CHEST™

Ethical and Practical Considerations in Providing Critical Care to Patients With Ebola Virus Disease

Parizad Torabi-Parizi, MD; Richard T. Davey Jr, MD; Anthony F. Suffredini, MD; and Daniel S. Chertow, MD

Infectious disease epidemics in the past have given rise to psychologic and emotional responses among health-care workers (HCWs), stemming from fear of infection during patient care. Early experiences in the AIDS epidemic provide an example where fear of contagion resulted in differential treatment of patients infected with HIV. However, with a deeper understanding of AIDS pathogenesis and treatment, fear and discrimination diminished. Parallels exist between early experiences with AIDS and the present outbreak of Ebola virus disease in West Africa, particularly regarding discussions of medical futility in seriously ill patients. We provide a historical perspective on HCWs' risk of infection during the provision of CPR, discuss physicians' duty to treat in the face of perceived or actual HCW risk, and, finally, present the protocols implemented at the National Institutes of Health to reduce HCW risk while providing lifesaving and life-sustaining care.

CHEST 2015; 147(6):1460-1466

ABBREVIATIONS: CRRT = continuous renal replacement therapy; EVD = Ebola virus disease; HCW = health-care worker; NIH = National Institutes of Health; PPE = personal protective equipment; SCSU = Special Clinical Studies Unit; SOP = standard operating procedure

To date, the current West African Ebola outbreak has claimed > 9,000 lives, making it the deadliest Ebola epidemic since the discovery of the virus in 1976.[1,2] The transfer of expatriate patients infected with the Ebola virus to their resident countries in Europe and the United States, where capacity for advanced medical care is readily available, has raised concerns regarding the appropriateness and safety of providing lifesaving or life-sustaining measures to these patients. We review the ethical and practical considerations that influence these decisions and describe the approach adopted by the Special Clinical Studies Unit (SCSU) of the Clinical Center at the US National Institutes of Health (NIH).

A Historical Perspective of Health-care Worker Risk and CPR

CPR was first recognized as a potential lifesaving measure by academic and advisory organizations in the 1960s, and since that time early and aggressive resuscitation efforts by health-care providers and lay rescuers have been encouraged.[3-5] From early on, concerns related to exposure to potentially infectious material during CPR administration have been voiced. These concerns became particularly evident early in the AIDS epidemic. In 1989, the American Heart Association issued guidelines to

Manuscript received February 4, 2015; revision accepted February 11, 2015; originally published Online First March 12, 2015.

AFFILIATIONS: From the Critical Care Medicine Department (Drs Torabi-Parizi, Suffredini, and Chertow), Clinical Center, National Institutes of Health, Bethesda, MD; and Clinical Research Section (Dr Davey), Laboratory of Immunoregulation, National Institute of Allergy and Infectious Diseases, National Institutes of Health, Bethesda, MD.

CORRESPONDENCE TO: Parizad Torabi-Parizi, MD, Critical Care Medicine Department, National Institutes of Health, 10 Center Dr, 2C145, Bethesda, MD 20892; e-mail: torabiparizip@cc.nih.gov

DOI: 10.1378/chest.15-0278

address concerns related to infection risk during CPR and the Centers for Disease Control and Prevention issued guidance for the prevention of HIV and hepatitis B virus transmission to health-care workers (HCWs) and public safety workers.[6,7] Public health officials stressed the lack of evidence for HIV or Hepatitis B virus transmission during CPR even when mouth-to-mouth rescue breathing was used, yet recommended use of barrier devices to further reduce risk.

HIV transmission during CPR has been estimated to range from one in 1 million events when HIV prevalence is high (ie, about 30%) to one in 1 billion events when prevalence is low (ie, 0.1% to 1%).[8] However, despite evidence for low risk of HIV transmission during CPR, psychologically perceived risk affected the frequency and quality of care delivered to patients with AIDS. A survey of first responders suggested that attitudes toward providing CPR to strangers in an out-of-hospital setting had been adversely affected as a result of the AIDS epidemic.[9] Among physicians and nurses in the late 1990s, reluctance to provide mouth-to-mouth resuscitation in outpatient or inpatient settings resulted in marked delays in ventilation.[10,11] Possible discrepancies in quality of CPR delivered to those infected with HIV vs those not infected have been associated with worse outcomes in the former group.[12]

Medical Futility and Infectious Diseases

Early in the HIV epidemic, prior to availability of effective HIV antiretroviral therapy, opportunistic infections (eg, *Pneumocystis jiroveci* pneumonia) frequently led to ICU admissions with associated high case-fatality.[13] Failure of supportive intensive care to significantly alter outcomes and the absence of HIV-specific therapies frequently led to discussions of medical futility. Consequently, ICU use for the care of patients with AIDS during this era decreased, and end-of-life discussions between patients and their medical providers increased prior to hospital admission.[14] By 1988, however, despite lack of effective HIV antiviral therapy, ICU use and subsequent survival of patients with AIDS with *Pneumocystis* pneumonia increased, likely due to more aggressive supportive care, increasing use of a growing spectrum of antibiotic choices, and the use of steroids as adjunctive therapy.[15,16]

The *Pneumocystis* pneumonia example highlights the potential for variability in health-care delivery as a function of societal and provider perceptions. The concept of medical futility refers to interventions that are unlikely to produce any significant benefit for a specific patient at a specific time. Futility does not apply globally to categories of patients, general medical situations, or to all geographic locations. Lifesaving and life-sustaining measures that might be considered futile at a single point in time might not be viewed as such as knowledge or practice advance. Similarly, resuscitation efforts in a resource-limited country where escalated levels of post-resuscitation life support are not available might be futile, whereas the same interventions may be effective in locations where advanced care is readily available.

Physician Duty and Ebola Virus Disease

Historically, the emergence of epidemics has prompted the medical profession to periodically reexamine its responsibilities to society. The code of medical ethics originally drafted by American Medical Association members in 1847 states “when pestilence prevails, it is [the physicians’] duty to face the danger, and to continue their labors for the alleviation of the suffering, even at the jeopardy of their own lives.”[17] With the advent of antibiotics in the mid-20th century and the perceived manageable risk from infectious disease exposure, the Association’s revised Principles of Medical Ethics placed greater emphasis on physician autonomy and less emphasis on duty to serve.[18] However, with the advent of the AIDS epidemic, the concept of duty to treat reemerged, albeit in the context of nondiscrimination of seropositive patients.[19] Most recently, against the background of the plausible threat of bioterrorism attacks, the code of ethics reemphasizes the involvement of physicians in global health-care responses. “Because of their commitment to the care for the sick and injured, individual physicians have an obligation to provide urgent medical care during disasters. This ethical obligation holds even in the face of greater than usual risk to their own safety, health, or life.”[20]

The recent Ebola outbreak has required the medical profession to once again assess its obligations to the public. With the devastating and disproportionate numbers of HCWs in West Africa who have died of Ebola virus disease (EVD) in the line of duty, often due to inaccessible or inappropriate personal protective equipment (PPE) use, fundamental discussions balancing duty to treat patients with EVD with risk to providers are ongoing.[21-25] In resource-rich settings, the role of supportive critical care interventions, including use of mechanical ventilation or hemodialysis, and the risk-benefit of CPR have been a focus of discussion. Social stigma, fear, and knowledge gaps in disease pathogenesis and transmission risk have contributed to some providers electing against participation in the care of patients with EVD or establishing a priori limits in patient-care interventions.

Despite recent examples of safe and effective life-sustaining care of patients with EVD (eg, mechanical ventilation and renal replacement therapy) from centers with specialized clinical biocontainment units, it has been proposed by some that provision of CPR to critically ill patients with EVD is globally futile and poses an unacceptably high risk to HCWs.[21,26,27] High EVD case-fatality observed in Africa, lack of specific EVD treatment, potential risk of exposure to infectious fluids during CPR, and adverse consequences of delayed institution of CPR due to the time required for providers to safely don PPE might seem to support the notion of futility of CPR in patients with EVD.

Our Perspective

Interventions deemed futile in West Africa due to resource constraints might be effective in resource-rich settings, as the high EVD case-fatality observed in West Africa is largely related to limited access to basic, yet effective, care (eg, fluid and electrolyte monitoring and replacement), as well as delay in presentation to medical facilities, in part due to the stigma associated with the disease.[28-31] Electrolyte derangements (eg, hypokalemia, hypomagnesaemia) or severe hypovolemia leading to cardiopulmonary arrest are reversible phenomena. Initiating CPR on a patient with EVD while aggressively correcting underlying reversible abnormalities is appropriate in resource-rich settings. However, performing CPR on a patient with refractory shock and multiorgan failure might not be appropriate regardless of underlying infectious etiology or setting. Individualized clinical judgment in the context of available resources and patient autonomy must drive patient-care decisions for those with EVD, not a priori concept of futility.

Technical and Procedural Considerations

Provision of safe and effective care in a high-containment unit requires considerable investment in planning, material resources, and training.[32] Factors that might facilitate improved care include the presence of trained emergency response personnel in or near the unit at all times, ready access to emergency equipment and supplies, and the ability to provide ICU-level, postemergency care. HCW safety must be optimized through the creation of and strict adherence to standard operating procedures (SOPs) for the execution of clinical tasks, particularly those that have been associated with increased risk of inadvertent exposure to infectious material.[32,33] To this end, various institutions and societies have issued guidelines for the care of the patients infected with the Ebola virus.[34-36]

Code Team Composition, Response Time, and Emergency Equipment

To minimize response time in the SCSU at NIH, personnel dressed in full PPE with advanced cardiovascular life support training are available on the unit at all times and are responsible for initiating resuscitation efforts when indicated. If a patient's condition is deemed tenuous, a critical care nurse is assigned to the patient and an intensivist remains available on the unit. Code teams dedicated only to responding to SCSU patient emergencies consist of an intensivist, a respiratory therapist, and a critical care nurse who have undergone specific procedural and code-team simulation training in full PPE (e-Appendix 1: emergency response SOP).

Emergency response carts, equipped with defibrillators, airway equipment, and emergency drugs, are immediately available on the unit and positioned to be readily accessible by the health-care team. Acute-care drugs, including vasoactive drugs and antibiotics, are immediately available through an automated medication dispensing cabinet located on the unit, minimizing the time to administer these therapies. Preemptive use of invasive procedures, including vascular access and intubation, is encouraged to limit interventions performed under duress, and PPE adherence monitors are used on entering or leaving the biocontainment area.[32]

Personnel Safety and Simulation-Based Training

Health-care provider risk must continuously factor into decisions to provide lifesaving and life-sustaining measures to patients infected with high-consequence pathogens. Procedures including blood draws, venous or arterial catheter placement, or tissue manipulation, such as endotracheal intubation, carry the risk of PPE barrier breach and, therefore, possibly skin or mucosal surface exposure. Ebola virus transmission occurs through exposure of infectious body fluids to mucous membranes or nonintact skin. While respiratory droplet transmission of Ebola virus has not been documented in humans, the potential for transmission from infectious upper respiratory tract secretions is of significant concern.[37,38]

Experience with severe acute respiratory syndrome provides an example of increased HCW infection risk associated with respiratory droplet exposure and the value of adequate PPE training and use to reduce risk.[39] In the case of severe acute respiratory syndrome, overcrowding of medical wards, poor ventilation, and inadequate PPE were associated with high transmission rates.[40] The performance of aerosol-generating procedures, including endotracheal intubation, noninvasive ventilation, and bag-mask ventilation prior to intubation, were all associated with increased transmission risk.[41] Adequate PPE training and use was associated with decreased transmission risk.[42]

Therefore, measures must be put in place to minimize HCW risk while providing advanced care to patients with EVD. We developed SOPs for endotracheal intubation, central venous catheter placement, use of renal replacement therapy, emergency (Code Blue) response, biohazardous material exposure management, and extraction of an incapacitated HCW (see discussion later in this article and e-Appendix 1) in the care of patients with EVD. Table 1 highlights recommended procedural modifications to reduce HCW risk of infectious material exposure. We also developed and implemented scenario-based training on these procedures to establish and maintain staff proficiency while working in full PPE. All critical care SCSU staff members are required to complete this training biannually.

Endotracheal Intubation

In the process of endotracheal intubation of a patient infected with a high-consequence pathogen, the operators are at risk for exposure to potentially infectious oral, gastric, and respiratory secretions. Manipulation of a patient's oral opening during laryngoscopy poses additional risk of injury to the operator's fingers. Only experienced operators should perform endotracheal intubation of patients with EVD to minimize risk associated with excessive oropharyngeal manipulation during multiple intubation attempts. Providers should administer deep sedation, paralytics, or both as needed to reduce risk of bite trauma (e-Appendix 1: endotracheal intubation SOP).

Invasive Procedures

Elective placement of peripherally inserted central catheters may be sufficient in some cases to facilitate blood draws or to administer IV therapies. Central catheter placement may be required for hemodynamic monitoring or for renal replacement therapy. When a large central catheter is needed, several factors should be considered to minimize the risk of injury to the operator. The presence of an additional practitioner to assist with and to enhance vigilance during the procedure is desirable. The use of ultrasound guidance for catheter placement allows for only the dominant hand with the needle to be on the field at any time, minimizing the risk of injury to the nondominant hand during the procedure. We place extra emphasis on visual tracking of all needles on the operating field, on minimizing actions that might aerosolize infectious fluids, and on the potential use of conscious sedation for procedures to limit patient movement, thus decreasing the risk of injury to the operator (e-Appendix 1: invasive procedure SOP).

Mechanical Ventilation

Although there are no human data to support airborne transmission of Ebola, infectious aerosols generated during positive pressure ventilation may place providers at increased risk. Accidental or intentional disconnection of the ventilator circuit may lead to contamination of the environment or one's PPE and, therefore, should be minimized. Additionally, patient self-extubation may lead to patient harm or emergent situations that might be difficult to address in a timely fashion in a high-containment unit.

Consequently, we recommend use of ventilators with the ability to automatically shut off when the ventilator circuit is broken and suggest that breaks in the ventilator circuit be minimized. When it is necessary to break the ventilator circuit, all staff in the room should be informed in advance and the exhalent should be diverted away from those present. A high-efficiency particulate absorption filter should be added to the exhalation line post-patient to collect infectious material. Finally, to minimize the risk of self-extubation, patients should be maintained at deeper levels of sedation and use of soft-wrist restraints should be considered (e-Appendix 1: mechanical ventilation SOP).

Continuous Renal Replacement Therapy

Acute kidney injury has been described in patients with EVD and the Centers for Disease Control and Prevention have issued recommendations for performing acute hemodialysis in patients with EVD.[43] Continuous renal replacement therapy (CRRT) has advantages over intermittent hemodialysis in a high-containment setting and successful use of CRRT in a patient with EVD in the United States has been reported.[44] Critical care nursing and physician staff in the SCSU at NIH are proficient in running CRRT systems, obviating the need for specialized dialysis nurses and minimizing the number of at-risk individuals in the facility.

TABLE 1] Procedural Modifications to Reduce Health-care Worker Exposure Risk in the Care of Patients With Ebola Virus Disease

Intervention	Risk-Prone Step or Scenario	Recommended Modifications
Endotracheal intubation	• Inadequate patient sedation and relaxation might require forceful mouth opening maneuvers during laryngoscopy, creating the risk of bite injury.	• Use experienced operators. • Dose induction agents liberally. • Administer paralytic agents as needed. • Await unresponsiveness. • Avoid forcing mouth open.
Invasive procedures	• Patient motion and uncooperativeness increases the risk of needle-stick injury. • Placement of one hand on the patient to discern landmarks while manipulating the needle with the other increases the risk of a needle-stick injury. • The presence of more than one sharp object on the field at any time increases the risk of a needle-stick injury. • Forcing sharp objects (ie, needles) into a small container increases the risk of a splash or needle-stick injury.	• Involve two providers. • Consider use of conscious sedation. • Perform ultrasound guidance. • Use a one-handed technique. • Remove sharp objects sequentially. • Use a large sharps container.
Mechanical ventilation	• Accidental or intentional breakage in the ventilator circuit can expose the environment and staff to infectious aerosols. • Self-extubation may lead to patient injury or emergent situations that are difficult to address in a timely fashion in a high-containment unit.	• Select ventilator with automatic shut-off for broken circuit. • Limit breaking ventilator circuit. • Notify staff when breaking ventilator circuit. • Divert exhalent away from providers. • Use inline post-patient HEPA filter. • Sedate to RASS-2. • Consider use of soft wrist restraints.
Renal replacement therapy	• Catheter malfunction or dislodgment can lead to loss of large amounts of infected blood. • Catheter manipulation, even with needleless systems, can lead to exposure to infected blood. • Circuit clotting leads to loss of a large amount of infected blood that increases the risk of health-care worker exposure. • Large amounts of potentially infectious liquid waste are generated in the process of renal replacement therapy.	• Maintain visibility of catheter insertion site and check site frequently. • Avoid disconnecting circuit to flush lines. • Return blood to patient early if clotting is suspected. • Establish new circuit if clotting is suspected. • Use regional citrate anticoagulation if there are no contraindications. • Manage effluent as liquid waste and avoid aerosol exposure by transferring liquids under the cover of absorbent pads.
Code Blue response	• Rushing to respond to an emergency situation can increase the likelihood of PPE breach. • Dexterity in performing tasks can be impaired while wearing full PPE. • Communication between team members is affected due to the PAPRs.	• Respond without rushing. • Establish clear roles and responsibilities. • Maintain effective communication.

HEPA = high-efficiency particulate absorption; PAPR = powered air-purifying respirator; PPE = personal protective equipment; RASS = Richmond Agitation Sedation Scale.

Delivery of safe and effective CRRT to patients with EVD requires modifications in the spectrum of care from catheter and extracorporeal circuit management, to frequent monitoring of laboratory values, to handling of potentially highly infectious waste.

Because catheter malfunction or disconnection may lead to extravasation of highly infectious blood, we recommend maintaining continuous visibility of the catheter insertion site and visual inspection of the site every 30 min to ensure proper connection. Clotting of the circuit may lead to large-volume blood loss in the extracorporeal circuit that would require cautious handling and safe disposal. We recommend early return of extracorporeal blood at first sign of the circuit clotting and, if necessary, recommend the use of regional citrate anticoagulation.

CRRT requires frequent monitoring of laboratory test results, including electrolytes and clotting times. Point-of-care testing is available in the SCSU, allowing for timely clinical decision-making. While dialysis effluent fluid is not thought to be infectious under standard circumstance,[44] we recommend handling effluent as infectious waste, given potential for breaches in the system. For this purpose, we have constructed large containers that allow for dwelling of large amounts of liquid material in the presence of detergent disinfectant cleaners prior to disposal. Transfer of liquid waste from one container to another is performed under the cover of absorbent pads to limit aerosol exposure (e-Appendix 1: CRRT SOP).

Mock Code Training for the Conduct of CPR

As discussed, the provision of CPR within a high-containment unit poses several challenges in addition to those of code-team composition, response time, and access to emergency equipment. These include limitations to physical dexterity and the introduction of barriers to effective communication related to PPE wear. To heighten awareness of these challenges, we have implemented mock code-simulation training sessions. During these scenarios, the code-team members are asked to perform tasks that are likely to be necessary during a resuscitation effort, such as handling the code cart, drawing up and administering medications, placing defibrillation pads on the patients and delivering shocks. The use of PPE can muffle voices and, therefore, requires extra attention to speak with others at a louder level than usual and with clarity. During this training, we emphasize the need to define clear roles and responsibilities to the team members. Importantly, effective communication is achieved by speaking up and clearly, by making direct eye contact with other members of the team, and by practicing closed-loop communication. Additionally, use of hands-free communication devices can be considered under the powered air-purifying respirator hood (e-Appendix 1: emergency response SOP).

Occupational Exposures and Evacuation of Incapacitated HCWs

While all efforts must be made to prevent occupational exposures or events that result in an incapacitated HCW in a high-containment setting, contingency planning for these possibilities is essential to timely and appropriate responses. In the SCSU at NIH, we have established protocols for early wound decontamination following safe PPE removal. Materials and supplies required for decontamination following an exposure (eg, surgical disinfectant scrub, an eye-wash station) are immediately available on exit from the SCSU. Similarly, we have established a protocol for evacuation of an incapacitated HCW wearing full PPE that identifies the route of evacuation, specifies modified decontamination procedures, and allows for timely institution of medical care (e-Appendix 1: biohazard material exposure and impaired employee extraction SOPs).

Conclusions

In conclusion, the health-care team must assess the benefit of lifesaving and life-sustaining measures and the risk posed to the health-care providers when caring for individuals infected with highly infectious or contagious pathogens. We believe that delivery of lifesaving and life-sustaining interventions can be done safely in patients infected with high-consequence pathogens, provided adequate training, equipment, and protocols are in place. Finally, as a profession, we must reaffirm our ethical obligation toward society in our duty to treat.

Acknowledgments

Financial/nonfinancial disclosures: The authors have reported to *CHEST* that no potential conflicts of interest exist with any companies/organizations whose products or services may be discussed in this article.

Other contributions: The opinions expressed herein represent those of the authors and do not reflect official views or policies endorsed by the US Department of Health and Human Services.

Additional information: The e-Appendix can be found in the Supplemental Materials section of the online article.

References

1. Ebola situation report, 2014. World Health Organization website. http://www.who.int/csr/disease/ebola/situation-reports/en/. Accessed March 9, 2015.
2. Johnson KM, Lange JV, Webb PA, Murphy FA. Isolation and partial characterisation of a new virus causing acute haemorrhagic fever in Zaire. *Lancet*. 1977;1(8011):569-571.
3. Standards for cardiopulmonary resuscitation (CPR) and emergency cardiac care (ECC). 3. Advanced life support. *JAMA*. 1974;227(suppl 7):852-860.
4. Standards for cardiopulmonary resuscitation (CPR) and emergency cardiac care (ECC). I. Introduction. *JAMA*. 1974;227(suppl 7):837-840.
5. Standards for cardiopulmonary resuscitation (CPR) and emergency cardiac care (ECC). II. Basic life support. *JAMA*. 1974;227(suppl 7):841-851.
6. Centers for Disease Control and Prevention. Guidelines for prevention of transmission of human immunodeficiency virus and hepatitis B virus to health-care and public-safety workers. *MMWR Morb Mortal Wkly Rep*. 1989;38(suppl 6):1-37.
7. The Emergency Cardiac Care Committee of the American Heart Association. Risk of infection during CPR training and rescue: supplemental guidelines. *JAMA*. 1989;262(19):2714-2715.
8. Bierens JJ, Berden HJ. Basic-CPR and AIDS: are volunteer life-savers prepared for a storm? *Resuscitation*. 1996;32(3):185-191.
9. Ornato JP, Hallagan LF, McMahan SB, Peeples EH, Rostafinski AG. Attitudes of BCLS instructors about mouth-to-mouth resuscitation during the AIDS epidemic. *Ann Emerg Med*. 1990;19(2):151-156.

10. Brenner B, Stark B, Kauffman J. The reluctance of house staff to perform mouth-to-mouth resuscitation in the inpatient setting: what are the considerations? *Resuscitation*. 1994;28(3):185-193.
11. Brenner BE, Van DC, Lazar EJ, Camargo CA Jr. Determinants of physician reluctance to perform mouth-to-mouth resuscitation. *J Clin Epidemiol*. 2000;53(10):1054-1061.
12. Raviglione MC, Battan R, Taranta A. Cardiopulmonary resuscitation in patients with the acquired immunodeficiency syndrome. A prospective study. *Arch Intern Med*. 1988;148(12):2602-2605.
13. Schein RM, Fischl MA, Pitchenik AE, Sprung CL. ICU survival of patients with the acquired immunodeficiency syndrome. *Crit Care Med*. 1986;14(12):1026-1027.
14. Wachter RM, Luce JM, Turner J, Volberding P, Hopewell PC. Intensive care of patients with the acquired immunodeficiency syndrome. Outcome and changing patterns of utilization. *Am Rev Respir Dis*. 1986;134(5):891-896.
15. Wachter RM, Russi MB, Bloch DA, Hopewell PC, Luce JM. *Pneumocystis carinii* pneumonia and respiratory failure in AIDS. Improved outcomes and increased use of intensive care units. *Am Rev Respir Dis*. 1991;143(2):251-256.
16. Bennett RL, Gilman SC, George L, Guze PA, Bennett CL. Improved outcomes in intensive care units for AIDS-related *Pneumocystis carinii* pneumonia: 1987-1991. *J Acquir Immune Defic Syndr*. 1993;6(12):1319-1321.
17. Baker R. *The American Medical Ethics Revolution: How the AMA's Code of Ethics Has Transformed Physicians' Relationships to Patients, Professionals, and Society*. Baltimore, MD: Johns Hopkins University Press; 1999.
18. History of AMA ethics. American Medical Association website. http://www.ama-assn.org/ama/pub/about-ama/our-history/history-ama-ethics.page. Accessed December 28, 2014.
19. Huber SJ, Wynia MK. When pestilence prevails...physician responsibilities in epidemics. *Am J Bioeth*. 2004;4(1):W5-11.
20. Code of medical ethics opinion 9.067. Physician obligation in disaster preparedness and response. American Medical Association website. http://www.ama-assn.org/ama/pub/physician-resources/medical-ethics/code-medical-ethics/opinion9067.page. Accessed December 7, 2014.
21. Fins J. Responding to Ebola: questions about resuscitation. The Hastings Center website. http://www.thehastingscenter.org/Bioethicsforum/Post.aspx?id=7135&blogid=140. Accessed November 7, 2014.
22. Van Geem K. Ebola patients and the ethics of unilateral do-not-resuscitate orders. Voices in Bioethics website. http://voicesinbioethics.org/2014/11/24/ebola-patients-dnr-orders/. Accessed December 28, 2014.
23. Lahey T. Should doctors deny ebola patients CPR? Project HOPE website. http://healthaffairs.org/blog/2014/12/11/should-doctors-deny-ebola-patients-cpr/. Accessed December 28, 2014.
24. Halpern SD, Emanuel EJ. Ethical guidance on the use of life-sustaining therapies for patients with Ebola in developed countries. *Ann Intern Med*. 2015;162(4):304-305.
25. Forrester JD, Hunter JC, Pillai SK, et al; Centers for Disease Control and Prevention (CDC). Cluster of Ebola cases among Liberian and US health care workers in an Ebola treatment unit and adjacent hospital—Liberia, 2014. *MMWR Morb Mortal Wkly Rep*. 2014;63(41):925-929.
26. Wolf T, Kann G, Becker S, et al. Severe Ebola virus disease with vascular leakage and multiorgan failure: treatment of a patient in intensive care [published online ahead of print December 19, 2014]. *Lancet*. doi:10.1016/S0140-6736(14)62384-9
27. Kreuels B, Wichmann D, Emmerich P, et al. A case of severe Ebola virus infection complicated by gram-negative septicemia. *N Engl J Med*. 2014;371(25):2394-2401.
28. Chertow DS, Kleine C, Edwards JK, Scaini R, Giuliani R, Sprecher A. Ebola virus disease in West Africa—clinical manifestations and management. *N Engl J Med*. 2014;371(22):2054-2057.
29. Bah EI, Lamah MC, Fletcher T, et al. Clinical presentation of patients with Ebola virus disease in Conakry, Guinea. *N Engl J Med*. 2015;372(1):40-47.
30. Davtyan M, Brown B, Folayan MO. Addressing Ebola-related stigma: lessons learned from HIV/AIDS. *Glob Health Action*. 2014;7:26058.
31. Fowler RA, Fletcher T, Fischer WA II, et al. Caring for critically ill patients with ebola virus disease. Perspectives from West Africa. *Am J Respir Crit Care Med*. 2014;190(7):733-737.
32. Decker BK, Sevransky JE, Barrett K, Davey RT, Chertow DS. Preparing for critical care services to patients with Ebola. *Ann Intern Med*. 2014;161(11):831-832.
33. Fischer WA II, Hynes NA, Perl TM. Protecting health care workers from Ebola: personal protective equipment is critical but is not enough. *Ann Intern Med*. 2014;161(10):753-754.
34. Canadian Critical Care Society, Canadian Association of Emergency Physicians, Association of Medical Microbiology & Infectious Diseases Canada. Ebola clinical care guidelines: a guide for clinicians in Canada. Version 2. Association of Medical Microbiology & Infectious Diseases Canada website. http://www.ammi.ca/media/73235/Ebola%20Clinical%20Care%20Guidelines%20v2%2028%20Oct%202014.pdf. Accessed December 23, 2014.
35. Interim guidance for emergency medical services (EMS) systems and 9-1-1 public safety answering points (PSAPs) for management of patients who present with possible ebola virus disease in the United States. Centers for Disease Control and Prevention website. http://www.cdc.gov/vhf/ebola/hcp/interim-guidance-emergency-medical-services-systems-911-public-safety-answering-points-management-patients-known-suspected-united-states.html. Accessed December 28, 2014.
36. Infection prevention and control guidance for care of patients in health-care settings, with focus on Ebola. World Health Organization website. http://www.who.int/csr/resources/publications/ebola/filovirus_infection_control/en/. Accessed December 28, 2014.
37. Review of human-to-human transmission of Ebola virus. Centers for Disease Control and Prevention website. http://www.cdc.gov/vhf/ebola/transmission/human-transmission.html. Accessed December 9, 2014.
38. Martines RB, Ng DL, Greer PW, Rollin PE, Zaki SR. Tissue and cellular tropism, pathology and pathogenesis of Ebola and Marburg viruses. *J Pathol*. 2015;235(2):153-174.
39. Summary of probable SARS cases with onset of illness from November 1, 2002 to July 31, 2003. World Health Organization website. http://www.who.int/csr/sars/country/table2003_09_23/en/. Accessed December 9, 2014.
40. Hui DS. Severe acute respiratory syndrome (SARS): lessons learnt in Hong Kong. *J Thorac Dis*. 2013;5(suppl 2):S122-126.
41. Tran K, Cimon K, Severn M, Pessoa-Silva CL, Conly J. Aerosol generating procedures and risk of transmission of acute respiratory infections to healthcare workers: a systematic review. *PLoS ONE*. 2012;7(4):e35797.
42. Moore D, Gamage B, Bryce E, Copes R, Yassi A; BC Interdisciplinary Respiratory Protection Study Group. Protecting health care workers from SARS and other respiratory pathogens: organizational and individual factors that affect adherence to infection control guidelines. *Am J Infect Control*. 2005;33(2):88-96.
43. Centers for Disease Control and Prevention. Recommendations for safely performing acute hemodialysis in patients with Ebola virus disease in US hospitals. Centers for Disease Control and Prevention website. http://www.cdc.gov/vhf/ebola/hcp/guidance-dialysis.html. Accessed December 24, 2014.
44. Connor MJ Jr, Kraft C, Mehta AK, et al. Successful delivery of RRT in Ebola virus disease. *J Am Soc Nephrol*. 2015;26(1):31-37.