



Transportation of Patients in a Bioemergency

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The 2014–2016 Ebola outbreak increased awareness worldwide of the burden of infectious diseases. Although noncommunicable diseases are the leading cause of morbidity and mortality in most developed nations, infectious diseases remain a major public health concern in the United States and around the world. With globalization and travel, there is a heightened need for preparedness. Systems and processes need to be in place to not just recognize and treat affected individuals but transport them safely with minimal risk of spread.

Prevention of transmission is paramount. Environmental and administrative controls, together with work practices and personal protective equipment must be implemented to prevent direct person-to-person spread via contact with infectious body fluids or droplets and also by indirect spread through fomites. In this chapter we provide a framework for transportation of patients in both the out-of-hospital and hospital settings. Preparedness planning and infection control strategies for each illness need to account for routes of transmission and risk of exposure.

Out-of-Hospital Transport

Healthcare and relief workers traveling to the epicenter of epidemics to provide care is increasingly commonplace. With this there is an increased need to repatriate ill workers and to be vigilant for returning travelers who develop signs and symptoms of illness. Systems and processes need to be in place to recognize signs and symptoms of illness and to manage patients with highly hazardous communicable

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diseases (HHCD) in the out-of-hospital setting, whether that be a planned intercontinental critical care transport, a domestic interfacility transport, or a local emergency medical services (EMS) response to a medical emergency. Ideally dedicated teams, educated about HHCDs and trained in fastidious implementation of infection control practices, would be available for the planned transport of these patients, but emergency medical services responders will also need to be sufficiently knowledgeable and trained to manage a patient with a HHCD, should the patient's condition preclude waiting for a dedicated team [1]. Outlined are the descriptions of practices that will need to be considered.

Hierarchy of Controls

A hierarchy of controls is used to protect healthcare workers, patients, and others from exposure to infectious bodily fluids, droplets, and aerosols [2]. The hierarchy ranks interventions based on their effectiveness in reducing the likelihood of exposure. In order of preference, the hierarchy describes (1) elimination of potential exposures, (2) engineering/environmental controls, (3) administrative controls/work practices, and (4) safety/personal protective equipment.

Elimination of Potential Exposure

Eliminating exposure for EMS personnel is a challenge, but plausible in certain contexts. Patients that are known to have a HHCD or are highly suspected of having one, when possible, should preferentially be transported only by personnel and agencies that have the requisite education and training, policies and procedures, demonstrated competencies, and qualified supervision to manage and transport the patient safely. In communities where these capabilities exist, and where there is need for a planned transport of a patient with a HHCD, untrained personnel can avoid exposure. A ready example of a planned transport is an interfacility transport of a patient from one hospital to another (e.g., from a community hospital to a specialty center). Another example of a planned transport is a traveler recently returned from a country with widespread transmission of a HHCD who is being actively monitored by the public health authority for fever and other signs of illness. When it is determined that the traveler has fallen ill and is in need of a medical assessment, qualified teams can be designated to transport the patient, avoiding exposure for others.

When patients access healthcare by dialing 911, it is difficult for emergency responders to eliminate the possibility of exposure. However, call center screening for travel history and signs and symptoms of illness that raise concern about a HHCD can help by alerting the responders to the risk, allowing them to rightsize the response team and eliminate potential exposure for other personnel [3].

Engineering and Environmental Controls

These rank second on the hierarchy of controls, as the implementation of environmental controls decreases the likelihood of exposure without requiring active



Fig. 8.1 Ambulance with impervious barrier drapes applied as an environmental control. (Photo courtesy of Alex Isakov)

healthcare worker interaction. Environmental controls aim to manage the hazard such that it does not come in contact with the healthcare worker or other personnel. An example of implementation of environmental controls for out-of-hospital management and transport of a patient with a HHCD is modification and preparation of the ambulance or transport vehicle. For example, when transporting a patient confirmed or suspected of having a HHCD, the driver compartment should be isolated from the patient compartment, so that the driver compartment can always be considered clean. In case of transport of patients that require airborne precautions or those requiring aerosol-producing procedures, a positive-pressure environment should be created in the driver compartment using the ventilation system [4]. The ventilation system in the driver compartment should be set in non-recirculating mode with the fan on high. The ventilation system in the back of the ambulance will preferentially also not recirculate air, and the exhaust fan should also be set on high [5]. This should decrease the likelihood of exposure to an infectious aerosol in the driver compartment and maintains appropriate air exchange in the patient compartment.

Depending on the type of vehicle used for transport, the interior needs to be prepared to minimize exposure of environmental surfaces and equipment as well as facilitate decontamination and disinfection following the mission. Various methods have been used to envelop the interior of the patient compartment with impervious barriers to protect against contamination of surfaces [5] (Fig. 8.1). This is especially important for patients who pose a high risk for sharing infectious bodily fluids through active bleeding, vomiting, or diarrhea. The stretcher can be protected with an impervious sheet, and essential medical equipment can be placed in a clear plastic bag [6].

Patients may also be asked to wear a disposable undergarment to capture diarrhea and may be asked to wear a coverall to protect the healthcare worker from draining wounds, or contaminated clothing. If a patient is unable to comply, impervious sheets may be used to envelop the patient during transport. A patient isolation unit may be employed as an environmental control. This has been described for long fixed-wing transports. A portable isolation unit may also be employed by ground or rotor wing air ambulances. Agencies electing to use portable isolation units will need to consider operating procedures for patient management and the unit's decontamination and disinfection or final disposition.

Administrative Controls

Administrative controls are policies and work practices that the healthcare worker implements to avoid exposure and to prevent exposure of others. These rank third in the hierarchy of controls because they require consistent application by healthcare workers and supervisors. There are many examples of policies and work practices implemented to protect the healthcare workers whose scope of work requires management and transport of patients with serious communicable diseases. The application of screening questions to identify patients with fever and other signs and symptoms of illness, like cough, rash, vomiting, or diarrhea, can alert the healthcare worker to the risk of exposure prior to contact [3]. Healthcare workers must fastidiously apply standard precautions with every patient contact, which includes strict adherence to hand hygiene, the use of exam gloves, and the application of other protective equipment to protect the skin and mucous membranes from exposure to bodily fluids. Standard precautions also address the proper cleaning and disinfection of medical equipment and environmental surfaces and the proper use of sharps. In addition to standard precautions, transmission-based precautions may also be required when standard precautions alone do not adequately protect the healthcare worker from the contagion.

Other examples of work practices include limiting the number of healthcare workers making patient contact, prohibiting healthcare worker reentry into the driver compartment of the ambulance after making patient contact, preventing unprotected contact with the patient, and the utilization of trained observers and checklists for the donning and doffing of PPE. Standard clinical care guidelines may need to be modified for transport to enhance safety by avoiding invasive and aerosol-producing procedures when possible and decreasing exposure to sharps in a moving vehicle. Patients may be administered anti-nausea or antidiarrheal medications to decrease the likelihood of emesis or diarrhea. Procedures must be in place for managing breaches of PPE and inadvertent exposure to bodily fluids, as well as for immediate consultation with medical control for decision support. Procedures should also be in place to inform how the patient will be transferred out of or into a hospital. The patient should be transported to the designated location via the most direct path in a manner that limits exposure to unprotected staff, patients, and visitors. Hospital or facility security should be in place to secure the route and guide the transport personnel to the designated unit [7]. A post transport medical surveillance program should be implemented for the care team to ensure early recognition of signs of illness [3].

Safety Equipment and PPE

Safety equipment and PPE ranks last in the hierarchy of controls because it serves as the last line of defense against exposure to infectious bodily fluids, when other controls cannot avoid exposure. Selection of PPE should be based on standard- and transmission-based precautions and in accordance with CDC guidelines. PPE selection should also accommodate the condition of the patient, the anticipated mission requirements, and the work environment [6].

Application of PPE in adherence with standard precautions should include exam gloves during any patient contact and goggles/face shield and simple mask for any airway procedures (intubation, suctioning), with addition of a gown for any situations likely to generate splash/liquid exposures [8]. In cases of large draining wounds or diseases requiring contact precautions, a disposable fluid-resistant gown that extends to at least mid-calf or disposable fluid-resistant coveralls should be used along with disposable gloves in addition to standard precautions. A disposable surgical facemask should be used at all times for droplet precautions, and eye protection may also be advised. In case of airborne illnesses, respiratory protection against inhalation of aerosols is key. PPE includes a disposable National Institute for Occupational Safety and Health (NIOSH)-approved, fit-tested N95 respirator or powered air-purifying respirator (PAPR) with full hood and high-efficiency particulate air (HEPA) filter. PAPRs should be considered for employees that cannot safely fit test on N95 masks due to facial hair, facial structure, etc. [9]. In case of highly pathogenic organisms like EVD, Marburg virus, or Lassa fever, PPE is based on extent of symptoms and presence of active emesis, diarrhea, or bleeding [10].

On prolonged missions, powered air-purifying respirators may be more comfortable when airborne precautions are required. The use of a hooded PAPR may also help avoid other challenges such as fogging of eyewear and risk of inadvertently touching the face. Splash risk with bodily fluids is also decreased [1]. Consider work rest cycles for personnel wearing PPE. Personnel should be competent with donning and doffing equipment. Donning and doffing should be performed under the supervision of a trained observer. The CDC and ASPR have checklists available for donning and doffing procedures as a guideline as well as training resources [3, 11].

Education and Training

As a matter of policy and a commitment to safe practice, paramedics, emergency medical technicians, flight nurses, EMS physicians, and other out-of-hospital healthcare workers need to be educated about infectious pathogens that they may become exposed to in the workplace. They should receive education on signs and symptoms of illness, modes of transmission, incubation periods, available treatments and vaccines, and general management of the patient. Most importantly they must be educated to interrupt transmission with emphasis on standard- and transmission-based infection control practices (Fig. 8.2) [5]. This education is important to mitigate any fears or apprehensions and facilitate the delivery of safe and effective care.

- Introduction and overview of transport of patients with serious communicable disease
 - Education and training
 - Equipment
 - Concept of operations
- Tenets of infection control
 - Standard precautions
 - Hand hygiene
 - PPE
 - Patient care equipment
 - Environmental controls
 - Injury prevention
 - Transmission-based precautions (contact, droplet, aerosol)
 - PPE
 - Patient care equipment
 - Patient placement
 - Categorization of common pathogens
- Education about serious communicable pathogens
 - Epidemiology of illness
 - Microbiology of pathogen
 - Methods of acquisition/transmission
- Natural disease course
 - Incubation
 - Signs and symptoms
 - Transmission
 - Recovery
- Preventing transmission/infection control
- Treatment
- Vaccine/prophylaxis
- Operational planning and procedures
 - Clinical care guidelines
 - Crew composition and roles
 - Vehicle preparation
 - Special equipment
 - PPE
 - Selection
 - Donning
 - Doffing
 - Decontamination and disinfection procedures
 - Waste management
 - Partnership with receiving facilities
 - Postmission surveillance

Fig. 8.2 Education and training

Healthcare workers are also trained in use of personal protective ensembles. Developing and maintaining a high level of competency with the use of PPE is vital for workforce safety. This should also include fit testing per Occupational Safety and Health Administration (OSHA) Respiratory Protection Standard (29 CFR 1910.134) [12]. Initial training should be followed up with periodic refreshers and exercises prior to a mission.

Additional training on communications, patient care during transport, infection control practices, PPE selection, donning/doffing PPE, and decontamination is also needed [7]. After initial instruction, team medic competency-based training must be evaluated, with special attention to the proper donning and doffing of a variety of personal protective ensembles in the presence of a trained observer.

Special Considerations

Stakeholders

Key stakeholders must be identified early and depending on the case and jurisdiction may include federal, state, and local governments, state or local department of health, and emergency management authorities, state and local EMS and law enforcement agencies, healthcare systems, unions, and others. Relationship building and coordination among these agencies is vital, and coordinated planning and training helps ensure a smooth transport of the patient.

State and local authorities should be involved in facilitating transport and ensuring proper authorities are available to respond to any issues related to the route during transport (traffic, weather-related events). In case of transport involving an airport, airport authorities should be included in mission planning. Multidisciplinary coordination is key for a safe transport. Relationships should be established and time taken to develop and exercise SOPs. Training exercises will provide an opportunity to execute a step-by-step plan and provide the various agencies an opportunity to examine the interface of their respective roles and responsibilities.

Federal authorities also participate in planning and coordination for patient transport and have resources and capabilities which include movement of patients by air ambulance. These resources are largely coordinated by the Department of Health and Human Services, through its Office of the Assistant Secretary for Preparedness and Response. The Centers for Disease Control and Prevention and NIOSH provide guidelines that can be adopted by state and local agencies that will facilitate safe management and transport of patients with HHCDs [7].

Clinical Care Guidelines

Plans for resuscitation and/or active treatment during transport must be considered in case of clinical deterioration and/or death. The transport team should understand which interventions and procedures might be anticipated and which will not be considered during the transport (e.g., cardiac arrest resuscitation, intubation, or other invasive procedures) [13]. Plans should consider patient condition, required devices and medication needs, types of PPE necessary, and length of transport time [7]. Consider involving ethics and infectious diseases experts in the planning and discussion.

Ensure that capabilities and protocols exist for transporting pediatric patients, with details for how to handle those with special healthcare needs. Include plans for patients with functional or access needs (e.g., hearing, vision, limited mobility), device dependence, and limited English proficiency. Consider the developmental stage of the patient, especially with pediatric patients, when addressing fears associated with PPE, fears of not having family members present, and an understanding of the transport process [14]. Advance preparation with tabletop exercises and mock drills will help minimize staff apprehension and will assist in implementing timely infection control precautions while maintaining care standards.

The service medical director should be involved in the development of all these guidelines. EMS medical directors ensure quality patient care, with responsibilities including the ongoing design, operation, evaluation, and revision of the EMS system from initial patient access to final patient care destination, the development of medical policies and procedures, and ensuring that patient care activities performed by EMS providers are appropriate and within their scope of practice [15]. The EMS medical director will be actively involved in planning/preparation and available for consultation during interfacility transport.

Communication

Communications can be challenging for the transport team, given the need for personal protective equipment and concern about contaminating equipment. Communications can be facilitated by hands-free radios or devices, which are worn inside the protective ensemble, to prevent exposure to bodily fluids. When communications are not encrypted, the transport team should be careful to protect privileged health information. Transport team supervisory personnel should conduct the majority of the communication with external agencies like police, security, receiving facility, etc. to allow the clinical team to focus on patient care.

Anticipating and preparing for public interest and media attention is key to educating the community and maintaining their confidence. Risk communications should be incorporated into the transport plan. Messaging should be proactive and short, using plain language while adhering to risk communication principles. Media relations and communications officers with experience in emergency risk communication should be identified in advance to manage public interest and media relations. They can also be used to provide communications guidance to the individuals or agencies involved in the transport [16].

Post Mission

Once the transport is completed, the providers involved should be debriefed and post mission surveillance initiated. Appropriate public health, emergency management, and public safety authorities need to be informed. The receiving facility should continue communications with the transporting agency regarding any further positive diagnostic tests on the patient that may impact transport team surveillance or prophylaxis.

Decontamination and Disinfection

The ambulance is decontaminated and disinfected and the transport team doffs their PPE [3] under supervision of qualified and trained personnel. Significant risk for inadvertent exposure occurs especially during doffing potentially contaminated PPE [17]. The interior of the ambulance, the stretcher, and any exposed equipment are disinfected with an Environmental Protection Agency-registered hospital-grade disinfectant appropriate for the suspected or known pathogen in a predesignated location. The use of sprays is avoided to decrease risk of aerosolizing the pathogen and potentiating spread. Standard operating practices need to be in place to decontaminate the unit.

Once decontaminated, guidelines need to be in place for handling waste that are in compliance with federal regulations, including how medical waste will be packaged, who will transport the waste to the medical waste disposal facility, which medical disposal facilities are used, and the required documentation. Hospitals should create a multidisciplinary team to develop standard protocols for the

management of medical waste. This team should include environmental services, infection prevention and control, biosafety officers, hospital administration, and others with expertise in hazardous waste disposal [18].

Intra-facility Transport

Few recommendations and guidelines are published for patient transport within a facility. Once a patient has been admitted to a tertiary facility for care, during the duration of their care, transport outside of the room must be limited as much as possible. Phlebotomy, procedures, and laboratory testing should be limited to the minimum necessary for essential diagnostic evaluation and medical care. Patients may however need further diagnostic testing and management, and while many tests are portable and can be performed at bedside, some diagnostic tests and surgical or invasive clinical interventions will require the patient to be transported to different areas of the hospital. These tests can often be planned ahead, but, in the case of emergent testing or treatment, transport to and from the patient care areas may need to be performed with little notice.

The route to radiology or the interventional suite in the hospital and other locations to which the patient may need to be transported should be predetermined. A mechanism to keep other patients, visitors, and the general public clear of the routes at the time of transport should be established. The path from the room to the testing site needs to be secured by facility staff. This must include identifying an elevator that can be secured to not allow access from other floors until the patient has arrived and the elevator decontaminated [19]. Staff accompanying the patient must be in an appropriate PPE ensemble and knowledgeable of standard operating procedures. The patient can be asked to wear an impervious suit and mask or enveloped in an impervious sheet during transport. The incident response guide at the Bellevue Hospital center has a trained staff walking behind the stretcher and transport team to note possible points of contamination in case a higher level of cleaning or PPE may be required [20]. When necessary, environmental staff should clean the entire transport route including the elevator per hospital cleaning protocols.

If transport or movement outside the isolation room is necessary, the patient should be instructed to wear a surgical mask, if possible, and observe respiratory hygiene. This is a category II recommendation per the CDC guidelines [8]. Category II recommendations are supported by suggestive clinical or epidemiologic studies or a theoretical rationale. For patients with skin lesions associated with varicella or smallpox or draining skin lesions caused by *M. tuberculosis*, the affected areas must be covered to prevent contact or aerosolization of infectious body fluids [8]. This is a CDC category IB recommendation. Category IB recommendations are strongly recommended for implementation and supported by some experimental, clinical, or epidemiologic studies and a strong theoretical rationale. Healthcare personnel transporting patients who are on airborne precautions do not need to wear a mask or respirator during transport if the patient is wearing a mask and infectious skin

lesions are covered [8]. Hospital guidelines may differ depending on type of HHCD and its mode of transmission.

Standard operating procedures (SOP) with great attention to detail need to be in place for transport of these at-risk patients within the facility to prevent contamination and spread. PPE and decontamination measures used are dependent on the pathogen involved and mode of spread. Procedures need to be in place for transport of body fluids, blood, and patient care equipment within the facility. Preparations must also be made for unexpected cleanup of spills and body waste during transport.

Ideally patients are kept within their airborne infection isolation room (AIIR), but SOPs should also be in place for emergency evacuation in the case of weather, fire, or other catastrophes. The hospital evacuation plan should be taken into consideration and an evacuation route planned based on minimal exposure to other patients or providers.

Conclusion

While identification and treatment of patients with HHCDs is vital, equally important is the safe transportation while minimizing the risk of spread to the healthcare workers and community. Achieving adequate isolation while transporting from a pre-hospital environment to the healthcare facility and within the facility can be challenging based on mode of spread. Education and training are key for implementation of effective standard- and transmission-based infection control practice in HHCDs. This requires implementation of appropriate administrative policies, work practices, and environmental controls, accompanied by focused education, training, and supervision. Standard operating procedures need to be in place and distributed prior to actual transport to ensure the stakeholders are trained and aware of the policies to ensure a smooth transport with minimal risk.

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