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Infection Control for Healthcare Workers: Managing Special Pathogens in Pediatric Care

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Abstract

The emergence of special pathogens, including novel coronaviruses, influenza viruses, and ebolaviruses, poses significant challenges to healthcare systems in providing safe and effective care while minimizing transmission risks. Hospital infection prevention and control (IPC) teams play a crucial role in managing these pathogens, particularly in pediatric populations, where balancing developmentally appropriate, family-centered care with infection control measures is essential. The Centers for Disease Control and Prevention (CDC) recommends an "Identify, Isolate, and Inform" approach for optimal management of patients with special pathogens. This involves developing screening strategies incorporating exposure history and clinical presentation, promptly isolating suspected cases, and notifying relevant stakeholders. Specific isolation measures, personal protective equipment (PPE), and environmental cleaning protocols vary depending on the pathogen. Occupational health teams

face distinct challenges in pediatric hospitals, necessitating expertise in managing adult healthcare workforce concerns while understanding the unique aspects of pediatric care. Effective communication, psychological support, and comprehensive respiratory protection programs are critical for healthcare personnel (HCP) safety. Regular drills and training exercises are essential to maintain preparedness and reinforce clinical competencies. Ensuring reliable access to medical countermeasures (MCMs) requires collaboration between emergency management and supply chain personnel. Implementing family-centered care for pediatric patients with special pathogens involves balancing medical treatment, psychosocial well-being, and infection control. Organizational and systems support, including designated hospital networks and pediatric-focused initiatives like the Pediatric Pandemic Network, are crucial for sustaining preparedness efforts in children's hospitals. Ongoing challenges include resource allocation and the need for a well-structured national preparedness framework that prioritizes pediatric considerations.
Keywords: Infection Control, Healthcare Workers, Pediatric Care

Introduction

Special pathogens are broadly characterized as highly transmissible infectious agents with the potential to cause severe disease in humans. The contemporary healthcare workforce has encountered the emergence of multiple special pathogens throughout their professional tenure, along with the resurgence and global dissemination of previously rare yet known infectious agents. These include novel coronaviruses, novel influenza viruses, and ebolaviruses. Some of these pathogens have escalated to pandemic proportions, leading to significant consequences on human morbidity and mortality, global economic stability, and healthcare infrastructure. The presence of special pathogens imposes substantial challenges on healthcare systems in their efforts to ensure the provision of safe and effective healthcare while concurrently minimizing disease transmission to healthcare personnel (HCP), patients, and their families.

Hospital infection prevention and control (IPC) teams play a crucial role in formulating policies and protocols for managing special pathogens, facilitating the early identification of patients who exhibit exposure history and/or clinical manifestations associated with a special pathogen. Early identification enables HCP to promptly isolate the affected patient, implement pathogen-specific and/or disease-specific mitigation strategies, and subsequently notify the IPC team and relevant stakeholders to coordinate the delivery of high-quality and safe care (Flinn et al., 2023). IPC teams in pediatric healthcare facilities, along with other key stakeholders, face unique challenges in balancing developmentally appropriate, family-centered care with the imperative to safeguard essential caregivers, visitors, and the broader community. This review aims to examine the IPC implications of special pathogens in pediatric populations.

Classification of Special Pathogens

The classification of special pathogens, factors contributing to their emergence, available countermeasures, and the risks posed to pediatric patients and HCP vary considerably among different pathogens. The general categories of special pathogens are outlined below, with some pathogens exhibiting characteristics that overlap multiple categories.

High-Consequence Infectious Diseases (HCIDs)

HCIDs represent a subset of special pathogens characterized by severe clinical outcomes and the absence of medical countermeasures (MCMs). These pathogens typically meet several criteria, including (1) acute infectious disease manifestation, (2) a high case-fatality rate, (3) the absence of effective prophylaxis and/or treatment, (4) difficulty in prompt recognition and detection, (5) potential for transmission within the community and healthcare settings, and (6) the necessity for an enhanced individual, population-level, and systemic response to ensure effective

and safe management. HCIDs can encompass both novel pathogens, such as avian influenza viruses and emerging coronaviruses, and reemerging pathogens, such as mpox and viral hemorrhagic fever (VHF) viruses, including ebolaviruses and Marburg virus. The resurgence and spread of these pathogens may be linked to behavioral risk factors or conditions associated with novel pathogen emergence, as will be elaborated upon later. Certain HCIDs, such as VHFs, may necessitate highly specialized biocontainment measures and rigorous IPC protocols to mitigate risks to HCP. As exemplified by the coronavirus disease 2019 (COVID-19) pandemic, the development of MCMs and the accumulation of clinical knowledge over time may lead to changes in the classification of HCIDs. If the severity of disease at the individual level declines due to improved treatment and prevention strategies, a pathogen may no longer be classified as an HCID; however, it may still require stringent hospital IPC and public health interventions.

Novel Pathogens

Numerous novel pathogens, including emerging coronaviruses such as severe acute respiratory syndrome (SARS), Middle Eastern respiratory syndrome (MERS), and severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), as well as avian influenza viruses, have been identified in the past two decades. At the time of their emergence, knowledge regarding pathogenesis, clinical presentation, diagnostic methods, and MCMs was often incomplete, posing significant challenges in timely identification, disease mitigation, and transmission control. Novel human pathogens frequently have zoonotic origins and emerge when disruptions occur at the human–animal interface, often due to agricultural practices or infrastructure expansion into previously isolated regions. The international transmission of these pathogens is facilitated by migration and global travel, particularly for infections that spread via the respiratory route and can be transmitted by individuals with mild or subclinical illness, as observed with COVID-19. The emergence of novel pathogens has also been associated with high disease incidence among HCP occasionally resulting in elevated mortality rates (Elkholy et al., 2020).

Vaccine-Preventable Diseases

Factors such as vaccine hesitancy and disparities in vaccine accessibility (Deal et al., 2021), both of which were exacerbated during the COVID-19 pandemic, have led to declining vaccination coverage within populations. This decline has precipitated outbreaks of several vaccine-preventable diseases including measles and poliovirus, which have significant implications for hospital IPC measures.

Agents of Bioterrorism

Certain pathogens and their associated toxins are classified as bioterrorism agents by the U.S. Centers for Disease Control and Prevention (CDC) with their classification dependent on disease severity, ease of dissemination, and the level of public health preparedness required. The degree of person-to-person transmission varies among these agents, consequently influencing the level of risk posed to HCP and the IPC strategies necessary for mitigation.

Identify, Isolate, and Inform

The Centers for Disease Control and Prevention (CDC) has established guidance for the optimal management of patients with special pathogens, utilizing the framework of "Identify, Isolate, and Inform." This approach requires healthcare institutions to develop strategies aimed at the early identification of patients at risk for special pathogens upon entry into the facility, ensuring timely isolation and appropriate notification of relevant stakeholders. These strategies must be informed by the prevailing epidemiological landscape at global, regional, and local levels for each pathogen. For instance, a limited outbreak of Ebola virus disease (EVD) confined to a single nation

may necessitate targeted patient screening in adjacent countries, whereas a widespread outbreak across multiple nations may warrant broader screening measures. The CDC Health Alert Network serves as a critical resource for disseminating information regarding urgent public health incidents. Alongside local and state public health advisories, these alerts provide the necessary triggers for active surveillance and screening initiatives.

Identify

The identification of high-risk patients necessitates a systematic screening process incorporating both exposure history and clinical presentation. A comprehensive exposure history should include inquiries regarding recent travel, epidemiologic risk factors, and documented or potential exposure to confirmed cases. The CDC has developed an algorithm to facilitate the screening of EVD. The initial step in this algorithm involves assessing whether the patient has traveled to a country with ongoing Ebola transmission or has had contact with a confirmed EVD case within the preceding 21 days. If either condition is met, further evaluation is conducted for symptoms such as fever, headache, weakness, muscle pain, vomiting, diarrhea, abdominal pain, or hemorrhage. While this algorithm is specific to EVD, a similar structured approach can be adopted for other pathogens. For example, during a widespread measles outbreak extending beyond a localized region, screening should incorporate inquiries regarding travel to affected areas or known exposure to confirmed measles cases, along with an assessment of characteristic clinical manifestations. In cases of measles and other vaccine-preventable infections, collecting vaccination history is crucial for determining the likelihood of infection. The Washington State Department of Health has developed an assessment tool to assist clinicians in evaluating measles risk in patients presenting with concerning exposure history or symptoms suggestive of the disease. Additionally, electronic health record systems can serve as valuable tools for facilitating travel history documentation and symptom-based screening (Burkholder et al., 2019).

Isolate

Upon identifying a patient of concern, immediate isolation should be implemented using the appropriate rooming and personal protective equipment (PPE) based on the specific pathogen. Certain pathogens, such as VHFs, may necessitate high-level biocontainment measures. While few healthcare facilities maintain dedicated biocontainment units, all hospitals must establish designated locations for managing patients with special pathogens, including VHFs. Advanced planning for patient care spaces allows for the implementation of traffic control measures, delineation of areas for donning and doffing PPE, and the conduction of simulation exercises to optimize preparedness. Healthcare institutions should document the locations of their negative pressure and airborne infection isolation rooms (AIIRs) and establish clear protocols for their utilization. It is important to recognize that not all negative pressure rooms qualify as AIIRs. AIIRs are distinct in that they not only maintain negative pressure but also provide at least 6 to 12 air exchanges per hour, with air either exhausted directly outside the facility or recirculated through a high-efficiency particulate air (HEPA) filtration system. In certain cases, a higher rate of air exchange can reduce the required vacancy period following occupancy by a patient with an airborne infectious disease. AIIRs are the preferred setting for managing patients with suspected or confirmed airborne-transmissible infections; however, their availability is often limited. If an AIIR is not accessible, patients should be transferred to a facility equipped with AIIRs as soon as feasible. In the interim, a negative pressure room should be utilized, and if one is unavailable, the patient should be placed in a single occupancy room with the door closed. Additional measures to mitigate transmission risk while awaiting transfer include placing a face mask on the patient whenever possible or employing a portable HEPA-filtered air purification system.

The movement of patients with special pathogens within the healthcare facility should be minimized, and patient transport routes should be carefully planned to reduce potential exposure to others. For patients with suspected or confirmed airborne infections, respiratory hygiene should be enforced, including the use of a face mask whenever feasible. In cases where a patient cannot tolerate a mask, a light blanket may be placed over the head to reduce the risk of aerosol dispersion. For infections that are transmitted via non-respiratory routes, such as those involving infectious skin lesions, the affected areas should be covered with a sheet or gown to prevent environmental contamination.

PPE requirements vary by pathogen; however, adherence to appropriate donning and doffing procedures is universally critical. Following the recommended sequence for donning PPE ensures the efficient and proper application of protective equipment, thereby minimizing the risk of contamination during patient care activities. Similarly, the removal of PPE must be conducted with meticulous attention to detail, adhering to prescribed protocols to prevent self-contamination. This includes following the recommended doffing sequence and incorporating appropriate PPE cleaning and disinfection measures. Establishing a dedicated space for PPE donning and doffing, along with the presence of a trained observer, enhances compliance with correct procedures. These precautions should be consistently implemented for all special pathogens and are particularly essential when managing patients with VHFs.

Environmental Cleaning and Waste Management

Recommendations for environmental cleaning and waste management protocols vary depending on the specific pathogen. It is essential to review the labels of cleaning and disinfectant products for their efficacy against particular pathogens and to adhere to the manufacturer's guidelines, including the recommended disinfectant dwell times. Waste management planning should incorporate compliance with relevant local and federal regulations to ensure safe and effective disposal practices.

For patients infected with VHF viruses or Middle East respiratory syndrome coronavirus (MERS-CoV), maintaining a log of all individuals entering the patient's room is advised. The approach to staffing ratios will depend on the specific pathogen and must account for factors such as the type of personal protective equipment (PPE) used by healthcare personnel (HCP), including Occupational Safety and Health Administration (OSHA) requirements for designated rest periods. Additionally, the need for site managers, observers, and support personnel (runners) should be considered when structuring staffing models. The HCP team should include nurses, respiratory therapists, and acute and critical care providers. When selecting additional team members, priority should be given to individuals with expertise in airway management and vascular access. In general, only essential HCP directly involved in patient care should enter the hospital room of a patient with a special pathogen, particularly in cases involving high-consequence infectious diseases (HCIDs) such as Ebola virus. This precaution is especially crucial for HCIDs, where limiting personnel exposure is of paramount importance. To further reduce staff exposure to pediatric patients with special pathogens, HCP providing direct face-to-face care should be trained to perform additional responsibilities beyond patient care, such as environmental cleaning and restocking supplies.

Additional considerations should be made when managing pediatric patients with special pathogens, such as confirmed cases of Ebola virus disease (EVD). The presence of site managers can facilitate oversight of the implementation of infection prevention and control (IPC) measures, ensuring adherence to established protocols. Furthermore, activating the hospital incident

command system should be considered to support efficient communication, decision-making, and coordination of staffing, resources, and overall hospital response.

Inform

Once patients are identified and appropriately isolated due to suspicion of a special pathogen, the healthcare facility's IPC team should be contacted immediately. The IPC team plays a crucial role in verifying that appropriate isolation measures and PPE protocols are in place while also facilitating communication with public health authorities. The decision to proceed with diagnostic testing should ideally be made in collaboration with public health officials, as public health departments often serve as the primary gatekeepers for access to testing resources. Importantly, public health authorities manage community-level exposure assessments and follow-up actions, including evaluating household and family exposures and providing guidance on quarantine or isolation measures for affected individuals.

After the initial communications with IPC and public health officials have been established, additional consideration should be given to both internal and external organizational communication strategies. These communications are often coordinated through the hospital incident command system. Developing a structured communication framework in advance of an outbreak or public health emergency ensures that an effective communication cascade is activated when needed.

Occupational Health

The occupational health team within a pediatric hospital faces distinct challenges, including the necessity of appointing leaders who possess expertise in managing occupational health concerns for an adult healthcare workforce while also understanding the unique aspects of pediatric patient care. Physicians with training in public health, internal medicine, and pediatric infectious diseases are well-suited to contribute to occupational health leadership and engage key stakeholders in special pathogen preparedness efforts.

A critical component of occupational health preparedness involves establishing systems to document and monitor HCP involvement in the care of patients with special pathogens, particularly within biocontainment units. This includes maintaining a structured system for tracking potential occupational exposures, conducting daily symptom surveillance of HCP involved in patient care, and implementing procedures for managing potentially infectious adult HCP, including transfer agreements with adult biocontainment units when necessary. The occupational health team also plays a role in supporting HCP vaccination initiatives and other medical countermeasures (MCMs). Developing and formalizing these policies and procedures before an outbreak is crucial for ensuring timely and effective responses.

Occupational Health Models in Pediatric Healthcare Facilities

Various models exist for delivering occupational health services to HCP in pediatric healthcare institutions. One approach is an in-house model, where an occupational health professional provides direct care to employees within the same healthcare system. This model offers potential benefits, including familiarity with institutional operations and the pediatric care environment, fostering trust between employees and occupational health providers. However, a drawback of this model is that occupational health personnel may not be equipped to provide wellness services, behavioral health care, or specialized occupational injury management. Additionally, employees may express concerns regarding confidentiality when receiving occupational health services from colleagues within the same institution.

Alternatively, a pediatric hospital may establish a contractual agreement with an external occupational health provider or partner hospital. This contractual model often involves oversight

by an occupational health physician trained in adult medicine, necessitating engagement from pediatric physicians to assess exposures specific to pediatric patients. One advantage of this model is that it allows for the provision of comprehensive wellness services, behavioral health care, and occupational injury management within the workplace. However, a notable limitation is that external occupational health providers may lack familiarity with the pediatric healthcare setting, have limited access to the institution's electronic medical record system, and may not fully understand the unique risks associated with pediatric infectious disease exposures.

Regardless of the chosen occupational health model—whether in-house, contractual, or a hybrid approach—the system must be structured to support the monitoring and surveillance of HCP potentially exposed to highly transmissible pathogens. Additionally, the occupational health team should be equipped to effectively communicate potential occupational risks and implement risk mitigation strategies within a workforce dedicated to pediatric patient care.

Caring for Healthcare Personnel Providing Care to Pediatric Patients with Known or Suspected Special Pathogen Infections

Managing healthcare personnel (HCP) who have been exposed to vaccine-preventable and/or special pathogens is generally straightforward when dealing with healthy and highly immunized employees. However, exceptional circumstances arise when unimmunized or seronegative HCP, as well as those with underlying medical conditions, are responsible for caring for pediatric patients with a known or suspected pathogen. These scenarios underscore the critical importance of effective communication among the occupational health team, clinical providers, and hospital epidemiology personnel. Lessons learned from the COVID-19 pandemic have provided valuable insights into surveillance and monitoring strategies necessary for ensuring the safety of HCP caring for pediatric patients with special pathogens(Bielicki et al., 2020).

The use of automated applications and self-reporting strategies, particularly temperature monitoring via smartphone applications that integrate with hospital occupational health databases, became widely accepted for surveillance purposes. Despite challenges associated with certain commercial devices and findings indicating that temperature screening was not effective in preventing symptomatic SARS-CoV-2–infected HCP from entering healthcare settings (Maung et al., 2022), fever remains a potential early indicator of infection for non-SARS-CoV-2 pathogens. Due to diurnal variations in body temperature, conducting twice-daily temperature assessments, as practiced by facilities managing adult patients with viral hemorrhagic fevers (VHFs), may enhance the detection of temperature fluctuations. When combined with symptom reporting, temperature monitoring can serve as an early warning system for identifying illness in HCP caring for pediatric patients with special pathogens. While digital applications and electronic data entry systems streamlined data collection and review, they also contributed to data entry fatigue. Attestation statements may have promoted more accurate and honest symptom reporting, though multiple factors influence self-reporting accuracy (Lichtman et al., 2021).

To optimize HCP surveillance, identifying personnel with direct patient contact through electronic proximity tracking, linking HCP identification badges with patient identification bands, is recommended. A similar approach can be applied to track interactions between HCP identification badges and labeled infectious waste or bodily fluids, identifying personnel who had contact with infectious materials despite not being directly involved in patient care. Surveillance strategies should also include monitoring HCP who handle infectious materials, even if they do not engage in direct patient interactions.

Minimizing presenteeism—where HCP continue to provide patient care while symptomatic—requires policies that support self-exclusion from the healthcare environment when ill. In cases where quarantine measures are necessary or when a symptomatic HCP is reported, public health authorities may need to be involved.

Beyond physical health considerations, attention to the psychological and mental well-being of HCP is essential. Caring for pediatric patients with known or suspected special pathogens can be isolating, and HCP may experience stigma from their families, colleagues, and communities (Srivatsa & Stewart, 2020). To address these challenges, institutions should provide access to counselors and occupational health assistance programs, offering a supportive and nonjudgmental environment for HCP to discuss concerns and emotional challenges. Previous Ebola virus outbreaks demonstrated that the psychological impact extended beyond direct-care providers to any personnel associated with healthcare institutions treating such patients. Engaging hospital leadership, including public relations and communications officers, in crafting internal and external messaging can help mitigate stigma associated with the care of pediatric patients with special pathogens.

Respiratory Protection Programs and Specialized Personal Protective Equipment Training

To ensure optimal preparedness for HCP caring for pediatric patients with known or suspected special pathogens, respiratory protection programs and additional personal protective equipment (PPE) training must be implemented. For protection against airborne pathogens, fit testing for N95 respirators should be prioritized for both clinical and nonclinical personnel who may experience prolonged face-to-face patient interactions or extended stays in patient rooms. According to Occupational Safety and Health Administration (OSHA) Standard 1910.134, fit testing must be conducted before requiring an employee to use a respirator in the workplace and must be repeated at least annually. Additional fit testing is necessary when changes in facial structure or respirator models could affect the fit of the device. During a pandemic, when supply chain constraints may limit access to previously fit-tested respirators, institutions may need to reassess respirator allocation and conduct new fit tests as required.

During the COVID-19 pandemic, some healthcare facilities deferred annual fit testing to preserve limited supplies of N95 respirators. As a result, institutions should develop prioritization programs to allocate fit-testing resources to HCP who will derive the greatest benefit from these protective measures. A comprehensive respiratory protection program should encompass a respiratory health questionnaire, clinician review for recommended clearance, educational training, hands-on respirator use instruction, and proper donning and doffing procedures. When annual fit testing is not feasible, institutions may substitute questionnaire administration and education as temporary measures, prioritizing fit testing for frontline clinical HCP.

For HCP unable to wear N95 respirators safely, alternative respiratory protection devices, such as powered air-purifying respirators (PAPRs) or controlled air-purifying respirators, should be available. Managing pediatric patients with certain special pathogens, such as Ebola virus or Marburg virus, necessitates additional high-level PPE policies and training. Guidance from the Centers for Disease Control and Prevention (CDC) and the National Emerging Pathogen Education and Training Center (NETEC) provides detailed recommendations on PPE usage.

Vaccination Programs

Hospitals should establish policies ensuring that HCP remain fully vaccinated in accordance with the recommended adult immunization schedule. In some cases, vaccination may be mandated as a condition of employment for individuals without documented and verified

medical exemptions, although accommodations for philosophical exemptions may be necessary based on local laws and regulations (Weber et al., 2022).

To improve vaccine accessibility, healthcare facilities should offer immunizations in convenient locations and timeframes, including between-shift clinics, evening-staffed vaccination sites, and mobile vaccination carts. Providing vaccines within pediatric hospitals may be particularly beneficial for caregivers of high-risk patients—such as premature neonates, immunocompromised children, and critically ill pediatric patients—who may otherwise face logistical barriers to receiving immunizations. This strategy enhances vaccine uptake while reducing the risk of caregiver-to-HCP transmission of infectious diseases.

In cases involving novel pathogen emergence, prioritization of vaccines and other medical countermeasures may be necessary. Risk stratification based on health conditions, age, or patient care responsibilities may be resource-intensive and could lead to perceived inequities. If vaccine supply is limited, institutions should implement equitable strategies for prioritizing subsets of HCP for vaccination and expand eligibility criteria as additional doses become available.

Drills and Training

A fundamental component of establishing and sustaining a program for the care of children with special pathogen infections, including within a designated biocontainment unit, is ensuring that healthcare personnel are adequately prepared to manage such patients. Comprehensive training is required to provide healthcare workers with a thorough understanding of the epidemiology, diagnosis, and treatment of specific pathogens, as well as to cultivate the necessary skills for confidence and safe patient care practices. Personnel must be thoroughly trained in institutional policies and procedures, including infection prevention and control measures, environmental sanitation, personal protective equipment (PPE) usage, and established unit-specific clinical care protocols. The composition of the clinical team must be structured to guarantee the safe provision of patient care within both dedicated biocontainment units and designated areas within general hospital settings. If certain clinical care activities cannot be conducted safely due to a heightened risk of pathogen transmission to healthcare personnel, contingency plans must be devised to address deviations from standard practices. For instance, during the 2014–2015 Ebola virus disease (EVD) outbreak, adaptations such as transitioning laboratory diagnostics to point-of-care testing and limiting highly specialized interventions like extracorporeal membrane oxygenation for patients with multiorgan failure were implemented (Dilorenzo et al., 2021).

Healthcare teams providing care in biocontainment units typically comprise specialists from multiple disciplines, including physicians, nurses, laboratory technicians, and critical care personnel. In facilities preparing to treat pediatric patients, it is essential to ensure that an adequate number of pediatric-trained staff are both available and well-versed in the specific requirements of pediatric special pathogen care. The initial training process must be extensive to establish foundational knowledge and skills, while ongoing education and simulation exercises are necessary to maintain a constant state of readiness and to reinforce clinical competencies. Infection prevention and control (IPC) teams play a vital role in facilitating this preparedness education among frontline healthcare staff.

A crucial aspect of team-based training is the cultivation of trust, camaraderie, and mutual support among team members. This foundational trust is essential for fostering high-functioning teams, particularly in high-stress situations where activation occurs. Trust among colleagues is critical in the provision of care for children with special pathogens, ensuring that team members

effectively monitor PPE usage and identify any potential breaches that could lead to inadvertent exposure. High-trust teams are more likely to implement the necessary "flattening" of traditional institutional hierarchies, which is essential for encouraging all team members to voice concerns, highlight potential safety risks, and seek clarification when necessary to optimize patient and staff safety. Establishing a non-hierarchical environment, where responsibilities such as room cleaning or waste disposal are shared among all present healthcare workers regardless of role, is a crucial component of fostering an effective and collaborative team dynamic. These relationships of trust and cooperation are reinforced through routine drills and training exercises.

Healthcare teams responsible for the care of pediatric patients with special pathogens must regularly practice the donning and doffing of PPE specific to their unit, working in pairs to validate adherence to proper procedures and minimize the risk of self-contamination. Drills should also integrate clinical scenario simulations within the patient care setting, employing high-fidelity mannequins or trained patient actors when feasible to identify and resolve logistical challenges in the biocontainment environment. Potential obstacles may include the safe execution of physical examinations (e.g., auscultation using alternative stethoscopes), proficiency in invasive procedures such as intravenous line placement and phlebotomy, and proper handling of medications within the unit. Healthcare personnel should also be trained in performing advanced environmental cleaning techniques, including the safe management of spills involving patient bodily fluids, to reduce reliance on environmental services staff and limit their exposure to infectious agents. Training should also encompass critical emergency procedures, such as endotracheal intubation, cardiopulmonary resuscitation, and the secure transport of deceased patients. Another essential component of training is practicing the safe transportation of patients, necessitating scenario-based planning to ensure efficient execution. For those working within biocontainment units, training should cover patient admission protocols, including the safe handoff of patients from emergency medical services (EMS) personnel transporting them directly from the community. Specialized transport equipment, such as isolation pods, should be incorporated into these drills to ensure that unit personnel are proficient in their use.

Drills also serve as opportunities to prepare for unforeseen scenarios that healthcare teams may encounter. Unexpected elements can be introduced into training exercises to identify system-wide or individual healthcare worker deficiencies in preparedness. Examples of such scenarios include managing a rapidly deteriorating patient in the biocontainment setting, facilitating labor and delivery for a pregnant patient, handling an anxious and noncompliant pediatric patient, or responding to urgent facility repairs or a medical emergency involving a healthcare worker within the biocontainment unit. Additional environmental challenges to consider during training include the safe containment and decontamination of blood and body fluid spills or the thorough cleansing of patients with extensive bodily fluid contamination, along with the appropriate handling of contaminated linens and surfaces. Resources and training support for many of these scenarios are available through the National Emerging Pathogen Education and Training Center (NETEC).

Access to Medical Countermeasures

Medical countermeasures (MCMs) for special pathogens encompass a broad range of interventions, including pharmaceutical agents (e.g., antimicrobial medications), biologics (e.g., vaccines, blood products, and monoclonal antibodies), and medical devices (e.g., PPE, diagnostic tests, and ventilators). These countermeasures are subject to regulation by the U.S. Food and Drug Administration (FDA). The availability of MCMs varies significantly depending on the specific pathogen and its impact on public health. Furthermore, the stages of clinical development and

accumulated clinical experience with MCMs differ across pathogens, particularly in the pediatric population, where clinical trials and empirical data are often scarce or nonexistent.

To ensure a reliable supply of essential MCMs for both routine use and potential surges in demand, children's hospitals must foster collaboration between emergency management teams and supply chain personnel. Such preparedness is necessary not only to maintain standard clinical operations during predictable seasonal increases in respiratory illnesses but also to support contingency planning for novel pathogen outbreaks that may lead to widespread pediatric morbidity. In addition, staff training exercises designed for special pathogen preparedness require the availability of an ample inventory of relevant supplies.

Pandemic conditions can significantly disrupt supply chains, affecting the production and distribution of critical MCMs. During public health crises, securing adequate inventory may become particularly challenging as demand rapidly surpasses supply. Standalone pediatric hospitals and smaller healthcare systems may face additional difficulties in obtaining sufficient MCM stocks due to reduced leverage in procurement negotiations. Various preparatory and contingency measures are essential to mitigate these risks. One strategy involves maintaining a diverse selection of MCM options to provide greater flexibility during supply shortages. However, it is important to anticipate operational and educational adjustments when new products are introduced. For instance, transitioning to an alternative N95 respirator model necessitates additional fit testing, adopting a different diagnostic assay requires laboratory validation, and switching to a new vaccine formulation may involve modifications to dosing and administration protocols. These considerations should be integrated into institutional planning to uphold staff and patient safety.

During public health emergencies characterized by MCM shortages, children's hospitals have implemented innovative strategies to sustain clinical operations. For example, early in the COVID-19 pandemic, some laboratories developed in-house diagnostic assays for SARS-CoV-2 or produced their own viral transport media; others used 3D printing to manufacture nasal swabs. One pediatric hospital addressed limited N95 respirator supplies by assembling a multidisciplinary stewardship team responsible for monitoring appropriate usage and providing real-time PPE education, an initiative that was well received by frontline healthcare workers.

To promote equitable access to MCMs among pediatric populations, especially in underserved communities, additional measures must be adopted. Historically, children have been among the last groups to be included in clinical trials for new MCMs. Consequently, children's hospitals may need to collaborate with clinical research and pharmacy teams to secure access to potentially life-saving treatments through FDA-approved investigational new drug applications or expanded access (compassionate use) mechanisms. Caregivers may express concerns regarding novel therapeutics, particularly those authorized under FDA Emergency Use Authorization. Such concerns may be more prevalent among marginalized populations, including non-Hispanic Black individuals (Alfieri et al., 2021) and socioeconomically disadvantaged groups. Proactive educational initiatives and efforts to counter misinformation can enhance equitable access. One pediatric hospital improved access to COVID-19 therapeutics by proactively identifying and contacting newly diagnosed children in real time rather than relying on physician referrals. Mobile health teams and community partnerships can further enhance access to MCMs in underserved areas (Jiménez et al., 2022).

Family-Centered and Child-Centered Care

During the 2014–2015 Ebola virus disease (EVD) outbreak, pediatricians in the United States managed a considerable number of children who were either suspected of exposure or infection. Over a seven-month period from July 2014 to January 2015, the Centers for Disease Control and Prevention (CDC) provided clinical guidance for 89 pediatric patients, of whom 33 had epidemiological links to potential exposure; 15 underwent testing, with all results returning negative for EVD. From these experiences, delays in addressing other medical conditions were identified, alongside challenges in managing the care and needs of family members.

The findings of this report coupled with insights from experienced physicians who provided care for children under investigation for EVD, stimulated further discussions on balancing both the clinical and psychosocial requirements of pediatric patients and their families. Family-centered care acknowledges and respects the inherent strengths, cultural values, and needs of children and their families, utilizing the healthcare experience as an opportunity to reinforce these strengths. As pediatricians, family-centered care is a fundamental principle of practice, recognizing that familial presence offers essential social and emotional support, thereby enhancing overall clinical outcomes. However, when a child is under evaluation for a special pathogen, traditional family-centered care approaches may require reassessment (Mehrotra et al., 2015). Since pediatric patient care does not adhere to a standardized approach, an individualized care plan is necessary, while certain fundamental principles may remain applicable. Furthermore, a child's medical condition may change over the course of hospitalization, transitioning from critical illness to rehabilitative needs, thereby necessitating dynamic adjustments to both clinical and family-centered care.

One of the most complex challenges in caring for pediatric patients with a confirmed or suspected special pathogen lies in balancing the need for medical treatment with the psychosocial well-being of both the child and their caregivers, while simultaneously ensuring the protection of healthcare personnel (HCP). Each healthcare facility must establish specific protocols regarding family presence and engagement based on the nature of the pathogen and the circumstances surrounding exposure. In some cases, particularly at the initial point of medical evaluation, family members may not be permitted immediate physical access to the child until stabilization occurs and additional information is available. Alternative methods for maintaining family engagement, such as telecommunication via telephone or video technology, may serve to partially address the emotional and psychological needs of both pediatric patients and their families. Language barriers may further complicate communication, particularly for patients and families originating from non-English-speaking regions. In such situations, video or telephonic interpretation services should be integrated into communication strategies. Additionally, if a family member is suspected or confirmed to have been exposed to or infected with the special pathogen, they may be subject to isolation or quarantine measures in accordance with guidance from local health authorities.

Collaboration with hospital ethics committees, child-life specialists, social workers, patient advocates, chaplains, and public health agencies may be instrumental in developing clear and ethically sound protocols. Once such guidance is established, effective dissemination of information is crucial to ensure consistent messaging among clinicians and families. It must be emphasized that guidelines are based on the best available scientific evidence at the time and are subject to revision as new information emerges. Transparent communication should focus on the healthcare team’s dual commitment to patient safety and infection control, with the ultimate goal of reunifying pediatric patients with their families as swiftly as possible.

Organizational and Systems Support for Preparedness

The 2014 Ebola outbreak in West Africa prompted significant enhancements in the preparedness of U.S. healthcare systems for special pathogens. As part of the response, the Department of Health and Human Services (HHS) Office of the Assistant Secretary for Preparedness and Response (now known as the Administration for Strategic Preparedness and Response [ASPR]) established a three-tiered hospital network comprising treatment, assessment, and frontline facilities, each with designated capabilities. In 2015, the National Ebola Training and Education Centers (NETEC) were launched, initially including 10 regional Ebola treatment centers with ongoing ASPR-led efforts to increase the number of centers. Children's hospitals should collaborate with regional emergency preparedness coalitions and public health authorities to determine their designated tier for special pathogen care, as well as to develop a business model supporting clinical preparedness initiatives. Past cases of Ebola transmission to HCP within the United States have underscored the necessity of such preparedness efforts. Furthermore, the COVID-19 pandemic has both introduced novel challenges and reinforced the importance of adapting existing preparedness frameworks beyond special pathogen readiness.

A critical factor in sustaining special pathogen treatment centers is the need to maintain a high level of operational and staff readiness, not only in response to global outbreaks but as a continuous institutional priority. However, sustaining these efforts can be difficult given the competing demands for resources, including personnel time, equipment, and financial investment. A well-structured national preparedness framework should ensure that all hospitals possess the capability to identify, triage, and appropriately transfer patients with suspected or confirmed emerging infectious diseases to specialized treatment centers.

Despite these logistical challenges, there remains an imperative to enhance the preparedness capabilities of all acute care facilities, including pediatric hospitals, as they may serve as the first point of contact for children presenting with special pathogens. Initially, national preparedness efforts did not sufficiently prioritize pediatric-specific considerations, leading to limited resource allocation for children's hospitals. However, more recent efforts have sought to bridge this gap, particularly with the establishment of the Pediatric Pandemic Network which was created during the COVID-19 response and is supported by the Department of Health and Human Services, Health Resources and Services Administration. This initiative represents a significant advancement in incorporating pediatric-focused preparedness efforts within the broader national emergency response framework, thereby ensuring that children's hospitals are adequately equipped to manage complex infectious disease cases in pediatric patients.

Conclusion:

The management of special pathogens presents significant challenges to healthcare systems, requiring a comprehensive approach to infection prevention, hospital preparedness, and healthcare worker safety. Healthcare personnel, particularly those in pediatric care settings, play a crucial role in mitigating the transmission of highly infectious agents while ensuring high-quality patient care. Strategies such as early identification, proper isolation, and efficient communication are fundamental to minimizing risks for both patients and staff. Furthermore, ongoing training, personal protective equipment (PPE) protocols, occupational health surveillance, and access to medical countermeasures are vital in maintaining healthcare worker safety and operational readiness.

Lessons learned from past outbreaks, including the 2014–2015 Ebola virus disease epidemic and the COVID-19 pandemic, emphasize the importance of sustaining preparedness

efforts beyond crisis periods. Investments in structured training programs, biocontainment infrastructure, and interprofessional collaboration are necessary to enhance healthcare worker resilience and response efficiency. Additionally, healthcare facilities must adopt evidence-based policies that balance clinical care with psychosocial considerations for both pediatric patients and their families.

As special pathogens continue to emerge and re-emerge, a proactive and multidisciplinary approach to hospital preparedness remains essential. Healthcare workers must be equipped with the necessary tools, training, and support systems to navigate the complexities of infectious disease outbreaks. By fostering a culture of safety, readiness, and continuous learning, healthcare institutions can effectively safeguard both their workforce and the patients they serve.

References

Alfieri, N. L., Kusma, J. D., Heard-Garris, N., Davis, M. M., Golbeck, E., Barrera, L., & Macy, M. L. (2021). Parental COVID-19 vaccine hesitancy for children: Vulnerability in an urban hotspot. *BMC Public Health*, *21*(1). Scopus. https://doi.org/10.1186/s12889-021-11725-5

Bielicki, J. A., Duval, X., Gobat, N., Goossens, H., Koopmans, M., Tacconelli, E., & van der Werf, S. (2020). Monitoring approaches for health-care workers during the COVID-19 pandemic. *The Lancet Infectious Diseases*, *20*(10), e261–e267. https://doi.org/10.1016/S1473-3099(20)30458-8

Burkholder, T. W., Dziadkowiec, O., Bookman, K., & King, R. A. (2019). Adherence to Universal Travel Screening in the Emergency Department During Epidemic Ebola Virus Disease. *The Journal of Emergency Medicine*, *56*(1), 7–14. https://doi.org/10.1016/j.jemermed.2018.09.038

Deal, A., Halliday, R., Crawshaw, A. F., Hayward, S. E., Burnard, A., Rustage, K., Carter, J., Mehrotra, A., Knights, F., Campos-Matos, I., Majeed, A., Friedland, J. S., Edelstein, M., Mounier-Jack, S., & Hargreaves, S. (2021). Migration and outbreaks of vaccine-preventable disease in Europe: A systematic review. *The Lancet Infectious Diseases*, *21*(12), e387–e398. https://doi.org/10.1016/S1473-3099(21)00193-6

Dilorenzo, M. A., Baker, C. A., Herstein, J. J., Evans, L., Lowe, J. J., Gibbs, S. G., Bhadelia, N., & Dilorenzo, M. A. (2021). Institutional policies and readiness in management of critical illness among patients with viral hemorrhagic fever. *Infection Control and Hospital Epidemiology*, *42*(11), 1307–1312. Scopus. https://doi.org/10.1017/ice.2020.1416

Elkholy, A. A., Grant, R., Assiri, A., Elhakim, M., Malik, M. R., & Van Kerkhove, M. D. (2020). MERS-CoV infection among healthcare workers and risk factors for death: Retrospective analysis of all laboratory-confirmed cases reported to WHO from 2012 to 2 June 2018. *Journal of Infection and Public Health*, *13*(3), 418–422. https://doi.org/10.1016/j.jiph.2019.04.011

Flinn, J. B., Britton, A. D., Garland, J., Cuzzolina, J., Biddinger, P. D., Mukherjee, V., & Grein, J. D. (2023). Rebuilding for Tomorrow's Outbreak: The State of Special Pathogen Preparedness in the USA in the Wake of COVID-19. *Current Infectious Disease Reports*, *25*(12), 313–322. https://doi.org/10.1007/s11908-023-00821-9

Jiménez, J., Parra, Y. J., Murphy, K., Chen, A. N., Cook, A., Watkins, J., Baker, M. D., Sung, S., Kaur, G., Kress, M., Kurien, S. J., Keeley, C., & Long, T. (2022). Community-Informed Mobile COVID-19 Testing Model to Addressing Health Inequities. *Journal of Public Health Management and Practice*, *28*, S101–S110. Scopus. https://doi.org/10.1097/PHH.0000000000001445

Lichtman, A., Greenblatt, E., Malenfant, J., & Kuo, A. (2021). Universal symptom monitoring to address presenteeism in healthcare workers. *American Journal of Infection Control*, *49*(8), 1021–1023. https://doi.org/10.1016/j.ajic.2021.02.009

Maung, Z., Kristensen, M., Hoffman, B., & Jacobson, M. A. (2022). Temperature Screening of Healthcare Personnel Is Ineffective in Controlling COVID-19. *Journal of Occupational and Environmental Medicine*, *64*(5), 382. https://doi.org/10.1097/JOM.0000000000002518

Mehrotra, P., Shane, A. L., & Milstone, A. M. (2015). Family-centered care and high-consequence pathogens thinking outside the room. *JAMA Pediatrics*, *169*(11), 985–986. Scopus. https://doi.org/10.1001/jamapediatrics.2015.1753

Srivatsa, S., & Stewart, K. A. (2020). How Should Clinicians Integrate Mental Health Into Epidemic Responses? *AMA Journal of Ethics*, *22*(1), E10–E15. Scopus. https://doi.org/10.1001/amajethics.2020.10

Weber, D. J., Al-Tawfiq, J. A., Babcock, H. M., Bryant, K., Drees, M., Elshaboury, R., Essick, K., Fakih, M., Henderson, D. K., Javaid, W., Juffras, D., Jump, R. L. P., Lee, F., Malani, A. N., Mathew, T. A., Murthy, R. K., Nace, D., Oshea, T., Pettigrew, E., … Young, H. (2022). Multisociety statement on coronavirus disease 2019 (COVID-19) vaccination as a condition of employment for healthcare personnel. *Infection Control and Hospital Epidemiology*, *43*(1), 3–11. Scopus. https://doi.org/10.1017/ice.2021.322