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Major Article

Determining training and education needs pertaining to highly infectious disease preparedness and response: A gap analysis survey of US emergency medical services practitioners



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Background: The Ebola virus disease outbreak highlighted the lack of consistent guidelines and training for workers outside of hospital settings. Specifically, emergency medical services (EMS) workers, who are frequently the first professionals to evaluate patients, often do not have advanced notice of patient diagnosis, and have limited time in their national curricula devoted to highly infectious disease (HID) identification and containment. All of these can place them at increased risk. To explore the depth of US EMS practitioners' HID training and education, a pilot gap analysis survey was distributed to determine where the aforementioned can be bolstered to increase occupational safety.

Methods: Electronic surveys were distributed to EMS organization members. The survey collected respondent willingness to encounter HID scenarios; current policies and procedures; and levels of knowledge, training, and available resources to address HIDs.

Results: A total of 2,165 surveys were initiated and collected. Eighty percent of frontline personnel were aware that their agency had an HID standard operating guideline. Almost 85% of respondents correctly marked routes of exposure for select HIDs. More than half of respondents indicated no maximum shift times in personal protective equipment.

Discussion: This research suggests EMS practitioners could benefit from enhanced industry-specific education, training, and planning on HID mitigation and management.

Conclusion: Strengthening EMS preparedness in response to suspected or confirmed HID cases may not only improve patient outcomes, but also worker and community safety.

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The 2014–2016 West Africa Ebola virus disease (EVD) outbreak resulted in best practices on patient care and supplemental clinical activities within health care settings to be widely disseminated.^{1–16} Highly infectious diseases (HIDs) like EVD tend to have high case fatalities; are easily transmissible from human to human; and require intensive medical, public health, and community control measures.¹⁷ Consequently, the EVD outbreak underscored the lack of consistent guidelines, training, and education for workers outside of traditional hospital settings who might also encounter potential HID scenarios, and subsequently respond to these hazards.

Specifically, for workers within emergency medical services (EMS), which represents traditional first responders in the United States, there are varying levels of certifications for those who provide immediate medical care during an event.¹⁸ Although EMS practitioners are not independent—they are typically contracted by local government or private organizations—they are often unsupervised, have minimal assistance, exercise critical decision making, and provide emergency care in high-pressure scenarios.¹⁹ The most common licensure levels in order of increasing eligibility requirements for EMS are: emergency medical responder, emergency medical technician (EMT), advanced EMT, and paramedic. National recommendations for EMS personnel licensure levels are determined by the National Highway Traffic Safety Administration (NHTSA); however, only 1.3% of the national EMS education standards and curricula competencies are allocated to addressing the vastly complex issue of infectious diseases.^{19,20} States utilize the NHTSA EMS model, but ultimately dictate the scope of practice for their state EMS regulatory system. Hence, state licensure models and funding levels differ, which could contribute to the national variability in EMS preparedness to respond to infectious disease incidents.

Because EMS practitioners are often the first health professionals to evaluate patients—frequently without advanced notice of diagnosis—their ability to quickly and accurately recognize symptoms of an HID can help prepare downstream resources for an appropriate response. Although emergency response systems emphasize the importance of EMS practitioners in mounting swift and effective patient care, EMS practitioners are often overlooked when providing HID-specific education and training. In agencies composed of full-time and volunteer practitioners, the dilution of resources may be exacerbated.¹⁹ The lack of time and comprehensive training needed to conduct an extensive patient history could result in an inaccurate diagnosis where early symptoms of an emerging or re-emerging HID could be mistaken for a routine influenza-like illness. Furthermore, the operational separation between EMS agencies and hospitals may prevent EMS practitioners from accessing the more comprehensive training resources often provided to hospital personnel, although HID education and training is necessary to both increase the safety of EMS responders and improve patient outcomes.²¹

Additionally, although EMS practitioners receive mandatory Occupational Safety and Health Administration (OSHA) training on bloodborne pathogens, the training tends to focus more on protecting individuals than on the logistics and importance of protocols for infection control and decontamination, which is integral in HID containment.^{2,5,7} These gaps in infection control training can potentially lead to an overall decreased comfort in responding to patients with HID and a consequent decrease in the ability of an emergency response framework to effectively contain an HID exposure.^{22–24}

To explore the extent of HID training and knowledge amongst EMS practitioners, a gap analysis survey pertaining to HID preparedness and response among EMS practitioners in the United States was administered. Results were analyzed to determine current levels of HID training, education, current protocols and procedures in place at the respondent's agency, and potential differences in levels

of certification or position responsibilities correlated to differences in HID knowledge to determine areas of HID training and education that can be bolstered in this industry to increase occupational safety and health in EMS practitioners.

MATERIALS AND METHODS

Study design and participants

Adapted from vetted checklists used by the European Network of Highly Infectious Disease Units to survey the capabilities, training, and resources available at European high-level containment facilities,²⁵ an EMS-specific gap analysis survey was developed, reviewed by subject matter experts in local and national EMS organizations, and administered during July 2016 utilizing Qualtrics Software version 2016.17 (Provo, UT) (Indiana University institutional review board exemption No. 1605983959). This study was part of a series of gap analysis surveys pertaining to HID mitigation and management for workers outside hospital settings and designed with the death care sector²⁶ and medical waste industry gap analysis surveys.²⁷ Two nearly identical electronic surveys (the only difference being personal pronouns), each composed of 48 questions, were administered at the supervisor/lead/management level (Lead) and the worker/member/frontline responder (Frontline) level. Participants selected which survey they believed most appropriate based on job position and were not assigned a specific survey upon distribution. National and local EMS and EMT organizations—International Association of EMS Chiefs, National Association of Emergency Medical Technicians, University of Nebraska Medical Center, and Infection Control/Emergency Concepts, Inc—sent the anonymous link to the surveys to e-mail lists of collectively 108,800 individuals; 2 follow-up e-mail messages were sent over a 3-week period to solicit further participation. The survey links were closed after 30 days.

Statistical analyses

The survey was divided into 3 sections that collected information on demographic characteristics (9 questions); responder-specific questions on comfort with and willingness to encounter HID scenarios and currently implemented policies and procedures (15 questions); and levels of education/knowledge, training, available resources, and personal protective equipment (PPE) to address HID scenarios (24 questions). Survey respondents were provided this definition of an HID, as defined by the European Network for Infectious Diseases, at the forefront of the survey: “A disease transmissible from person-to-person that causes life-threatening illness, and presents a serious hazard in health care settings and in the community, requiring specific control measures.” Examples of HIDs included viral hemorrhagic fevers, smallpox, severe acute respiratory syndrome, and other highly pathogenic agents.²⁵ Most of the survey was composed of single or multiselect multiple-choice questions, with the ability to provide qualitative responses throughout the survey where appropriate. Due to the preliminary nature of this HID gap analysis survey, descriptive statistics were solely used and generated via Microsoft Excel (Redmond, WA).

RESULTS

A total of 1,550 surveys at the Frontline level were initiated and collected, and 615 were initiated and collected at the Lead level, for a total of 2,165 and an overall response rate of approximately 2%. All survey questions were voluntary and skip patterns were integrated throughout; therefore, individual question response rates varied from 16.9%–74.4% at the Frontline level and 24.4% to 72.3%

at the Supervisor level, with a final survey completion rate of 47.4% and 46.0%, respectively, of those who initiated the survey. Individual question response rates are detailed throughout the results.

EMS survey respondents were holders of varying positions and some respondents indicated holding multiple titles. When asked for self-reported titles at the Lead level (451 responses), 12.9% were training or education officers; 52.8% were in high-level administration positions (ie, director, president, vice president, or captain); 20.2% were chiefs; and 14.2% were paramedics, firefighters, or EMTs. At the Frontline level (1,126 responses), 56.8% were paramedics (eg, medics, NPR, and EMT-P); 33.0% were EMTs (includes EMT-B and EMT-A); 4.8% were officers (ie, lieutenant, captain, chief, sergeant); and 5.4% were support (ie, office staff, instructors, or engineers). Detailed respondent demographic characteristics can be provided to readers upon request.

Industry-specific perceptions of willingness, comfort, and current levels of HID training and agency reporting

Respondents were asked to indicate current levels of infectious disease training. When asked whether their agency provided training on patient and practitioner safety related to infectious diseases and communicable diseases, 95.6% of Leads and 85.9% of Frontline respondents marked “Yes.” When asked whether respondents have ever been trained on how to screen and provide emergency medical treatment to patients that might have a HID like EVD, 85.7% of Leads and 72.8% of Frontline respondents marked “Yes.”

Respondents were surveyed on self-reported levels of willingness and comfort with encountering a potential HID scenario. When Frontline responders were asked to rate, on a Likert scale, how willing and comfortable they would be to encounter a potential HID scenario, Leads were also asked to rate their perceptions of how Frontline workers would respond. There were discrepancies in extreme willingness and comfort with encountering potential HID scenarios (Tables 1 and 2). For positive extreme responses, such as “Very willing” to encounter a potential HID scenario, Frontline-level individuals were more willing than the Leads perceived (19.0% difference) and Frontline individuals marked “Very comfortable” more frequently than Leads perceived (11.3% difference).

To identify potential comfort differences between EMS practitioners of different training histories, level of certification was cross-tabulated with willingness and comfort with encountering a potential HID scenario at the Frontline level. Results indicated that paramedics reported the most often to be “Very willing” (58.8%) and “Very comfortable” (58.6%) compared with EMTs (31.3% and 30.5%, respectively) and EMT-intermediates (8.0% and 7.6%, respectively).

To determine the extent of the relationship with their local or county public health department or local Centers for Disease Control and Prevention (CDC) Quarantine Station—located at 20 ports of entry (including airports) and border crossings, CDC Quarantine Station personnel work with the local EMS agency to transport a suspected

ill passenger from airport to hospital for further evaluation to prevent the spread of infectious disease²⁸—respondents were asked whether their agency had an effective and engaged relationship with the aforementioned; 42.45% of Frontline-level respondents reported “Yes,” 19.9% reported “No,” and 37.9% reported “I don’t know.” For Lead-level respondents, 61.7% reported “Yes,” 28.6% reported “No,” and 9.7% reported “I don’t know.” In the qualitative portion of the question, both Lead-level and Frontline-level respondents indicated the most common forms of communication with the local or county health department were annually coordinated exercises or tabletops and communication via e-mail with public health officials.

Additionally, respondents were surveyed on their awareness of the level at which agency reporting of when a patient with a suspected HID is evaluated is conducted for their agency. The most common response, in terms of the level at which mandatory infectious and communicable disease is reported, was marked at the agency level, followed by the county level (Leads reported 35.7% and 21.0%, respectively, and Frontline respondents reported 39.3% and 18.3%, respectively). In the open-ended responses, several Frontline-level respondents stated they did not know at which level mandatory reporting is conducted at or that it was above their pay grade. When asked whether their agency maintains its own communicable disease emergency response plan (CDERP), 50.9% of Leads marked “Yes,” 10.7% marked “In development,” and 11.2% marked “I don’t know”; whereas 32.0% of Frontline respondents marked “Yes,” 3.1% marked “In development,” and 44.8% marked “I don’t know.” More than two-thirds of Lead-level respondents (71.2%) reported having standard operating guidelines or procedures for a response to an HID, whereas 56.7% of the Frontline-level respondents marked “Yes” and 19.5% “I don’t know.” More than three-quarters of both groups reported that the standard operating guidelines or procedures have been revised in light of the EVD outbreak (76.7% Frontline and 82.9% Leads).

Infectious disease knowledge, resources, and training

In regard to where EMS survey respondents were receiving their up-to-date information about HIDs in relation to their industry, the majority selected government websites (ie, CDC and World Health Organization) (67.7% Leads and 50.1% Frontline) followed by their primary national organization’s website (ie, International Association of EMS Chiefs and National Association of Emergency Medical Technicians) (51.2% Leads and 42.3% Frontline). More than one-third of Frontline-level respondents (37.5%) received updated HID information from coworkers or word of mouth; 22.9% of Lead-level respondents also reported this mode of communication. Moreover, receiving updated HID information through continuing education or training provided directly by the workers’ agency was more common than through professional conferences or external organizations providing education and training.

Table 1

Percent differences in perception between the willingness of lead-level personnel and frontline-level personnel to encounter potential highly infectious disease scenarios

Respondent level	Very willing	Somewhat willing	Neither willing nor unwilling	Somewhat unwilling	Very unwilling
Lead	20.9	47.6	11.9	17.7	1.9
Frontline	39.9	34.9	12.0	9.0	4.2

Table 2

Percent differences self-reported comfort with encountering potential highly infectious disease scenarios in Lead-level personnel versus Frontline-level personnel

Respondent level	Very comfortable	Somewhat comfortable	Neither comfortable nor uncomfortable	Somewhat uncomfortable	Very uncomfortable
Lead	8.0	38.8	13.4	32.0	7.8
Frontline	19.3	38.1	11.9	24.8	6.0

To explore the overall knowledge possessed by EMS practitioners regarding HIDs, respondents were asked to mark the routes of exposure for select HIDs. EVD was incorrectly marked as airborne by 17.3% of Frontline-level respondents and 15.4% of Lead-level respondents; similar percentages were found in the airborne category for other viral hemorrhagic fevers like Marburg virus and Lassa fever. Anthrax was marked incorrectly as transmitted via human-to-human contact by 14.6% of Frontline-level respondents and 16.3% of Lead-level respondents.

Survey participants were also asked whether certain performance benchmarks needed to be met before responding to HID events. In regard to whether agencies require orientation training before members are allowed to respond to a potential HID situation, 63.8% of Lead-level respondents and 50.1% of Frontline-level respondents marked “Yes,” with 78.5% and 72.4% marking “Yes,” respectively, to successfully demonstrating competence via performance of manual skills and procedures rather than solely attending a continuing education course. More than 80% of Lead-level and Frontline-level respondents indicated that the aforementioned demonstration also ensured observation of possession of these skills to respond to a potential HID situation while wearing PPE. Almost two-thirds of respondents (63.5% Lead-level respondents and 61.7% of Frontline-level respondents) reported annual retraining or continuing education was mandatory for employees who are trained to work with HID scenarios at least on an annual basis. Half of Lead-level respondents (50.0%) reported that their agency does perform just-in-time (JIT) training before personnel responding to a potential HID situation and 12.9% marked “I don’t know”; 29.4% of Frontline-level respondents marked “Yes” to JIT training and 30.0% marked “I don’t know.”

Survey respondents were asked a variety of questions on employee health monitoring and PPE. When asked whether they were aware of their agency had procedures in place for health monitoring (ie, twice daily temperature and symptoms), to monitor an employee who was potentially exposed to an HID, 29.92% of Lead-level respondents reported “Yes” and 54.7% reported “No”; 27.7% of Frontline-level responses reported “Yes” and 67.6% reported “No.” The majority of respondents (80.3% Lead-level respondents and 63.5% Frontline-level respondents) were aware that their agency provided an employee assistance program. More than 50% of both groups (60.5% Lead-level respondents and 56.7% Frontline-level respondents) reported having mechanisms, procedures, or protocols in place for quality improvement and the safety of practitioners, such as the EMS Voluntary Event Notification Tool.

Respondents were asked about their agency’s PPE procedures, which are detailed in Table 3.

At the end of the survey, respondents were asked whether there was any other information or opinions they would like to share that the survey did not ask. Repeated open-ended feedback included

wanting more quality training and/or more comprehensive low-cost training pertaining to HIDs, respondents only serving as a volunteer with an EMS agency and having another full-time occupation, not feeling confident enough to respond to a HID with the magnitude or severity of EVD, and desiring a greater budget to provide HID training and resources to their responders.

DISCUSSION

The results of this US EMS industry-specific gap analysis survey suggest practitioners could gain from increased up-to-date education and training on HID risk mitigation and management. Because of the preliminary patient care that EMS practitioners provide, adherence to updated HID training and education should be legislated and regulated on equal footing as any other health profession. Despite more than 70% of both Lead-level and Frontline-level respondents indicating that their agency had provided training on patient and practitioner safety related to HIDs like EVD and severe acute respiratory syndrome, discrepancies in Lead-level and Frontline-level perceptions on willingness and comfort with responding to potential HID calls (Tables 1 and 2) and deficiencies in knowledge of the routes of exposure to several key HIDs were found. Moreover, open-ended feedback revealed concerns over the minimal amount of HID training practitioners currently receive from their agency, a lack of confidence in ability and resources to address a HID scenario, and a desire for more enhanced preparedness. Respondents indicated that they most often used government Web sites to obtain HID information; however, that was still <70% from both groups. In a public health emergency, EMS agencies that are strained and unprepared could lead to chaos and flawed judgment calls, like the EVD case in Dallas, TX, in 2014.²⁹ Hence, EMS agencies—as a trusted and regular contact—are the entities best positioned to distribute up-to-date factual education, evidence-based best practices, training, and guidelines to enhance practitioner health and safety when encountering highly infectious scenarios. This could be achieved by adding specific competencies on HIDs within continuing education requirements for state licensure and/or expanding the scope of HIDs in the national guidelines outlined by NHTSA.

Whereas an overwhelming majority did report being provided training on patient and practitioner safety pertaining to infectious and communicable diseases, when asked their level of willingness and comfort with encountering potential HID scenarios, those at the Frontline level reported being “Very willing” and “Very comfortable” with responding than their Leads, a 20% and 10% difference, respectively. Moreover, level of certification seemed to influence levels of willingness and comfort to report to these potential HID scenarios. Paramedics reported being the most willing and

Table 3
Responses to select statements regarding personal protective equipment (PPE) by Lead-level versus frontline-level personnel

PPE statements	Lead-level personnel marking “Yes”	Frontline-level personnel marking “Yes”
Protocols are in place that detail proper donning/doffing technique of PPE for conducting a screening for a suspected patient with an infectious or communicable disease	73.7 (289)	62.2 (647)
Agency has protocols or procedures in place for the selection of differing PPE ensembles depending on the highly infectious disease risk	68.5 (200)	66.6 (447)
Strategies are present for implementing and monitoring the correct use of PPE	57.7 (177)	47.6 (374)
There are no maximum shift times in PPE without changing out PPE to prevent physiological stress	60.8 (174)	47.2 (358)
Fit tests for respirators were performed at minimum annually on all personnel that might respond to a highly infectious disease scenario, in compliance with the agency’s respiratory protection program	76.5 (224)	68.4 (480)
Agency has procedures to ensure adequate PPE quantities are available in case of a surge in demand	67.9 (207)	41.1 (319)
Agency has protocols to monitor stockpiled PPE for expiration dates and proper storage	77.7 (220)	69.6 (402)

NOTE. Values are presented as % (n).

comfortable with responding to HID situations out of all certification levels. This could be attributed to the longer duration and depth of training paramedics receive and the lower turnover rates due to fewer routine transport calls and higher pay in the industry for paramedics compared with EMTs and emergency medical responders.^{19,30}

Respondents at the Frontline level had less awareness of the level at which infectious disease reporting was mandated (eg, agency or county), whether their agency has a communicable disease emergency response plan, and standard operating guidelines or procedures in response to an HID. Although this might seem out of the necessary scope of knowledge for an EMS practitioner, enhancing frontline knowledge of procedures and infrastructure their agency has in place in event of an HID can lead to increased preparedness and a safer, more efficient response.³¹ Additionally, although more than half of respondents indicated that there were mechanisms in place for quality improvement and to enhance the safety of practitioners, the regular use, capture, and overall utility of quality improvement tools like the EMS Voluntary Event Notification Tool is unknown. Hence, inclusion into existing national injury or occupational risk data surveillance systems like the National Institute for Occupational Safety and Health EMS Workers Injury and Illness Data Set^{32,33} might be a method to capture safety data for analyses to guide improvements and changes.

In regard to where respondents obtained their up-to-date information about HIDs, government and their primary national organization's Web sites were the most frequent responses. Although the majority of practitioners were able to correctly identify routes of exposure for select HIDs, which still leaves more than 15% of respondents incorrectly marking the modes of transmission for Category A agents like EVD, Lassa fever, and Anthrax. This highlights the potential for primary national organizations to increase and/or enhance HID information and education not only through their Web sites, but also via e-newsletters, regular communications to their membership, national conferences, Webinars, and continuing education courses. In addition to a wider dissemination, regular HID information and training resources posted to EMS national organization Web sites could foster uniformity in the resources being distributed across EMS agencies nationwide, and may lead to a corresponding improvement in EMS practitioner HID knowledge.

Although the majority of respondents noted that orientation training was required before responders were allowed to report to a potential HID scenario, EMS workers were still less than two-thirds compliant with undergoing periodic retraining at the Lead and Frontline levels. JIT training was reported as commonly not being conducted before responding to a potential HID situation. This may be due to most scenarios where EMS have no prenotification of an HID scenario; otherwise with advanced notification the appropriate PPE ensembles should reflect the threat level based on OSHA standards, and it would behoove EMS agencies to conduct JIT training. Studies in both simulated and actual emergency or pandemic scenarios have demonstrated the efficacy of JIT training to enhance responder preparedness.^{34–36} Furthermore, among survey respondents, employee health monitoring postencounter with a potentially infectious patient was lacking. It would benefit EMS agencies to conduct regular employee health monitoring in scenarios with potential exposure to HIDs to protect both the responders and communities in which they serve.

With enhanced training and education of recognition of potential HID patients, there will be a subsequent need for enhanced training and education for appropriate PPE selection and donning/doffing technique. With respect to PPE protocols and maintenance of PPE supply, the majority of respondents—and more so at the Lead level (>60%)—reported having no maximum amount of time in PPE before being required to change out of the PPE. This underscores

the lack of consistency and need for depth of broader educational requirements for PPE. It should be noted that responders who transported the EVD patient within Dallas were not wearing appropriate PPE and the ambulance was not decontaminated immediately after transport for the level required for EVD, resulting in potential EVD exposure to transport personnel, health care workers, and the community and leading to significant negative press.³⁷ Furthermore, extended periods of time in PPE can lead to physiological and psychological stress, as well as tears and degradation of the PPE, placing workers at increased risk for exposure. Furthermore, frequently responding to events outside of the confines of a hospital exposes EMS practitioners' PPE to variability in the environment (ie, weather and concrete surfaces) that can significantly influence PPE degradation more than the relative smooth finishes and predictable environment within a health care facility.¹ Most did report having protocols or procedures in place for selecting differing PPE ensembles, ensuring adequate supply in the event of increased demand, and monitoring stockpiled PPE for expiration dates and storage.

Generally, when asked questions on agency level reporting, employee resources, training, and PPE, Frontline-level responders selected "Yes" less often than Lead-level responders. This could be due to a lack of awareness among Frontline responders of the administrative/nonpractitioner aspects of their agency and/or a lack of communication from Lead-level to Frontline-level responders. An unexplored yet potentially important contribution to decreased HID knowledge among EMS practitioners may be the differences in training and education between full-time, part-time, and volunteer staff. It is possible that updates on best practices or training on HID transmissibility are not being fully disseminated from full-time staff to those who are part-time workers or volunteers. Although some emergency responders are not paid personnel (volunteers), they must still undergo some baseline level of training, so HID mitigation and management could be a module or component of that training, or at least those courses offered to volunteers to ensure that all individuals in the agency receive consistent and thorough information. Open-ended responses from survey participants indicated a want for more HID education and training, but ultimately it will be up to EMS agencies on the extent of mandating the aforementioned.

The results of this study indicate several concerning trends in the preparedness of EMS practitioners to safely respond to HID events. However, these knowledge and training gaps may be ameliorated through several means:

1. Changes to government and primary national organization websites that more effectively educate EMS practitioners on HID transmissibility and containment, as has been provided to health care workers for years (ie, CDC and World Health Organization Web sites).
2. Organizational changes that foster increased communication of HID training, knowledge, and available resources between administrators and leads with frontline responders, and between practitioners with differing certification levels. This model was utilized at Omaha Fire and Rescue, and led to the safe and successful transport of 3 EVD patients in the United States in a large metropolitan area.^{5,16}
3. Adhering to and expanding upon existing OSHA and CDC training guidelines and recommendations through increased volume of HID-specific training, including proper PPE use and decontamination techniques.
4. Implementing and/or increasing the volume of regular HID trainings that focus on the epidemiology of re-emerging and emerging HIDs.
5. Utilizing existing national resources, like training programs, that specifically provide free HID training to specific worker populations.³⁸

Lastly, EMS agencies may benefit from the designation of specifically trained groups of EMS practitioners to respond to confirmed HID incidents. EMS agencies may perceive responding to HID is a low-frequency event, and therefore EMS practitioners may lack the familiarity with certain HIDs and feel a certain level of discomfort when responding to HIDs as a result. Instituting specialized infectious disease transport teams within agencies to respond to and transport a known HID patient may alleviate many concerns and obstacles that arise when comparing a HID scenario to a day-to-day call. However, this assumes the ability to identify HID during the screening process prior to EMS dispatch and transport. A specialized infectious disease transport team for HID, like hazardous materials and items specialization, could receive comprehensive education, training, and equipment that exceeds what EMS practitioners typically receive, and could bring a greater level of comfort to all EMS personnel in the agency.

There were several limitations to this study. Because the survey was voluntary and self-reported, it could have led to selection bias. Additionally, although the survey was distributed by EMS and EMT agencies, it was developed and had the logo of an external source, which typically does not elicit as robust of an overall survey response rate (ie, nonparticipation). Although our response rate was >2,000, because it was sent to more than 100,000 individuals we did not believe it was appropriate to use more statistically rigorous techniques (ie, inferential statistics) for a small sample of the study population in this study. Additionally, although more than 100,000 individuals were sent the survey links it does not indicate that all e-mail addresses were functional or that individuals opened the e-mail message. If this study is replicated, to achieve a better overall response rate, it might be improved by a prominent national EMS agencies developing and administering the survey, rather than an external entity asking for the agencies to distribute the survey links. Moreover, anecdotally the national ratio of EMTs to paramedics is 1:4, whereas more than two-thirds of our Lead-level and Frontline-level respondents were self-reported as paramedics. Consequently, this discrepancy may not only be indicative of a broader pattern of reduced participation in EMS agency by EMTs as compared to paramedics, but may also not be representative of the entire US EMS practitioner population. Lastly, with the survey not forcing participants to answer any question to proceed, this led to varying response rates from question to question.

Challenges and future directions

If a future study building off this survey is conducted, it could entail a more comprehensive survey with specific scenario and protocol questions, including questions to help determine challenges EMS practitioners are facing in implementing mandatory requirements or enhancing training programs and education. In line with that, a section could be included specifically directed at volunteer EMS practitioners to gauge their desire to expand HID training and education. Additionally, a future study could focus on geographic locations—perhaps in larger cities with an existing high-level isolation unit or designated regional EVD and other special pathogens treatment center to determine whether those areas have more robust training and education programs pertaining to HIDs.

CONCLUSIONS

This research suggests that EMS practitioners could benefit from enhanced, up-to-date industry-specific education, training, and planning on HID mitigation and management. Due to the variations among state licensure models, there is a need for cohesive and comprehensive curricula as well as mandatory HID standards to be implemented at the national level to increase EMS practitioner

knowledge and readiness. Enhancing EMS practitioner preparedness and response to suspected or confirmed HID scenarios can not only bolster patient care, but also occupational health and safety, as well as community safety.³ Several simultaneous strategies were suggested to accomplish the aforesaid, including regularly posted information on EMS national organization Web sites, organizational changes that promote increased communication about HIDs and safety culture, expanding upon existing training guidelines, and using existing national training resources.^{34,39} For US EMS, improving practitioner education and training may result in enhanced preparation, capability, willingness, and comfort to respond to potential HID scenarios.

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