Special Populations
Pediatric and Obstetric Patients

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Pediatrics

A well-known mantra of pediatric medicine reminds us that “children are not simply little adults.” In fact, children differ from adults in myriad ways, many of which potentially impact their susceptibility and response to infectious diseases, as well as the ability to care for them once they become ill.

Anatomic and Physiologic Differences. Children have an increased surface-area-to-volume ratio as compared to adults. This results in the potential for greater transcutaneous heat and fluid loss and necessitates more meticulous attention to fluid and electrolyte balance among ill children. Similarly, it results in a greater susceptibility to percutaneous absorption of noxious substances (such as chemicals, toxins, and radiation). These effects are exacerbated further by children’s thinner and less well keratinized epidermis, and less subcutaneous tissue and fat. Furthermore, a child’s head contributes a greater proportion of his or her mass and surface area; a newborn infant’s head is 50% of its ultimate adult mass, while its body is only 5% of its ultimate mass. This is prob-
lematic in that the head is quite vascular and even more susceptible to heat loss than the remainder of the body. In addition, the head often cannot be fully covered in order to mitigate against this heat loss.

Children have an increased organ-to-body-mass ratio, making them more susceptible to traumatic organ injury. They have an increased minute ventilation, further compounding the problem of fluid loss, as well as increasing their exposure to noxious airborne particles and infectious agents. They have an immature blood-brain barrier, facilitating the entry of substances (and potentially microbes) into the central nervous system. Finally, they have more rapidly dividing cells, rendering them more susceptible to the effects of radiation.

**Developmental Considerations.** Myriad developmental considerations affect a child's susceptibility to infection. Children have large and complex social networks, with high numbers of interpersonal contacts. Moreover, they are housed in schools and day care centers where they are more likely than adults to contract and spread infectious diseases. They also engage in high-energy activity and live “closer to the ground,” making them particularly susceptible to contracting fomite-borne diseases; this susceptibility is further heightened by their tendency to place objects (fomites) in their mouths. While all of these factors would seem to increase a child's susceptibility, it should be noted that only 9–18% of victims of previous Ebola outbreaks were children, despite children making up roughly 50% of the people living in afflicted African nations. While it is possible that this reflects some inherent resistance to Ebola virus disease (EVD), it is more likely that children simply have less contact with infected persons (through caregiving roles and funereal preparations, for example). Notably, however, the most recent outbreak in North Kivu, Democratic Republic of the Congo, has been unusual in the higher percentage of infected children and mothers than in the past.

Similarly, developmental considerations affect a child’s ability to accept care and to respond to caregivers. Young children are often unable to cooperate with care, to follow the instructions of caregivers and public safety personnel, to flee the scene of a disaster, and to distinguish fantasy from reality. As such, caregivers in personal protective equipment (PPE) may be especially frightening, and children may tug and pull at PPE,
thus endangering those caregivers. They may also be more prone to the development of posttraumatic stress disorder (PTSD) than adults.

Pathologic Differences. Certain diseases produce different manifestations in children than they do in adults. Children with EVD are uniformly febrile, although only 16% exhibit hemorrhage. And, while respiratory and gastrointestinal symptoms are common among childhood EVD patients, central nervous system manifestations are rare. These factors combine to yield a clinical presentation in children that closely resembles influenza. Lassa fever has a mortality rate of 27% among symptomatic children, higher than that seen in adults. Moreover, congenital Lassa is nearly 100% fatal and presents a unique manifestation in infants, called “swollen baby syndrome,” which has a mortality rate of approximately 75%.

Smallpox also poses unique challenges for children. While older adults may possess some residual immunity from decades-old vaccinations, today’s children are uniformly unimmunized. Any attempt to ramp up an immunization campaign (in the face of a serious bioweapons threat, for example) would be hampered by an increased risk of vaccinal encephalitis among children compared with adults, as well as a risk of fatal fetal vaccinia among pregnant women. Pediatric plague victims may be more prone to digital necrosis (related to disseminated intravascular coagulation) than adults, owing to their smaller blood vessels, and to the development of plague meningitis. Finally, pediatric tuberculosis patients are more likely than their adult counterparts to develop life-threatening disease manifestations such as tuberculous meningitis and disseminated tuberculosis.

Therapy and Policy Considerations. Many therapeutic and political factors have the potential to affect the care of children with highly hazardous communicable diseases (HHCDs). Certain medications that might be used to treat adults are contraindicated in children, are unfamiliar to pediatric caregivers, or are unavailable in liquid preparations. Child-sized equipment is less widely available than is comparable adult equipment, and fewer personnel are trained in its use. Finally, pediatric-specific airborne infection isolation and high-level containment care (HLCC) beds are rare, pediatric-specific doctrine is sparse, and the con-
duct of research (and use of investigational drugs) is often more difficult in children.

During the 2014–16 West Africa outbreak, the HLCC units in the United States or Western Europe were not required to care for any pediatric patients with confirmed EVD; however, 18% of EVD patients in Guinea were children. Therefore, the care of pediatric patients in HLCC units should be a routine part of preparations. Several aspects need to be considered in such planning, including developing age-stratified stock lists for infants, toddlers, children, and adolescents; stockage of age- and size-appropriate pediatric equipment; pediatric-specific training and exercise scenarios for unit staff. A number of challenges must be considered to ensure the success of appropriate planning, as follows:

**Parental Presence.** Pediatric medicine embraces the concept of family-centered care, wherein parents are encouraged to participate actively in caring for their hospitalized child. In many instances (especially in the developing world), such participation is often expected, with parents or other family members providing many aspects of daily care, such as feeding, dressing, toileting, nursing, and comforting their child. However, appropriately addressing the possibility of parental presence at the bedside creates one of the most vexing problems encountered when caring for a child in an HLCC unit.

Therefore, it is imperative for facilities providing HLCC to children to have policies that address the presence of parents in a child’s hospital room if they are infected with an HHCD, in addition to the other issues noted below. The policies should articulate which, if any, circumstances would allow parents to enter the HLCC unit and patient room, and should ideally be stratified by age, developmental status, medical condition, and pathogen. Such policies that limit parental presence, developed in advance of an admission, might prove especially beneficial in situations involving a highly contagious child, where parents feel familial or personal pressure to do so, but at the same time may be uncomfortable interacting with their child.

Currently, many HLCC experts advocate against allowing parents entry into an EVD-infected child’s room. In addition to the potential risks of infection spread for those parents, the significant amount of training required in order for parents to don and doff PPE safely and properly
would not be practical. Moreover, even a cooperative parent who has been well trained presents a potential risk to other personnel in the unit who are required to then monitor the parent to guard against inadvertent breaks in infection control while at the same time attending to the child. The confined space in most HLCC units makes such monitoring particularly difficult, especially when breaks in infection control technique and protocol violations might go undetected by nursing and other personnel in the unit who are focused on the well-being and care of a very ill child. Furthermore, in such a confined setting, additional non-essential personnel may increase the risk of falls, sharps injuries, PPE snags, and other inadvertent breaches.

There are numerous other considerations that argue for a cautious approach regarding parental presence. Once allowed entry to a child’s room, parents might fail to recognize the gravity of potential symptoms or breaches in protocol, or may be reluctant to report them for fear of being excluded. Moreover, any parent who has a breach and must be placed under quarantine (or, worse, isolation if they become ill with the disease in question) loses the flexibility to care for other family members, thus increasing stress and adversely impacting the family’s general well-being. Finally, nursing personnel typically wear PPE for 2–4 hour shifts, whereas parents may wear such garb for extended periods of time, increasing the burden on them and the staff who must monitor them. More time in PPE increases the risk of fatigue-induced mistakes.

Although many experts believe the risks of parental presence in the room of a child infected with EVD (or other viral hemorrhagic fever) outweigh its benefits, the possibility of allowing such presence under certain conditions has been raised, depending on the causative agent, a child’s clinical status (i.e., whether “wet,” with significant vomiting, diarrhea, or hemorrhage, or “dry”), the child’s age and developmental status, and other aspects.

Whether limitations on parental presence should be applied to highly hazardous diseases that spread primarily by the airborne route, such as severe acute respiratory syndrome (SARS), Middle East respiratory syndrome (MERS), and novel influenza, is somewhat more controversial. The PPE ensembles needed to limit airborne transmission of such diseases are typically less burdensome than those required for manag-
ing EVD cases, and Centers for Disease Control and Prevention (CDC) guidelines already allow for family members and visitors to utilize N-95 respirators.

Use of video monitors to allow teleparenting as well as other technology solutions can help bridge the gap left by parental exclusion, although they are an admittedly inferior substitute for direct parental interaction. We recommend that parents be allowed to locate near the HLCC unit in a private, dedicated room, which allows ready access to telemonitoring equipment, therefore providing them nearly uninterrupted access to their child.

**Cohorting.** One of the primary concerns behind barring a parent from an infected child's room is the concern that the parent will contract the disease from their child. If the parent is already infected, such concerns no longer apply. In fact, EVD (and many other highly hazardous pathogens) typically spread to susceptible children from an adult household member. Therefore, the possibility exists that an infected child might reasonably be cohorted and cared for in the same room as their adult relative (or infected sibling). Resource constraints may require such a strategy in developing nations; however, we recommend against it in most cases. Both the child and parent may experience varying severity of disease or progress along differing disease time courses, making clinical management and psychological well-being of patients problematic in a cohort environment. For example, a parent who is improving clinically may witness the demise of his/her child (or vice versa), which could pose potential risks to themselves, as well as HLCC unit personnel. Temporary cohorting may be appropriate or unavoidable in the case of PUIs, if the family members have already been in close contact for extended periods, as long as we recognize the need to separate them if one individual rules in for disease while the others do not. Cohorting might also be appropriate when multiple family members are improving, but not yet ready for discharge. For any infant PUI born to an infected mother, the infant should be managed as if infected until infection can be ruled out definitively. Fathers and other uninfected potential caretakers should generally be excluded from contact with such a newborn, until the infant can be determined not to be infected.

**Breastfeeding.** Ebola virus is secreted in the breast milk of EVD-
infected lactating mothers, and it remains present for some time after recovery. Consequently, and in line with CDC guidance, we recommend mothers with EVD should avoid breastfeeding. Although we do support breast pumping for relief of engorgement, expressed breast milk from EVD-infected mothers should be managed as a category A infectious substance. There may be other options that can be individualized with other pathogens, depending on their known potential to be secreted in breast milk. For example, with SARS, virus has not been isolated from breast milk, although antibodies to the virus can be found in recovering mothers. This raises the possibility that breastfeeding could actually be beneficial to the infant in the later stages of maternal disease.

**Staffing.** Having pediatric and neonatal nursing staff directly involved in caring for children with HHCDs is important; however, HLCC units employ multiple staffing models. Some favor using intensive care unit and emergency room nurses in a primary role, with support from pediatric and neonatal nurses, while others reverse those roles. In either case, the staffing ratios might need to exceed the 3:6 staff/patient model used by HLCC units in 2014 for adults, due to the need for the presence of a health care worker (HCW) in a child’s room at all times and the extra staff potentially required to hold, comfort, or distract children undergoing procedures.

**Staff Protection.** Chapter 8 of this manual provides general advice on the use of PPE. However, when caring for young children, HLCC staff may choose to use supplements to their PPE, such as a cloth surgical gown, as an extra measure of protection against the possibility that an agitated, flailing toddler might rip or displace their underlying PPE. Any such modifications must weigh the potential benefits against the added heat stress associated with extra clothing and the impact this heat stress might have on further limiting HCW time spent on the unit in PPE. Despite its potential to interfere with play therapy and other therapeutic interactions between patients, their families, and caregivers, chemical sedation may be a necessary component of the management of a frightened, flailing toddler or child in certain situations and may be necessary to ensure both staff and patient safety. Similarly, physical restraint may occasionally be necessary in the HLCC setting, although we acknowledge that it is controversial. Its use should, consequently, be minimized,
and it should be employed only in conjunction with other modalities such as chemical sedation, behavioral management, and parental assurance (via tele-technology).

*Child Life.* Therapeutic play is an important modality in the care of pediatric patients. Child life professionals and pediatric occupational therapists are invaluable in fostering the appropriate environment for such play to take place. Safety concerns will dictate whether such specialists should be kept from a child’s room in most cases; however, exceptions might be made if such specialists are fully integrated into the HLCC unit care team, and if they participate in regular training alongside this team. In other situations, there are ways play therapy can be supported through using video teleconferencing or providing advice on play therapy to nurses and other members of the HLCC care team.

Toys play an obvious important role in a child’s life, and they may help a child understand and cope with their time in the unique confines of an HLCC unit. For example, Texas Children’s Hospital has designed a teddy bear garbed in PPE analogous to that worn by caregivers. Nonetheless, toys present an infection control risk in an HLCC unit, and any toys that enter the unit should, in most cases, be destroyed on the child’s discharge. Theoretically, toys that can be autoclaved might be returned to a child; however, this might prove a logistical challenge, because it necessitates that a unit has an in-suite or on-campus autoclave and dedicated sterilization cycle. Having duplicate toys presents an alternative solution; for example, one teddy bear is destroyed while an identical duplicate is “discharged” home with the recovered child.

*Reintegration.* Children face numerous physical, emotional, and psychosocial stressors in the hospital environment, which are exacerbated when they are denied direct contact with parents and family. Not only do children suffer the direct effects of HHCDs, which often involve lengthy hospitalization, painful medical procedures, and prolonged recovery periods, but family members, friends, schoolmates, teachers, and others fearing contagion may treat survivors with suspicion. In addition to its negative effects on learning and psychosocial development, prolonged school absence may contribute to a sense of alienation from classmates. Flashbacks, which have been reported commonly among adult survivors of EVD, may amplify feelings of helplessness, hopelessness, and
estrangement. Other aspects may exacerbate these problems, especially the death of parents or siblings, which commonly occurs among African children surviving with EVD.

For the reasons we have noted, it is paramount for facilities to have a coordinated approach to managing a child’s treatment, recovery, and transition from the HLCC unit to a recuperative setting, and ultimately to complete family, school, and social reintegration. During a child’s hospitalization, planning for such reintegration should begin as early as possible, and chances of success can be improved with assistance from child life providers, social workers, and child psychologists/psychiatrists.

**Obstetrics**

Every medical facility should include planning for the pregnant patient with an infectious disease. Preplanning for pregnancy contingencies includes responding to:

- Ectopic pregnancy
  - Bleeding with acute need to operate
  - Stable with potential options of medical therapy
- Miscarriage
  - Stable missed abortion
  - Incomplete abortion with bleeding
- Pregnancy without need to deliver
  - Previable
  - Viable
- Pregnancy with need to deliver fetus
  - Vaginal delivery
  - Cesarean delivery

Considering each of the above scenarios will generate significant dialogue about how to render care for a pregnant patient safely, or help determine what precautions are needed if delivery or surgery were to occur. Most important in the planning is the inclusion of all medical teams that might support a response, including obstetrics, maternal fetal medicine, neonatology, anesthesia, and nursing from all divisions with
further consideration of the support staff such as respiratory therapy. Hospital ethics committees may be worth consulting as part of the planning process when considering the above scenarios to allow for expediting responses if and when a clinical case presents.

When considering pregnancy in the face of HHCDs, one must immediately bear in mind two things. First are the new potential sources of infectious pathogens including placental tissue, amniotic fluid and sac, and fetal sources. The second is to remember that any pregnant patient can transition from being dry to having copious liquid contamination from bodily fluids within moments as infection can increase the rate of miscarriage or preterm delivery. With rupture of amniotic membranes, amniotic fluid will continuously leak from the uterus until delivery of products of conception occurs. Large amounts of bleeding may occur with the delivery of products of conception with either a fetus of viable gestational age or miscarriage of an early gestational fetus. Infection may also increase the likelihood for uterine bleeding.

The response to postpartum hemorrhage or postmiscarriage bleeding should be practiced, and pharmacologic agents to aide in the treatment of bleeding need to be available on any unit considering care of the pregnant patient. These agents include but are not limited to carboprost, methylergonovine, misoprostol, and Pitocin. Each of them have optimal clinical use in the setting of postpartum hemorrhage, but some have side effects that should be considered. For example, carboprost can increase bowel motility resulting in diarrhea, potentially leading to a greater amount of infectious fluids.

Response to other common obstetric emergencies such as eclamptic seizure or fetal distress should be incorporated into response planning and practice to ensure expedited care when the need arises. It should be noted that fear of the pregnant patient should be directly addressed with all staff. The fear of harming the fetus or of the increased risk of infection has led to failure to act or a delay in care. Staff should be empowered and know that most protocols for the infected and contagious adult should carry on as planned even in the setting of pregnancy. Antibiotic choices may vary somewhat, and added precautions may be needed; however, pregnancy should not limit care. Most radiographic imaging techniques are reasonable to perform if the patient has emergent needs, with only a
few techniques absolutely contraindicated, such as MRI with gadolinium contrast.

Reproductive goals should be discussed prior to discharge with all patients to provide appropriate counsel on potential future risks of transmission. The potential for sexual transmission and prevention measures should be communicated clearly to all patients of any gender, which should include discussion of contraception as a part of patient care plans, if desired, in the individual's reproductive goals.