:

Depending on the patient's condition, status, and signs and symptoms, some of our working group advised putting the adult patient in PPE (surgical mask, gown, impervious suit/sheet, undergarment, etc.) while being transported in a PIU. This is especially useful in the back of the ambulance, where close quarters cannot be avoided. The thought behind putting the patient in PPE inside a PIU is to arrest the spread of pathogens. The participants explained that having the patient wear the appropriate PPE may be useful in the event of a breach; needing to access the patient in PIU during transport; or in case of a PIU failure (e.g., HEPA blower failure requiring the need to open PIU). We advocate that EMS agencies anticipating the transport of patients with IDs to have written protocols addressing the issue of opening a PIU during transport.

The workgroup further discussed whether patients should wear N95 respirators or surgical masks. They concurred with Balazy and colleagues that surgical masks are adequate and that they are primarily designed to protect the environment from the wearer, whereas N95 respirators are intended to protect the wearer from the environment (2006). Nevertheless, we encourage establishing

early communication with the sending facility regarding patient preparation procedures.

The workgroup recommended that the team who packages the patient inside the portable isolator (using a verified packaging checklist) should not be the one to clean the outer surface of the PIU - to mitigate the threat of unrecognized contamination on the outside of the PIU. Although this practice may not be possible in the EMS setting and will require more personnel in PPE, every exposed EMS provider should be monitored following patient contact. If there is a limited number of providers, a change of gloves between packaging and cleaning must be done. Finally, our working group highlighted the importance of not allowing passengers, family members, or personal belongings in the sterilized driver compartment to prevent potential hazards or possible cross-contamination.

2. Treatment Considerations:

This section depends on whether the transport team is a Basic Life Support, Advanced Life Support, or a Critical Care Transport crew. Nevertheless, the workgroup reasoned that managing HID patients without understanding the epidemiology of the disease may produce fear and anxiety. In fact, understanding the nature of the illness helps Healthcare Workers (HCWs) recognize how to interrupt transmission, prevent cross-contamination, and decrease hesitancy and reluctance when caring for highly hazardous patients (Alexander, Masters, & Warren, 2020).

Pre-determining all patient care interventions was acknowledged to be a critical factor in achieving successful transport. Many of our participants encouraged the following: limiting the number of exposed providers; pre-treating for symptoms; limiting sharps; and limiting aerosol producing procedures (e.g., airway suctioning). Airway management and invasive procedures should be done before transport. We acknowledged that, if using a PIU, EMS providers could consider using blind airway insertion devices, such as King airway, rather than intubation. It is also best if diarrhea and vomiting can be controlled with pharmaceuticals prior to transport. When anticipating longer transport tasks, the working group noted the need to coordinate with the sending facility to place a Foley catheter to drain urine, especially when providing fluid therapy, as this is normally outside of EMS scope of practice.

In the case of clinical deterioration resulting in death during transport, the workgroup noted that prolonged Cardio Pulmonary Resuscitation (CPR) might not be possible. If so, the EMS crew will need to rapidly identify reversible causes of arrest and obtain more respondents in full PPE. The presence of additional providers in this confined setting may lead to infection control breaches and an increased risk of cross-contamination. For all of these reasons, and to protect the safety of the providers, the working group did not encourage CPR while en route to a receiving facility. However, this is highly dependent on the patient's condition, presenting symptoms, types of PPE, and length of transport time. Such intensive clinical care protocols (CPR, intubation, etc.) should involve the ethics principle and be planned with ID experts (Komar & Isakov, 2018).

3. Patient Hand-Off (Transfer of Care):

There was agreement that receiving hospitals should plan a secure (preferably indoor, climate-controlled) ambulance bay. It is best if the transfer of care site is spacious to permit multiple vehicles access, with clear separation of clean and dirty zones, to allow for ambulance decontamination and PPE doffing (discussed in the next sections). The site should also be equipped with bathroom facilities and running water.

The medic unit driver, or a member of the receiving facility, will open the back door and help remove the patient from the ambulance, but stay at the foot of the stretcher. The workgroup reasoned that opening and closing doors should not be done by any of the EMS caregivers due to contamination risk. Afterward, the medic driver should take the ambulance to the pre-determined location for decontamination, where he/she will doff PPE with the assistance of a trained observer using a verified PPE doffing checklist.

If paramedics help transfer the patient to the hospital bed, they will secure the stretcher and any used/exposed equipment for decontamination. Providers who assisted hospital staff with patient movement will perform PPE doffing inside the facility's decontamination area. All patient personal items are handled as contaminated items until autoclaved or chemically decontaminated to be returned to the patient.

Content Area #4: PPE Selection and IPC Related Processes:

The selection of the appropriate protective gear should be constructed based on a case-by-case analysis, transmission-based precautions (contact, droplet, aerosol), and in accordance with the CDC guidelines and recommendations. The workgroup noticed that the two goals when donning/doffing protective gear are the use of a proven checklist with the presence of a trained observer and frequent training of providers on competencies to use PPE ensembles. Many of our participants recommended that for caregivers, it may be necessary to wear impermeable gowns or coveralls; triple-layer gloves; boot covers; apron; full-face shield; and N95 respirators or Powered Air-Purifying Respirators (PAPR). A few of our international participants recommended using a fully encapsulating single piece suit with welded gloves and sock feet (Respirex FloPod™ Suit) with a two-way radio. The workgroup acknowledged the possibility of applying anti-fog products on face screens to enhance visibility.

We recognized that if the driver compartment is isolated, it is a redundant precaution for the medic driver to wear a N95 respirator, but consistent with the CDC guidelines issued for the transport of patients with SARS (CDC, SARS Guidance for EMS, 2004) - keeping in mind that there may be unrecognized mixing of air between the patient's and driver's compartments in some ambulance designs.

The participants also discussed the important of considering how long EMS providers are allowed in PPE while in the back of the ambulance. If prolonged transport is anticipated, there should be a designated, secured respite site where providers can switch roles and doff their PPE - planning with environmental

services and law enforcement is key. Also, when we discussed the respective maximum time limit in PPE, we agreed that it is subjected to personal tolerance; the level type of PPE; environmental conditions; physical fitness; work demand; and battery life of the blower unit. Most agreed that two to three hours is sufficient for providers to be in PPE, but no longer than safe and effective IPC practice (accommodating for patient loading and unloading times).

Lastly, most of our group participants rely on safety officers to monitor staff in PPE and the overall performance (may not be possible unless a safety officer travels with the team). And we noted that aside from training HCWs, it may be necessary to train other personnel and non-medical crew on PPE donning and doffing. This can include security officers and sanitation workers.

Content Area #5: Team Configuration and Communication:

It is expected that the transport operation will be supported by an incident command structure with a dedicated safety officer and a backup unit/secondary transport team carrying extra supplies. We agreed that best practice is to limit the number of exposed providers as reasonably possible. This, however, depends on the patient's condition and needs. Our working group indicated that, when using a PIU, a member of the hospital/biocontainment staff can assist with the PIU processes and ride with the ambulance crew. As to roles and responsibilities, we acknowledged that the medic driver will not make any patient contact but will assist the crew with opening and closing doors. The driver will be isolated from the patient compartment and will be wearing a coverall, N95 respirator, and goggles without wearing hooded PAPR and hazmat boots as this might not be safe to operate a vehicle. Also, private Radio channels are preferred to prevent from interruptions and/or the available radio scanning applications.

The number of providers inside the patient compartment varies based on several factors, including whether the patient is ambulatory or not, and whether he/she needs ventilatory support. Nonetheless, in addition to the medic driver, most agreed that having two paramedics in full PPE with communication devices installed inside the coverall (preferred disposable walkie-talkies) is sufficient. But if necessary, a specialty provider (e.g., peds/neo) can join the EMS team to provide further care. A supervisor and a safety officer - ready to be deployed in full PPE- are encouraged to travel with the crew to monitor the overall performance and IPC requirements. Additionally, in case of an emergency stop, the chase/secondary

vehicle may carry other supplies, such as water coolers, tables for equipment, and tent. Lastly, it may be required to coordinate with environmental services and law enforcement to establish secured respite sites where a change of crew (for prolonged transports) can occur.

Content Area #6: Decontamination and Waste Handling:

In this section, we first discussed the nature of the location in which the disinfection/decontamination will occur. We agreed that the transfer of care location within a hospital should be spacious to allow for multiple vehicles and to accommodate PPE doffing zones (with clear separation of clean and dirty areas). In this site, wipe down of vehicle, equipment, and the collection of biomedical waste will take place, keeping in mind that hazardous waste is highly regulated - Hazardous Material Regulations (HMR, 49 C.F.R., Parts 171-180). Also, having an indoor location is preferred because it can offer protection against weather elements and secure from bystanders and media.

We acknowledged that visibly soiled surfaces must first be decontaminated using an Environmental Protection Agency (EPA) registered disinfectant following the directions on the label. Used/exposed medical equipment and high touch surfaces (e.g., door handles) must also be decontaminated. Generated waste, including clothes worn under PPE, should be packaged in autoclave bags and bins and transported for autoclave/disposal facility. Our working group did not recommend using disinfectant sprays because it is an aerosol producing procedure.

Once all tape/wire ties have been cut, plastic draping inside the patient compartment can be folded in on itself and disposed of as hazardous waste. Finally, depending on the size of the autoclave, the ISOPOD can be cut down and autoclaved at the receiving facility - keeping in mind that best practice may be to partner with the receiving hospital or a specialized company to handle the waste.

After wiping down the entire ambulance with an EPA registered disinfectant, many of our working group suggested using vaporized hydrogen peroxide disinfection (Bioquell) for vehicle decontamination. And while others preferred applying Ultraviolet Germicidal Irradiation (UVGI) light, few recommended using gaseous Chlorine dioxide. Recent studies have shown that using UVGI in multiple locations can effectively reduce microbial contamination and mitigate decontamination concerns (Lindsley et al., 2018).

Content Area #7: Post-Transportation Actions:

We highlighted the importance of post-mission surveillance following the successful transport of HID patients. The workgroup noted that, in addition to being monitored for signs and symptoms of the disease for the incubation period and general wellbeing, it might be necessary to provide mental health resources to the EMS team following patient transport. We recommend using the NIOSH Emergency Responder Health Monitoring and Surveillance Framework to ensure the safety of the crew before, during, and following transport. Finally, the receiving facility should update the transport agency with regards to confirmatory patient testing, as this may impact post-mission medical surveillance.

('Table 1: What to Incorporate into an EMS-ID Training Curriculum")

Education

- **Identification of HID processes**
  - Incubation
  - Signs and symptoms
  - Modes of transmission and prevention
  - Available vaccine/prophylaxis
- **Infection prevention and control procedures**
  - Hand and glove hygiene concepts
  - PPE selection
  - PPE donning and doffing technique
  - Indication for the use of a portable isolator
  - Principles of isolation and quarantine
  - Cleaning, disinfection, and sterilization of PIU, vehicle, and reusable PPE
  - PPE breach and biohazard spill
  - Liquid and solid waste management

Vehicle and Special Equipment Preparation

- Desired PIU
- Environmental modifications and cabin draping procedures
- Team communication strategies and devices
- Pre-positioning the desired patient care equipment

Patient Management

- Team configuration and composition
- Patient preparation and placement
- En route clinical care guidelines
- Physical and psychological considerations
- Transfer of care processes

Post-Transportation Actions

- Debriefing
- Post-mission medical surveillance
- Continuing education

Recommendations for the future

Given infrastructural and knowledge gaps in the field of EMS transport of patients with HIDs, there is an urgent need to establish an evidence-based hands-on EMS training curriculum. Our working group agreed that current training practices tend to be based on history, tradition, and past responses and not real scientific evidence to support a solid best practice. Therefore, future research and pilot projects could help us identify the effectiveness of EMS-HID training programs and whether there are additional gaps to be covered.

Based on the workgroup discussions, we recommend having a network of ID specialists experienced with portable isolators to review, define, and recommend features that can be used by EMS agencies to set standards and protocols. Those ID specialists experienced with portable isolators could clearly define whether dry and stable patients need to be placed in a PIU and whether there are safer options for unstable patients that allow for direct patient contact and interventions, such as draping an ambulance and holding the use of portable isolators. Our working group highlighted the issue of opening a portable isolator during transport (for emergency interventions) and noted that current protocols do not address this issue. Thus, future research should tackle the topic of opening a PIU during transport and evaluate its impact on patients and crew safety.

Pediatric transport was another area identified by the workgroup as a gap. Future research could help us identify the use of portable isolators when transporting infants/children/youth sized HID patients. The CDC guidelines do not recommend putting pediatric patients in PPE during EMS transport (2018). Thus,

EMS agencies may need additional training on the use of (pediatric isolation transport units) and child restraint system (Pedi-Mate). Keeping in mind that these types of patients may be accompanied by a caregiver, who will need to be wearing the appropriate protective gear and briefed on IPC practices.

Lastly, EMS agencies should expand their public health role and become involved with community health monitoring resources, including participation in the collection of patient-related data. EMS leaders and managers should continue to recognize issues of interest, including crew safety and disease transmission, to not only inform decision-makers but implement the needed training programs accordingly. We advocate EMS organizations anticipating the transport of HID patients to establish partnerships with receiving hospitals and facilities to identify and solve common EMS problematic areas, including patient hand-off, decontamination, waste management, and staff surveillance and monitoring.

Finally, although this project has identified the components of the seven content areas for the EMS transport of patients with HIDs, utilizing this project to develop an EMS-HID training program is not the last step. EMS agencies should work on maintaining IPC competencies among their staff through frequent exercises and drills, followed by a systematic training evaluation process, which is to ensure the level of ID preparedness and quality among all prehospital providers.

As to the actual training, we propose the following:

- We recommend that the EMS-HID training program be at least two days to allow the adult learner the sufficient time to observe and practice the highlighted skills in ('Table 1: What to Incorporate into an EMS-ID Training Curriculum").
- Before the start of the actual training, it would be helpful for the trainees to receive electronic pre-training learning materials and videos that address communication strategies, IPC practices, Level C PPE donning and doffing, PIU features, decontamination techniques, and waste management.
- We encourage using a verified checklist to guide students and instructors on special equipment preparation, PPE donning and doffing, biohazard spill management, and decontamination techniques.
- Developing the following documents can facilitate the delivery of the training program and ensure quality throughout the project: instructor manual guide, student manual, e-learning materials, student and instructor assessments, and the appropriate evaluation instruments.
- Finally, conducting the appropriate pilot testing of the EMS-HID training curriculum before delivery can be beneficial in highlighting unrecognized gaps within the training.

Limitations

This project has a few potential limitations. First, no attempt was made to identify the credentials of the attendees nor their professional backgrounds. This strategy was used to ensure that each member was equally represented and to promote open discussion among all participants. The discussion was open to achieve an overall objective of sharing knowledge and identifying consensus around the seven pre-identified content areas. However, all of our working group participants were self-identified as EMS and HID experts, along with CDC and ASPR officials and other stakeholders.

This projected is also limited by the seven pre-identified Content Areas: (learned from past EMS responses to HIDs, including EVD). There may be additional EMS-HID problematic areas that were not identified in this project, including the transport of pediatric patients with highly hazardous diseases and identifying at-risk patients through 911 HID-screening questions.

Additionally, and as we have mentioned earlier, current EMS-HID training practices tend to be based on history and past responses and experiences but not real scientific-based evidence to support a solid best practice for training purposes. We encourage future research projects to assess and evaluate the effectiveness of an evidence-based hands-on EMS training curriculum.

Conclusion

The EMS Workgroup has wrestled with many of the distinctive challenges and uncertainties surrounding the transport of patients with highly communicable diseases. Areas of uncertainty included: using an ISOPOD versus the EpiShuttle, draping the back of the ambulance when using a PIU, placing all medical equipment inside the patient cabin, and the respective maximum time limit for providers in PPE. These are areas in which future research could provide guidance in order for EMS agencies around the U.S. to achieve a higher level of biocontainment. With that said, we realize that controversies will always remain. We advocate all EMS agencies anticipating the transport of HID patients to have close working relationships with receiving hospitals to address common problematic areas and strengthen EMS infection control procedures.

As we have seen in the recent COVID-19 outbreak, the value of training EMS providers, who played a major public health role during the outbreak, on the safe transport of patients with HIDs cannot be denied. At the conclusion of this project, we attempted to provide perspectives and considerations, from 25 national and international organizations, that will benefit prehospital providers caring for and anticipating the transport of patients with special pathogens. The results can be widely applicable for current and future training programs aiming at developing better EMS-HID practices. Future research should focus on developing transport recommendations for the HID pediatric population and identify the use of portable isolators when transporting infants/children/youth sized HID patients.

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