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Management guidelines for pregnant health care workers exposed to infectious dermatoses

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Abstract
Exanthematous diseases are frequently of infectious origin, posing risks, especially for pregnant health care workers (HCWs) who treat them. The shift from cell-mediated (Th1 cytokine profile) to humoral (Th2 cytokine profile) immunity during pregnancy can influence the mother’s susceptibility to infection and lead to complications for both mother and fetus. The potential for vertical transmission must be considered when evaluating the risks for pregnant HCWs treating infected patients because fetal infection can often have devastating consequences. Given the high proportion of women of childbearing age among HCWs, the pregnancy-related risks of exposure to infectious diseases are an important topic in both patient care and occupational health. Contagious patients with cutaneous manifestations often present to dermatology or pediatric clinics, where female providers are particularly prevalent; a growing number of these physicians are female. Unfortunately, the risks of infection for pregnant HCWs are not well defined. To our knowledge, there is limited guidance on safe practices for pregnant HCWs who encounter infectious dermatologic diseases. In this article, we review several infectious exanthems, their transmissibility to pregnant women, the likelihood of vertical transmission, and the potential consequences of infection for the mother and fetus. Additionally, we discuss recommendations with respect to avoidance, contact, and respiratory precautions, as well as the need for treatment after exposure.

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Introduction

It is estimated that 48.9% of practicing dermatologists are female (Association of American Medical Colleges, 2017). Given that 48.8% of physicians under the age of 35 years are female (American Medical Association, 2015), a significant portion of both female trainees and attending physicians are of childbearing age. In particular, dermatologists, pediatricians, and other health care workers (HCWs) in these offices routinely care for patients who present with infections with cutaneous manifestations. For pregnant HCWs, balancing patient care responsibilities and occupational safety can be challenging, especially when the risk of transmission in the clinical setting is unknown.

To our knowledge, there is no comprehensive review of the literature that specifically identifies the risk of transmission of common exanthematous diseases to pregnant HCWs. This review identifies various infectious exanthems to which pregnant HCWs may be exposed and summarizes current available evidence regarding risk of transmission. Specifically, we discuss parvovirus B19 (PVB19), hand, foot, and mouth disease (HFMD), mycoplasma-induced rash and mucositis (MIRM), measles, herpes simplex virus (HSV), varicella-zoster virus (VZV), and pityriasis rosea (PR). We also provide guidelines for each disease so pregnant HCWs may be exposed and summarizes current available evidence regarding risk of transmission. Specifically, we discuss parvovirus B19 (PVB19), hand, foot, and mouth disease (HFMD), mycoplasma-induced rash and mucositis (MIRM), measles, herpes simplex virus (HSV), varicella-zoster virus (VZV), and pityriasis rosea (PR). We also provide guidelines for each disease so pregnant HCWs may be exposed and summarizes current available evidence regarding risk of transmission.

Parvovirus

A wide range of clinical manifestations have been associated with PVB19 infection, including erythema infectiosum, arthropathy, and aplastic crisis. Erythema infectiosum is the most common dermatologic manifestation of PVB19, presenting in children between the ages of 5 and 14 years after a prodrome. The classic presentation involves a facial rash with a slapped-cheek appearance, followed by a morbilliform eruption on the extremities and trunk 1 to 4 days later. Once the rash appears, patients are no longer contagious (Servey et al., 2007). As such, although providers are at risk of infection during the PVB19 prodromal phase, they are likely protected if patients present with a rash.

The disease course itself is self-limiting, but PVB19 infection during pregnancy has been attributed to several adverse fetal outcomes, including intrauterine fetal demise, thrombocytopenia, and hydrops fetalis. Transmission occurs primarily via exposure to droplets and fomites but can also occur via vertical transmission. The rate of baseline immunity to PVB19 in pregnant populations ranges from 35% to 65% (Gillespie et al., 1990; Gratacos et al., 1995; Valeur-Jensen et al., 1999). The incidence of acute PVB19 infection in susceptible pregnant women is reported to be 1% to 2%, with an estimated vertical transmission rate of approximately 25% to 35% (Gratacos et al., 1995; Neu et al., 2015). Risks for childcare workers, including school teachers and daycare center employees, are well documented in the literature (Riipinen et al., 2014). A population-based cohort study in Denmark of >30,000 pregnant women found that working as a nursery school teacher and having more children in the household were among the greatest risk factors associated with acquiring parvovirus infection (Valeur-Jensen et al., 1999).

Data on the risk of transmission to HCWs, however, are conflicting (Adler et al., 1993). Various case reports and case series (Harrison and Jones, 1995; Lara-Medrano et al., 2016; Sungkate et al., 2017) have demonstrated risk of transmission of parvovirus infection to HCWs after exposure to infected patients. One single-center study at the Children’s Hospital of Philadelphia found an elevated risk of infection between exposed and unexposed staff (Bell et al., 1989). However, a cohort study of 87 HCWs exposed to two patients with PVB19-induced aplastic crisis found no significant increase in PVB19-specific immunoglobulin (Ig) M and IgG antibodies when compared with unexposed HCWs at the same facility (Ray et al., 1997).

Although the risk of transmission to HCWs has not been definitively identified, preventing the transmission of PVB19 infection is important because infection can lead to adverse pregnancy outcomes. PVB19 infection carries a 9% excess risk of miscarriage within the first 20 weeks of gestation and a 2.9% risk of fetal hydrops between weeks 9 and 20 (Miller et al., 1998).

Management recommendations

Pregnant HCWs should not be part of the care team for patients with suspected PVB19 infection, if possible. If exposure is suspected, risk assessment should consider the presence of an ongoing outbreak as well as the extent of contact that the HCW had with exposed patients. Droplet precautions should be strictly followed when caring for patients with PVB19. Refer to Table 1 for the different types of infection control and prevention precautions. If a pregnant HCW is exposed to a known or suspected parvovirus case, she should undergo PVB19 testing for IgM and IgG (Crowcroft et al., 1999; Katta 2002; Kho et al., 2008; Lamont et al., 2011). If IgM positive, pregnant HCWs at <21 weeks of gestation should undergo serial ultrasound examinations scheduled per obstetrician recommendation to assess for development of fetal hydrops. Maternal intravenous immunoglobulin (IVIG) administration is not recommended. Refer to Table 2 for a summary of infection risk, complications, prevention, and management guidelines.

Hand, foot, and mouth disease

HFMD is a highly contagious viral infection typically caused by coxsackievirus A16 and enterovirus 71. The infection, which is primarily transmitted via respiratory droplets, contact with blisters, or contact with feces, most commonly affects children under the age of 5 years. HFMD is classically characterized by a macular, morbilliform, or vesicular rash that affects the hands, feet, and oral mucosa. As one of the most common pediatric exanthems, HFMD is routinely seen by pediatric and dermatology HCWs, presenting a potential concern for occupational exposure.

Although outbreaks of HFMD have been regularly reported worldwide in children, symptomatic infections in adults are less common (Chang et al., 2004). Individual cases of adult infection have been reported in the literature (Murase and Akiyama, 2018; Stewart et al., 2013). The coxsackievirus A6 (CVA6) serotype has been linked to several HFMD outbreaks worldwide, affecting both adults and children (Kimmis et al., 2018; Ramirez-Fort et al., 2014). HFMD due to CVA6 differs in presentation from classic HFMD. Unlike in typical HFMD, adults with CVA6 HFMD are more likely to develop vesicular eruptions involving the dorsal hands and feet, as well as the face (Horsten et al., 2018). The lesions may also appear more purpuric than typical HFMD and can mimic secondary syphilis. Later in the disease process, the rash can desquamate and mimic fungal infection (Ramirez-Fort et al., 2014). Other features include widespread vesiculobullous and erosive lesions extending beyond the palms and soles, an eczema herpetiform-like eruption termed “eczema coxsackium,” and an eruption similar to Gianotti-Crosti in children (Mathes et al., 2013). There can also be occasional sparing of the oral mucosa (Second et al., 2017). Out-
breaks of HFMD in adults that have been reported in the literature have typically occurred in adults after exposure to children with HFMD (Centers for Disease Control and Prevention [CDC] Morbidity and Mortality Weekly Report, 2012) or among college students (Buttery et al., 2015) and military trainees (Banta et al., 2016).

HFMD during pregnancy has been rarely reported in the literature and is largely limited to case reports (Chow et al., 2000; Deeb et al., 2019; Ogilvie and Tearne, 1980), with no reports discussing pregnant HCWs specifically. One report identifies fetal demise secondary to maternal coxsackievirus A16 infection with confirmed massive placental perivillous fibrinoid deposition (Heller et al., 2016). Another found no evidence to suggest that HFMD affected pregnancy course or newborn development (Second et al., 2017). A retrospective observational study in Italy of 128 pregnant patients with clinically suspected HFMD or documented exposure found no conclusive evidence that HFMD affected fetal or neonatal outcomes (Giaèh et al., 2019). The CDC also reports no clear evidence that non-polio enterovirus infection during pregnancy increases the risk of severe complications, including miscarriage, stillbirth, or congenital defects (CDC, 2019a,b).

Management recommendations

Although the rate of HFMD is high among children, transmission to adults is less likely and often confers an asymptomatic or milder course. The literature regarding HFMD outcomes in pregnant women is limited. As such, we recommend proper and consistent hand hygiene and strict droplet and contact precautions for any pregnant HCW who participates in the care of a suspected HFMD case. It is also prudent to inform the HCW's obstetric provider for close monitoring (Ventarola et al., 2015). If an HFMD case is severe and requires hospitalization, we recommend isolation of the patient. If possible, we recommend having another provider assume care for patients with HFMD in these cases.

Mycoplasma-induced rash and mucositis

Mycoplasma infections are associated with various adverse outcomes in pregnancy. Although the incidence of Mycoplasma pneumoniae infection during pregnancy is unknown (Matsuda et al., 2017), pneumonia during pregnancy is well-associated with preterm labor and low birth weight (Chen et al., 2012).

MIRM refers to Mycoplasma pneumoniae–associated mucocutaneous disease with prominent mucositis and varying degrees of cutaneous involvement (Canavan et al., 2015). Classically, MIRM presents as severe conjunctivitis and blepharitis, severe oral mucositis with hemorrhagic crusting, and sparse vesiculobullous eruption in children and adolescents with a 2:1 male-to-female predominance (Canavan et al., 2015). To our knowledge, there are no reports in the literature of MIRM during pregnancy. Care for patients with MIRM involves supportive care, including fluids, analgesia, and ophthalmology and urology evaluation (Canavan et al., 2015).

Management recommendations

To our knowledge, MIRM has not been reported in a pregnant patient or HCW. We recommend dermatology consultation if an HCW is symptomatic after exposure to patients with mycoplasma manifesting as MIRM, with close monitoring of symptom resolution. Treatment should be similar to that for a nonpregnant patient with MIRM, which includes evaluation and monitoring by a physician, antibiotics, systemic corticosteroids, or (rarely) IVIG administration.

Measles

The global incidence of measles has climbed in recent years. Sizeable outbreaks continue to occur around the world, largely because of decreased vaccination rates. Although skin manifestations of measles are nondiagnostic, it is increasingly important for HCWs to be able to recognize the disease.

The clinical manifestations of measles virus infection classically begin with a prodrome characterized by fever, malaise, cough, coryza, and conjunctivitis. Koplik spots may appear during the prodromal phase. An erythematous, morbilliform exanthem appears approximately 3 to 5 days after the onset of symptoms, with cranial to caudal progression. The patient is considered contagious 4 days before and after the appearance of the rash. Notably, exanthem may be absent in immunocompromised patients and pregnant women, making measles more difficult to recognize.
### Table 2

Summary of infection risk, transmission, adverse outcomes, prevention, and treatment in PVB19, HFMD, MIRM, measles, HSV, VZV, and PR for pregnant HCWs.

| Pathogen/disease | Mode of transmission | Incidence in pregnant women | Rate of vertical transmission | Risk of adverse fetal/neonatal outcomes | Infection control precautions | Postexposure treatment |
|------------------|----------------------|-------------------------------|-----------------------------|---------------------------------------|------------------------------|------------------------|
| Parvovirus B19 (PVB19) | Respiratory secretions, saliva droplets, fomites, transplacental, blood products | 1–2% | 25–35% | 9% excess risk of miscarriage in first 20 weeks; 2.9% risk of fetal hydrops between weeks 9 and 20 | Droplet precautions | PVB19 testing for IgM and IgG. If IgM positive and <21 weeks of gestation, pregnant HCW should undergo serial ultrasound examinations |
| Hand, foot, and mouth disease (HFMD) | Respiratory secretions, saliva droplets, contact with blister fluid, fomites, or feces | Unknown | Unknown | Inconclusive; there is some concern regarding perinatal transmission to newborns | Droplet and contact precautions | Adequate hydration and analgesia; Inform obstetric provider; close monitoring |
| Mycoplasma-induced rash and mucositis (MIRM) | Respiratory secretions, saliva droplets | Unknown | Unknown | Unknown | Droplet precautions | Dermatology consultation if symptomatic |
| Measles | Saliva droplets, respiratory secretions, fomites | Unknown (rare) | Unknown; (horizontal transmission rate up to 90%) | Low birth weight, intrauterine fetal demise, prematurity; Maternal complications: diarrhea (60%), pneumonia (40%), encephalitis (5%), death (12%) | Airborne precautions | Nonimmune pregnant women should receive intravenous immunoglobulin treatment within 6 days of exposure. Any exposed HCW without evidence of immunity should be excluded from the healthcare setting from the fifth through 21st days after exposure |
| Herpes simplex virus (HSV) | Perinatal contact with lesions, saliva, mucosal contact | At least 2% in susceptible pregnant women; prevalence of genital HSV-1 and HSV-2 in pregnant women is 25–65% (including subclinical genital infection) 0.7–3 per 1000 pregnancies | Neonatal herpes develops in less than 1% of infants delivered vaginally to women with HSV-2 shedding at term; 50–80% of cases of neonatal HSV result from women who acquire genital HSV-1 or HSV-2 infection near term | Congenital HSV (sepsis, microcephaly, hydrocephalus, chorioretinitis), vesicular lesions, central nervous system involvement (lethargy, poor feeding, seizures, developmental delay, epilepsy, blindness, and cognitive disabilities) Intraterine growth restriction (23%), low birth weight (nearly universal), VZV pneumonia (2.5%), Congenital varicella syndrome (0.91% in first 20 weeks of pregnancy and 2% at 13–20 weeks of gestation) | Contact precautions if localized Airborne precautions if disseminated | Occupational exposure to HSV is unlikely if appropriate precautions are followed by HCW |
| Primary varicella zoster virus (VZV) infection | Vertical transmission (in utero, perinatal, postnatal); saliva droplets, respiratory secretions, and contact with vesicles | Overall incidence is 0.5–2%. When PR occurs in women ages 17–48 years, 18% of cases occur during pregnancy | Increased risk of miscarriage in first 15 weeks of gestation | Standard precautions | Susceptible (seronegative) pregnant HCWs exposed to VZV should receive varicella-zoster immune globulin (e.g., VarizIG) as soon as possible, ideally within 96 hours but up to 10 days after exposure. Susceptibility should be confirmed by serology prior to administration if possible. Careful monitoring for signs of infection despite passive immunization is essential. Nonimmune HCWs should be furloughed during days 8–28 after exposure and should be placed on sick leave until symptoms resolve. Fetal and maternal monitoring is crucial |
| Pityriasis rosea (PR) | Unclear etiology; associated with HHV-6 and HHV-7 | Overall incidence is 0.5–2%. When PR occurs in women ages 17–48 years, 18% of cases occur during pregnancy | Unknown; insufficient evidence | Unknown; insufficient evidence | Standard precautions | Close monitoring if PR occurs within first 15–20 weeks of gestation or if mother experiences constitutional symptoms or an unusually diffuse, prolonged rash. In these cases, consider acyclovir 400 mg TID for 7 days, which has been shown to hasten the resolution of PR lesions and relieve pruritus |

HCW, health care worker; PCR, polymerase chain reaction; TID, thrice daily.
Measles during pregnancy has been associated with an increased risk of adverse maternal, fetal, and neonatal outcomes. One retrospective cohort analysis of 55 pregnant women with measles in Namibia showed increased risks for low birth weight, spontaneous abortion, intrauterine fetal death, and maternal death when compared with pregnancies without measles (Ogbuanu et al., 2014). In this study, 71% of the women developed measles-related complications, including diarrhea (60%), pneumonia (40%), and encephalitis (5%). Of the pregnancies with known outcomes, 60% had at least one adverse outcome, including maternal death in 12% of cases.

Other studies comparing women with and without measles during pregnancy have shown an increased frequency of prematurity, increased likelihood of neonatal intensive care unit admission, and longer intensive care unit stays among neonates born to mothers with gestational measles (Ali and Albar, 1997; Siegel and Fuerst, 1966). The rate of congenital defects does not appear to be higher among neonates born to mothers with measles than to uninfected mothers (Siegel, 1973; Ali and Albar, 1997). However, congenital measles can occur, with severity ranging from mild to fatal (Gershon, 2006). Congenital measles has been reported among neonates born to women who had measles within 10 days of delivery (Charlier et al., 2015). Measles is highly contagious, with up to 90% of susceptible individuals becoming infected upon exposure (McLean et al., 2013). HCsWs are at a higher risk of being exposed to, and subsequently developing, measles than the general adult population (Shefer et al., 2011).

**Management recommendations**

All HCWs should provide evidence of immunity to measles prior to employment, and nonpregnant HCWs should receive the measles, mumps, and rubella (MMR) vaccine in the absence of such evidence (Bolyard et al., 1998; McLean et al., 2013; Siegel et al., 2007). Women should avoid becoming pregnant for 4 weeks after vaccination (McLean et al., 2013). The MMR vaccine is contraindicated during pregnancy owing to the theoretical risk of live vaccines to the fetus, although inadvertent MMR vaccination during pregnancy has not been associated with an increased risk of adverse outcomes and is not an indication for pregnancy termination (Bar-Oz et al., 2004). Close contacts of pregnant women should ensure their MMR titers are sufficient or should receive an MMR vaccination or booster.

Pregnant HCWs without evidence of measles immunity (seronegative), like all susceptible HCWs, should not enter the rooms of patients with known or suspected measles (Siegel et al., 2007). If exposed to measles, nonimmune pregnant women should receive IVIG treatment within 6 days of exposure (Siegel et al., 2007). Any exposed HCW without evidence of immunity should be excluded from the health care setting from the fifth through the 21st day after exposure (Bolyard et al., 1998; Shefer et al., 2011). If immune, pregnant HCWs may care for patients with measles and should follow airborne and standard precautions, with respiratory protection at least as protective as a N95 respirator (Bolyard et al., 1998; Siegel et al., 2007; Shefer et al., 2011).

**Herpes simplex virus**

Clinical manifestations of HSV infection vary widely. HSV-1 typically causes orofacial infection, whereas HSV-2 is predominantly responsible for genital herpes. However, each viral subtype can affect either anatomic location. Genital herpes is of concern to pregnant women given the risk of vertical transmission and the morbidity and mortality associated with congenital and neonatal infection. When symptomatic, genital herpes presents as painful, pruritic vesicles and ulcers that may be accompanied by headache, fever, dysuria, and tender inguinal lymphadenopathy. Recurrences are typically milder than primary infection, and even a primary infection may be subclinical.

Data suggest that at least 2% of susceptible women in the United States acquire HSV during pregnancy (Brown et al., 1997). Primary HSV infection during pregnancy may rarely lead to life-threatening disseminated disease (Sappenfield et al., 2013; Young et al., 1996), but the greatest risk is vertical transmission. Intrauterine infection is rare, but its occurrence is associated with severe neurologic, ophthalmologic, and cutaneous manifestations.
as well as a high risk of intrauterine or postnatal death (Marquez et al., 2011). More commonly, transmission of HSV to a child is due to contact with virus shed from the genital or perianal region during labor and delivery. Fifty percent to 80% of cases of neonatal HSV infection occur when genital HSV-1 or HSV-2 infection is acquired near term (Brown et al., 1997; Sullender et al., 1988). The risk is greatest when HSV is acquired within 6 weeks of delivery, when there is insufficient time for transplacental delivery of maternal antibodies (Brown et al., 1997). Transmission to the neonate is far less frequent among women who acquire genital herpes during early pregnancy or have a history of recurrent herpes, even if lesions are present at the time of delivery (Foley et al., 2014; Prober et al., 1987).

Women with a history of HSV should be offered daily suppressive acyclovir or valacyclovir starting at 36 weeks of gestation to reduce the likelihood of clinical lesions and viral shedding at delivery (Money and Steben, 2017). Cesarean section is recommended for women with primary genital herpes during the third trimester or for women with a history of genital HSV and either active lesions or prodromal symptoms at the time of labor (Foley et al., 2014; Money and Steben, 2017). Pregnant women should take appropriate precautions to avoid acquiring genital HSV, especially during the third trimester.

Management recommendations

Occupational acquisition of HSV during pregnancy is unlikely owing to the low rates of nosocomial HSV transmission, although contact with infectious lesions or secretions can lead to the development of herpetic whitlow. HCWs who are pregnant or of childbearing age should be counseled on the risks of HSV acquisition during pregnancy, which may pose a danger to the fetus. However, HCWs should not be routinely excluded from caring for patients with HSV solely on the basis of their pregnancy or intent to become pregnant (Bolyard et al., 1998). Nongenital herpes poses minimal risk to the fetus given the low rate of intrauterine infection, and transmission of genital herpes is not an occupational concern because sexual contact is required. All HCWs should follow standard precautions when caring for patients with HSV infection, and additional contact precautions are advised in certain high-risk cases, such as if the HCW is immunocompromised or if the patient has severe, disseminated HSV (Bolyard et al., 1998; Siegel et al., 2007).

Varicella zoster virus

VZV is responsible for varicella (chickenpox) during primary infection and herpes zoster (shingles) upon reactivation. Varicella is typically a mild disease in children, presenting as a diffuse vesicular rash. The rash is often pruritic and consists of lesions at different stages of development. A prodrome of fever, malaise, and myalgia may precede the exanthem. Primary infection is associated with higher morbidity and mortality when it occurs during adulthood, especially in immunocompromised patients and pregnant women. Varicella during pregnancy poses additional risks to the neonate. Herpes zoster typically manifests as a painful and unilateral maculopapular rash with lesions that follow a dermatomal distribution and evolve into vesicles that eventually crust within 7 to 10 days. Herpes zoster during pregnancy is not associated with birth defects or disease in the infant (Enders et al., 1994; Smith and Arvin, 2008).

Varicella is highly contagious. Patients are considered infectious from 48 hours prior to the onset of the rash until the skin lesions have fully crusted. The incidence of varicella is not thought to be higher among pregnant women than nonpregnant adults, and previous reports of greater severity have not been supported by recent studies (Sappenfield et al., 2013). The incidence of VZV infection during pregnancy has been estimated at 0.7 to 3 per 1000 pregnancies (Miller et al., 1993; Sever and White, 1968). Varicella pneumonia is considered the most significant complication of varicella during pregnancy, although a recent large cohort study found the incidence (2.5%) and maternal mortality (0%) to be lower than previously estimated (Zhang et al., 2015).

Transmission of VZV to the fetus can occur in utero, perinatally, or postnatally (Enright and Prober, 2004). Maternal varicella infection during early pregnancy introduces the risk of fetal varicella syndrome (FVS), with the greatest risk (2%) when infection occurs between 13 and 20 weeks of gestation (Enders et al., 1994; Harger et al., 2002; Pastuszak et al., 1994). Characteristic findings in FVS include cutaneous scars in a dermatomal distribution, low birth weight, neurological abnormalities, ocular defects, and limb deformities. FVS is associated with a mortality rate of 30% during the first few months of life (Sauerbrei and Wutzler, 2000). Varicella during the second and third trimesters presents a small risk of herpes zoster during infancy or early childhood (Enders et al., 1994). Maternal varicella occurring from 5 days before delivery to 2 days after delivery may result in severe neonatal varicella (Smith and Arvin, 2009), characterized by fever, vesicular lesions in various stages of development, and potential progression to disseminated disease (e.g., varicella pneumonia, hepatitis, meningoencephalitis).

Management recommendations

Nonpregnant HCWs without evidence of immunity (seronegative) to VZV should receive the varicella vaccine unless otherwise contraindicated (Shefer et al., 2011). Women should avoid becoming pregnant for 1 month after each infection (Marin et al., 2007). The vaccine is contraindicated during pregnancy due to the theoretical risk of live vaccines to the fetus (Marin et al., 2007), although inadvertent vaccination during pregnancy has not been associated with an increased risk of congenital anomalies (Wilson et al., 2008) and is not an indication for pregnancy termination (Ezeanolue et al., 2019; World Health Organization, 2014). Prenatal assessment for immunity to VZV is recommended for all pregnant women (Marin et al., 2007).

The varicella vaccine should be administered postpartum to nonimmune pregnant HCWs (Marin et al., 2007), and breastfeeding women may be vaccinated safely (Marin et al., 2007). Pregnant HCWs with no evidence of immunity, such as all susceptible HCWs, should avoid contact with patients with confirmed or suspected varicella or herpes zoster (Chin et al., 2014; Kim et al., 2018; Shefer et al., 2011; Siegel et al., 2007). Immunized pregnant HCWs should follow airborne and contact precautions when caring for patients with varicella or disseminated herpes zoster. The same is true when caring for immunocompromised patients with localized zoster until disseminated infection has been ruled out. Because airborne transmission from immunocompetent patients with localized zoster is unlikely, it is sufficient for immunized HCWs to follow standard precautions and cover all lesions until lesions are dry and crusted (Bolyard et al., 1998; Shefer et al., 2011).

All HCWs who are exposed to VZV should be monitored daily during days 8 through 21 after exposure (Shefer et al., 2011). If a susceptible pregnant HCW is exposed, varicella-zoster immune globulin (e.g., VarizIG) should be administered as soon as possible, ideally within 96 hours but up to 10 days after exposure (Marin et al., 2013). Susceptibility should be confirmed by serology testing prior to administration, if possible. Careful monitoring for signs of infection despite passive immunization is essential. Nonimmune HCWs should be furloughed during days 8 through 28 after exposure (Shefer et al., 2011). If symptoms of varicella or disseminated
Pityriasis rosea

PR is an acute, self-limiting papulosquamous disorder that characteristically begins with the appearance of a small, isolated, oval plaque referred to as the herald patch. A generalized eruption of smaller, but morphologically similar lesions, appears on the trunk and proximal extremities within 1 to 2 weeks. Their long axes are classically oriented to create a Christmas tree pattern on the back or a V-shaped pattern on the upper chest. Oropharyngeal lesions may rarely be present. Prodromal symptoms may precede the exanthem. Pruritus is reported in approximately 50% of cases (Eisman and Sinclair, 2015), but PR otherwise tends to be asymptomatic and usually resolves spontaneously within 4 to 8 weeks.

The etiology of PR is unclear. Various clinical and epidemiologic features of PR support a viral origin, including its self-limiting course, low recurrence rate, occasional household clustering, possible seasonal variation, prodromal symptoms, response to acyclovir, and higher prevalence during states of impaired immunity (e.g., pregnancy). There is a well-established association between PR and human herpesviruses 6 and 7 (HHV-6/7; Broccolo et al., 2005; Drago et al., 1997, 2009; Watanabe et al., 2002), although many patients show no evidence of active infection with HHV-6/7, and several other viruses (including reactivated HSV-2 in the case of a pregnant woman) have been implicated anecdotally in the pathogenesis of PR (Cruz et al., 2011).

PR occurs most commonly between the ages of 10 and 35 years (Eisman and Sinclair, 2015) with an approximate incidence of 0.5% to 2% (VanRavenstein and Edlund, 2017). It disproportionately affects pregnant women compared with young, nonpregnant women (Corson, 1950), possibly due to increased susceptibility to HHV-6/7 reactivation in the setting of altered immunity.

There are several reports in the literature of healthy, uncomplicated deliveries in patients with PR (Bianca et al., 2007; Chuh et al., 2005; Corson, 1950; Overton, 1968). However, a large case series following 61 patients with gestational PR showed an association with adverse outcomes (Drago et al., 2008, 2014). The overall miscarriage rate among these cases was 13% but increased to 57% if PR developed during the first 15 weeks of gestation. The series suggested that viral reactivation of HHV-6 may have led to intrauterine transmission and subsequent fetal loss. Other unfavorable fetal outcomes reported included premature delivery and neonatal hypotonia. PR development before gestational week 15, the presence of enanthem, and a high HHV-6 viral load were classified as major risk factors for poor outcomes. Constitutional symptoms and involvement of >50% of body surface area were considered minor risk factors (Drago et al., 2018).

Atypical forms of PR may be associated with prolonged viral reactivation in the plasma and potential intrauterine transmission (Drago et al., 2016). The risk of maternal HHV-6 reactivation and intrauterine transmission has been described by others, but low rates of congenital infection (approximately 1%) were reported. Furthermore, most congenital infections occurred due to chromosomal integration rather than transplacental infection (Caserta et al., 2007, 2014). Further studies are needed to substantiate the findings by Drago et al. and elucidate the effects of PR on pregnancy outcomes.

Management recommendations

Recommendations in the literature regarding PR during pregnancy are sparse and based on sparse evidence. Differential diagnoses should be ruled out, with particular attention given to excluding secondary syphilis. Syphilis should especially be considered if a rash is present on the palms or soles. Serologic screening for syphilis is strongly recommended for all pregnant women with suspected PR because there is a serious risk of congenital infection if not promptly treated (Chuh et al., 2005; Mahajan et al., 2016). Drug-related PR-like eruptions should also be considered because these are not associated with viral reactivation and may not pose the same risk to the fetus (Drago et al., 2016). There is one reported case of a PR-like drug eruption due to ondansetron use in a pregnant woman with nausea and vomiting (Alame et al., 2018), but many other drugs are known to cause such eruptions.

Because PR is self-limiting, management is generally limited to reassurance and the treatment of symptoms with emollients, antihistamines, and occasionally topical steroids. However, there are special recommendations for the management of pregnant women. Particularly close monitoring is called for if the mother develops PR within the first 15 to 20 weeks of gestation or experiences constitutional symptoms or an unusually diffuse, prolonged rash (Drago et al., 2008, 2014, 2016; Monastirli et al., 2016). In these cases of atypical PR in pregnant women, conflicting recommendations exist in the literature. Some recommend avoiding systemic therapy (Mahajan et al., 2016), while others recommend considering the use of acyclovir (Chuh et al., 2016; Drago et al., 2015, 2018), which has been shown to hasten the resolution of PR lesions and relieve pruritus. A low-dose regimen (400 mg three times daily for 7 days) is recommended if such intervention is indicated.

Given the potential increased risk of miscarriage during the first 15 weeks of gestation, pregnant HCWs should avoid contact with patients known to have PR during the early stages of pregnancy, if possible, and all pregnant HCWs should use appropriate contact precautions when caring for patients with PR. Although PR is not thought to be contagious and women of childbearing age have likely already been exposed to HHV-6/7, this recommendation is based on the uncertainty surrounding its etiology and the potential danger of infection to the fetus.

Severe acute respiratory syndrome coronavirus 2

Since December 2019, SARS-CoV-2 has resulted in an increasingly devastating global pandemic. In response to the overwhelming number of patients with the novel COVID-19 requiring hospitalization and intensive care unit-level care, many medical providers who do not traditionally perform roles in these settings have been called to assist. The medical community’s knowledge of COVID-19 continues to evolve rapidly. Information regarding any potential dermatologic manifestations of the disease, as well as the disease’s impact on pregnancy, is limited as of April 2020. Pivotal data from patients in Wuhan, China, have revealed that cutaneous manifestations of COVID-19 are rare, with only 2% of >1000 patients having any type of documented rash (Guan et al., 2019).

Both pregnant HCWs and patients have expressed concern regarding potential complications from COVID-19, although the disease appears to disproportionately affect men compared with women or the pediatric population. Two small retrospective analyses of pregnant women with confirmed COVID-19 pneumonia did...
not find evidence of intrauterine vertical transmission or elevated risk of neonatal or fetal complications (Chen et al., 2020; Schwartz, 2020). Another cohort study of 17 pregnant patients, including three HCWs, also did not find conclusive evidence of vertical transmission (Khan et al., 2020). In a separate study of 13 pregnant patients with COVID-19, researchers did not find evidence of vertical transmission but did note that five patients required emergency cesarean section to avoid pregnancy-related complications (Liu et al., 2020).

Although data on pregnant women from previous coronavirus pandemics are limited, pregnant women do not appear to be more likely to acquire SARS-CoV-1 or MERS-CoV, other coronaviruses similar to SARS-CoV-2 that cause SARS and Middle East Respiratory Syndrome, respectively (Rasmussen et al., 2020). However, data from pregnant patients with SARS found that when pregnant women actually did acquire SARS-CoV-1, they tended to have more neonatal and maternal complications, including increased rates of intensive care unit admission and mortality, compared with non-pregnant patients (Lam et al., 2004; Wong et al., 2004).

Management recommendations

As with all HCWs, pregnant HCWs should follow infection-control recommendations from public health officials and abide by occupational health and safety guidelines established by the individual health care systems in which they work. Pregnant HCWs should not provide any clinical care if they test positive for COVID-19. Any pregnant HCW who has symptoms suggestive of COVID-19 should self-isolate after testing for SARS-CoV-2 until results are available. The Royal College of Obstetricians and Gynaecologists recommends that female HCWs who are >28 weeks pregnant avoid direct contact with all patients during the ongoing pandemic, even if the HCW is asymptomatic or has not had contact with patients known or suspected to be infected with COVID-19 (Rimmer, 2020). Those who are <28 weeks pregnant, however, can continue to work in patient-facing roles provided they use proper personal protection equipment (Rimmer, 2020).

Some individual institutions have chosen to prohibit any pregnant HCW, whenever possible, from caring for patients with COVID-19. General principles regarding the management of COVID-19 during pregnancy include early isolation, aggressive infection-control procedures, testing for SARS-CoV-2 and coinfection, oxygen therapy as needed, avoidance of fluid overload, empiric antibiotics (due to secondary bacterial infection risk), fetal and uterine contraction monitoring, early mechanical ventilation for progressive respiratory failure, individualized delivery planning, and a team-based approach with multispecialty consultations (Rasmussen et al., 2020).

Although breastfeeding is not currently contraindicated in patients with COVID-19, it is recommended that patients wear a face mask while breastfeeding to minimize risk of droplet transmission to the newborn (Dashrath et al., 2020). Although SARS-CoV-2 has yet to be identified in breastmilk, newborns are still susceptible to transmission from contact with mothers or other family members, highlighting the importance of proper hand hygiene and social distancing measures.

Conclusion

This review summarizes common exanthematous diseases to which pregnant HCWs may be exposed in the clinical environment. Large trials on outcomes in pregnant women, especially HCWs, are limited. As such, guidelines and recommendations for prevention for pregnant HCWs are limited. Here, we have reviewed and summarized recommendations from the literature. Further research is necessary to evaluate the impact of these measures on prevention. Recommendations should ensure adequate protection for HCWs while limiting unnecessary or cumbersome practices that would unnecessarily prevent pregnant HCWs from performing clinical duties.

In addition, vaccination prior to pregnancy of preventable diseases, such as measles and varicella, is crucial. All clinicians should encourage women of childbearing potential to receive appropriate vaccinations prior to conceiving. Although the CDC provides vaccination recommendations for all HCWs (Advisory Committee on Immunization Practices and CDC, 2011), vaccination laws are typically determined by individual countries or, in the case of the United States, at the state level. The CDC’s recommendations for the vaccination of HCWs are summarized in Table 3. Mandated vaccination requirements have been shown to be highly successful. For example, influenza vaccination rates in HCWs have significantly increased when health care institution-based mandates have been implemented in conjunction with government-mandated vaccination requirements (Lin et al., 2016; Wang et al., 2017). All trainees, regardless of sex, should be appropriately vaccinated prior to matriculation in health professional programs, and all HCWs and trainees should demonstrate proof of current immunity prior to working at new sites or institutions.

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Study Approval

The author(s) confirm that any aspect of the work covered in this manuscript that has involved human patients has been conducted with the ethical approval of all relevant bodies.

Conflict of Interest

None.

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