Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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COVID-19 and Pregnancy: Risks and Outcomes

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ABSTRACT: The normal physiologic changes of pregnancy are known to increase susceptibility to respiratory illness. Individuals who are pregnant are more likely to acquire a SARS-CoV-2 infection and develop COVID-19 than the general population; they are at increased risk for hospitalization; ventilator-assisted breathing; and other subsequent maternal, fetal, and neonatal health issues. Although the incidence of infection and subsequent morbidity is increased in pregnancy, mortality does not seem to be increased. Individuals who are vaccinated against COVID-19 before childbirth can pass antibodies to their fetuses via the placenta during pregnancy and to their infants during breastfeeding. It is important for health care providers to be cognizant of the potential impacts of COVID-19 on pregnant individuals and their offspring.

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SARS-CoV-2 and the disease it causes, COVID-19, (Katopodis et al., 2022), has claimed lives around the world since it first appeared in late 2019. The numbers of cases worldwide have waxed and waned in the ensuing years, with viral mutations producing new variants. The ongoing development and distribution of vaccines and the discovery of new treatments have affected its spread. Scientific research has been intense throughout the COVID-19

CLINICAL IMPLICATIONS

- Coronaviruses infect a human host primarily via air droplets inhaled through the respiratory tract.
- Normal physiologic changes that occur during pregnancy increase the risk of morbidity and mortality related to respiratory illnesses.
- COVID-19 vaccination in pregnancy has been beneficial in preventing serious illness in pregnancy.
- Pregnant individuals who receive the COVID-19 vaccination can transmit antibodies to their fetuses, which can continue for months after birth.
- COVID-19 antibodies are found in the breast milk of lactating vaccinated women.

pandemic, and much has been learned about the impact of the virus on the body, including its effect on multiple body systems. One area of particular interest is its unique impact on pregnancy.

The combination of COVID-19 pathophysiology and normal pregnancy changes in the immune and respiratory systems and coagulation pathways are confounding. According to the Centers for Disease Control and Prevention (CDC), pregnant individuals who contracted COVID-19 had increased risk of hospitalization, ICU admission, and the need for mechanical ventilation compared with those who were nonpregnant, especially with the delta variant (CDC, 2022e; Ellington et al., 2020). However, mortality rates did not seem to be any greater in pregnancy than in the general population (Ellington et al., 2020). As of July 22, 2022, 225,656 pregnant women in the United States have been diagnosed with COVID-19, resulting in 34,693 hospitalized cases, of which 673 patients required intensive care admissions, 148 required invasive ventilation, and 42 required extracorporeal membrane oxygenation; there were 306 reported deaths (CDC, 2022e). Understanding the impact of COVID-19 and how it affects pregnant individuals and newborns is the focus of this article. (Note: because of the continually evolving conditions of the pandemic and of the variants of virus circulating, some of the information contained herein may become outdated).

Historical Impact of Viral Illnesses on Pregnancy

Past pandemics provide a glimpse into the impact of viral infections during pregnancy. Lifelong adverse health effects have been identified in the offspring of infected individuals, including increased rates of diabetes, heart, and kidney disease. During the 1918 Spanish influenza outbreak, these complications were found to be related to the gestational age of the fetus at the time of infection during pregnancy (McCarthy et al., 2021). Increased development of adult-onset cardiovascular disease could be traced to those individuals whose mothers were infected during the first trimester. Individuals with chronic kidney disease were found to have been exposed to the virus during the third trimester when the kidneys were maturing (McCarthy et al., 2021).

Inflammation from a viral infection during pregnancy has the potential to affect fetal brain development, potentially leading to neurological and psychological problems later in life (Mor et al., 2017; Shook et al., 2022b). An increase in the diagnosis of schizophrenia in hospitalized adults was noted in those who were born during the 1957 influenza pandemic (Mendick et al., 1988). A significant increase in the incidence of autism spectrum disorder and schizophrenia were noted in offspring related to the rubella pandemic in 1964 (Patterson, 2009). We know from the 2009 H1N1 influenza pandemic in the United States that pregnant individuals had greater morbidity and mortality rates than the general population (Mor et al., 2017). More recently, Zika virus infection during the first trimester of pregnancy was found to result in fetal microcephaly and other brain and eye deformities (CDC, 2022f, 2022g; Mor et al., 2017). Furthermore, even those without obvious birth defects were more likely to have seizures, movement disorders, feeding difficulties, and developmental delays than those not exposed to Zika during pregnancy (CDC, 2022f, 2022g).

Brief Review of COVID-19

On March 11, 2020, the World Health Organization declared COVID-19 a global pandemic (Cucinotta & Vanelli, 2020). Internationally renowned virus pioneer June Almeida and her colleagues first identified coronaviruses in a London laboratory in 1968 (Almeida et al., 1968). *Corona* refers to the characteristic fringe seen around the virus when viewed under an electron microscope that is similar to the solar corona (Almeida et al., 1968; Almeida & Tyrrell, 1967; Tyrrell et al., 1975). Unlike many viruses, SARS-CoV-2 is highly virulent, has a tendency to mutate, and is able to use multiple host cell mediators to gain access to bodily organs (Katopodis et al., 2022). It is also able to infect other animals, raising the further threat of economic, veterinary, and public health concerns (V'kovski et al., 2021).

In humans, coronaviruses infect the host primarily via air droplets inhaled through the respiratory tract (Katopodis et al., 2022). Infected individuals do not have symptoms in the early stage of infection; some will go on to develop symptoms when the virus actively spreads throughout the body (Cordon-Cardo et al., 2020). According to the European Centre for Disease Prevention and Control (2021), the most common symptoms are headache, loss of taste and smell, fatigue, muscle aches, cough, nasal symptoms, sore throat,

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shortness of breath, and fever. A subset of those individuals will go on to experience severe symptoms and widespread organ damage to the lungs, heart, kidneys, brain, and liver, usually prompting hospitalization (Cordon-Cardo et al., 2020). The most severe symptoms occur in the last stage, when diffuse endothelial injury occurs from severe hyperinflammation and dysregulated thromboinflammatory pathways, resulting in microthrombus formation and systemic microvascular dysfunction. There is some suggestion that the underlying pathophysiology of severe disease is primarily driven by the inflammatory response and coagulopathy rather than direct viral injury at this point in the illness (Cordon-Cardo et al., 2020).

COVID-19 and Pregnancy

Immune Response

Among the most important changes to normal physiologic processes that occur during pregnancy are those to the immune system to accommodate the growing and developing fetus and maintain the pregnancy. The body's ability to adapt the immune system typically provides the balance between the growth and development of the fetus and the ability to fight off invading pathogens.

During the initial stages of pregnancy, the immune system is in a proinflammatory state in which immune cells at the implantation site support embryo and placental development. Once the pregnancy is established, the maternal immune system and the fetal–placental unit's trophoblasts take active roles in secreting anti-inflammatory cytokines that remove dying trophoblastic cells and protect fetal cells. This prevents a maternal immune response against the fetus and promotes its growth and development. During the third trimester, the immune system once again becomes proinflammatory to initiate and maintain labor and promote the separation of the placenta after birth (Mor et al., 2017). These changes make pregnancy more vulnerable to infection from COVID-19 and its hyperinflammatory state.

Respiratory Response

Hormonal and physiologic changes to the respiratory system further increase maternal susceptibility to respiratory infections. Progesterone causes a relaxation of the ribs, and changes to the hypothalamus result in increased tidal volume of the lungs (X. Zhao et al., 2020). The elevation of the diaphragm decreases chest wall compliance and lung residual capacity, resulting in a functional maternal hypoxia. The body compensates by taking deeper breaths and hyperventilating, increasing the risk of inhaling respiratory droplets or aerosols. Pathogens adhere more easily to the mucous membranes in the upper airways and are more difficult to clear because of mucosal dryness from progesterone and edema from estrogen (X. Zhao et al., 2020). These normal physiologic changes make pregnant individuals more prone to respiratory infections, including SARS-CoV-2.

> It is important for anyone who develops symptoms of COVID-19 to be tested so that early diagnosis can be made when the test result is positive

Coagulation Response

Pregnancy is considered a hypercoagulation state, which ultimately assists with homeostasis after childbirth. Hormonal changes result in a five- to sixfold increased risk of developing thromboembolic disease beginning early in the gestational period and continuing until 12 weeks after childbirth (Antony et al., 2021). Among the coagulation changes in pregnancy, there is a significant rise in von Willebrand factor. Fibrinogen levels also increase up to twofold from prepregnancy levels (Antony et al., 2021). Multiple procoagulants are increased, venous stasis escalates, and endothelial injury can occur, resulting in damage to the vascular system (Antony et al., 2021). This can further cause placental infarcts, decreased placental perfusion, fetal growth restriction, and hypertensive disorders such as preeclampsia. The presence of antiphospholipid syndrome or other preexisting coagulopathies are known to increase the incidence of placental infarcts and recurrent miscarriages, as well as placental pathologies (Merriam & Pettker, 2021).

Early in the COVID-19 pandemic, it became clear that thromboembolic events and disseminated intravascular coagulation triggered high morbidity and mortality for individuals affected with severe disease (Aires et al., 2022; Iba et al., 2020; Munro et al., 2020). Although the precise process for these events was unclear, one proposed mechanism seemed to be initiated by the high production of proinflammatory cytokines (Aires et al., 2022; Iba et al., 2020). In addition, levels of von Willebrand factor antigen, a known coagulation factor and endothelial injury marker, were found to be 300% of normal or greater and were highly predictive of death and prolonged hospital stays (Cotter et al., 2022). Development of emboli in those with active COVID-19 has been implicated in respiratory compromise; acute coronary syndrome; limb or digit compromise; and damage to major organs, including the brain, heart, liver, and kidneys (Munro et al., 2020). Katsoularis et al. (2022) further found that the risk for deep vein thrombosis, pulmonary embolism, and bleeding (especially in the brain) were much greater for up to 3, 6, and 2 months, respectively, after recovery from COVID-19.

Placental Changes

Because the placental blood barrier protects the fetus from some diseases and environmental insults, vertical transmission of SARS-CoV-2 is rare, occurring in only 2.8% of

neonates born to individuals with COVID-19 (AbdelMassih et al., 2021). Despite minimal vertical transmission of the virus, individuals who have contracted COVID-19 during pregnancy are at greater risk for developing placental infarcts because of the increased proinflammatory cytokines and von Willebrand factors found during pregnancy and SARS-CoV-2. These infarcts in placental circulation can result in placental insufficiency, decreased oxygen and nutrient delivery, fetal growth restriction, impaired fetal brain development, increased risk for preterm birth, and even death (AbdelMassih et al., 2021; A. Chen, et al., 2022; Hsu et al., 2021; Seymen, 2021).

Understanding these increased risks helps health care providers be more aware of potential complications when pregnant individuals acquire COVID-19. As with previously described viral infections, the gestational age at which the pregnant individual becomes infected may determine outcomes. In a small study early in the pandemic, researchers found that individuals who were diagnosed during the first or second trimesters had significant chronic ischemic placental changes; however, the neonates tested negative for the virus at birth and were healthy at 6 months (Y. Zhao et al., 2021). It was theorized that the maternal systemic inflammatory response within the first and second trimesters was responsible for injury to the placentas (Y. Zhao et al., 2021). Other researchers conducted multicenter studies and examined the placentas of individuals who tested positive for SARS-CoV-2 during the second and third trimesters and had live births. Although some microscopic changes were noted, they were not statistically significant compared to the placentas of individuals who did not have COVID-19 (Celik et al., 2022; Tasca et al., 2021). Placentitis has been a noted feature in the examination of stillbirth placentas, which may account for increased stillbirth rates in those with COVID-19 (Konstantinidou et al., 2022; Stenton et al., 2022). Further research is needed in this area to fully understand the impact of SARS-CoV-2 on placental development and function.

Researchers have documented the potential for acute and chronic adverse neurodevelopmental outcomes in neonates exposed to SARS-CoV-2 during pregnancy (Shook et al., 2022b). Early signs of insufficient neurodevelopment in social–emotional growth and developmental delays were noted in infants as early as 3 months of age and continued to be an issue at later intervals (Shook et al., 2022b). Researchers have identified that definitive causation is difficult to establish because of small sample sizes and the need for longevity studies. Research in this area will be ongoing as affected offspring grow into adulthood.

Preeclampsia

Preeclampsia is a multisystem disorder that can negatively affect the fetus and the pregnant individual during pregnancy and the puerperium. Before COVID-19, researchers noted a trend for increasing rates of preeclampsia in the United States. Between 2005 and 2014, rates of preeclampsia increased by 21% (Fingar et al., 2017), and Cameron et al. (2022) further found a more rapid increase in rates of preeclampsia after 2014, particularly in urban areas. The exact etiology of the increased rates has not been determined, although increased obesity rates and increased comorbidities are thought to be contributing factors.

Some researchers note that since the discovery of SARS-CoV-2, the rate of preeclampsia in individuals who have tested positive for the virus has increased dramatically, even up to a fourfold incidence (Papageorghiou et al., 2021; Villar et al., 2021). Those individuals diagnosed with severe preeclampsia often have preexisting comorbidities such as obesity, diabetes, hypertension, and other metabolic diseases that affect metabolism and are also at increased risk of negative outcomes from COVID-19 (CDC, 2022c, 2022d). COVID-19 and preeclampsia result in increased inflammatory markers, making it a challenge for providers to diagnose and treat appropriately (Naeh et al., 2022).

It is unclear whether there is a causal relationship between COVID-19 and preeclampsia (Naeh et al., 2022). Because the inflammatory symptoms of both are similar, mistaken diagnoses may occur. Some providers are now identifying a preeclampsia-like syndrome in women who have COVID-19 that imitates the signs and symptoms of preeclampsia (Naeh et al., 2022). Further research into identifying the potential biomarkers that distinguish between COVID-19 and preeclampsia is needed.

Psychosocial Impacts

Childbirth in the United States is a social event. The consequences of quarantine, isolation, social distancing, and hospital visitor restriction policies during the pandemic changed how families approached and experienced childbirth (Gutschow & Davis-Floyd, 2021; Jackson et al., 2021). Although many women voiced lost independence and self-identity, felt more isolated, and had subsequent feelings of guilt when breaking social distancing guidelines to meet emotional needs, some women also sensed increased partner interaction and relief from social obligation pressures (Jackson et al., 2021). Women also voiced fears of isolation, being infected with SARS-CoV-2, being denied chosen adequate labor support, passing along the virus to their newborn, and being separated from their newborn after birth (Gutschow & David-Floyd, 2021). Interruption in face-to-face prenatal care practice also increased anxiety levels about the pregnancy (Gutschow & Davis-Floyd, 2021).

Mollard and Whittmaack (2021) found that of the 885 women they surveyed who gave birth during the pandemic, 61% expressed inadequate childbirth support, 33.8% had high levels of anxiety, 18.6% reported depression, and 20.5% perceived that it was unsafe to give birth in the

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hospital. Women overall reported higher anxiety, depression, and stress levels related to the changes implemented during the pandemic (Fallon et al., 2021; Gutschow & Davis-Floyd, 2021; Jackson et al., 2021; Mollard & Whittmaack, 2021; Morris et al., 2022). When unexpected events occur or there are preexisting comorbidities, there is a greater risk for anxiety and depression during the antenatal and postpartum periods (Holland & Richmond, 2022).

Implications for Practice

Nurses and advanced practice providers can have a significant impact on educating the public on evidence-based practice at every point of care. Inaccurate or biased news reporting, social media, and general fear about SARS-CoV-2 and COVID-19 have greatly influenced personal and public responses to the crisis. Nurses have a responsibility to investigate the evidence for best practice to affect positive outcomes for individuals, their families, and the public.

Prevention of COVID-19

At the time of this writing, the CDC (2022c, 2022d) continues to recommend that pregnant individuals and others who are at increased risk of acquiring COVID-19 wear masks when indoors in public places, especially in those areas of the country with high transmission rates. Furthermore, it is important for anyone who develops symptoms of COVID-19 to be tested so that early diagnosis can be made when the test result is positive. Anyone who contracts COVID-19 while pregnant should communicate with their obstetric provider to the ensure initiation of appropriate treatment as soon as possible.

Vaccination

Because of the increased risk of hospitalization and ICU admissions, the CDC (2022c, 2022d) recommends that those who are pregnant or who are planning to become pregnant receive the full series of COVID-19 vaccinations and stay up to date on all other immunization recommendations. The American College of Obstetricians and Gynecologists (ACOG; 2022a, 2022b); Society for Maternal Fetal Medicine (SMFM; 2022); American College of Nurse-Midwives (2021); National Association of Nurse Practitioners in Women's Health (2021); and Association of Women's Health, Obstetric, and Neonatal Nurses (2022) all support COVID-19 vaccination during pregnancy. Lack of inclusion of pregnant women in early vaccine trials and significant vaccine hesitancy resulted in decreased vaccine coverage in pregnant women (Hosokawa et al., 2022; Stock et al., 2022). Vaccination during pregnancy decreases morbidity and mortality related to COVID-19 (Kalafat et al., 2022). Vaccination has found to be safe, with no increases in vaccine-related maternal or fetal complications (Association of Women's Health, Obstetric, and Neonatal Nurses, 2022; Blakeway et al., 2021; F. Chen et al., 2022; Kalafat et al., 2022).

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> As new research is published about COVID-19, interventions and treatment plans can be tailored to each unique individual for the best potential outcome

Vaccination prepregnancy has not been shown to affect fertility, conception, or rates of spontaneous abortion (F. Chen et al., 2022; Wesselink et al., 2022). Researchers who conducted a prospective cohort study of more than 2,000 couples found that the timing of the vaccination; type of vaccine received; and other identified variables, including socioeconomic, lifestyle, and medical considerations, had no impact on either partner's ability to conceive (Wesselink et al., 2022). Men who tested positive for SARS-CoV-2 were less likely to conceive within 60 days, possibly because the presence of fever, a common symptom of COVID-19, causes a reduction in sperm count and sperm motility (Wesselink et al., 2022).

Emerging information obtained from researchers supports the efficacy of COVID-19 vaccination during pregnancy. Shook et al. (2022a) compared individuals who were fully vaccinated (received two doses of a messenger RNA vaccine) with those who were infected with the virus between 20 and 32 weeks' gestation. Individuals and fetal umbilical cords were tested after birth; vaccinated individuals had higher antibody levels (Shook et al., 2022a). Infants born to individuals in this study were then tested at 2 and 6 months of age. Again, infants whose mothers were vaccinated before childbirth had significantly higher levels of immunoglobulin G antibodies (Shook et al., 2022a).

Breastfeeding

Before COVID-19, researchers established the many benefits of breastfeeding. Researchers suggest that antibodies in breast milk may in fact coat the mucosal lining of the infant's mouth, throat, and gut, providing valuable protection against

many diseases (Atyeo & Alter, 2021; Lyons et al., 2020). Researchers identified that COVID-19 antibodies were found in the breast milk of lactating vaccinated women (Fox et al., 2020; Hand & Noble, 2020). Infants who exclusively breastfed after their mother received the COVID-19 vaccination had higher levels of SARS-CoV-2 antibodies for at least 6 months of age or longer because of continual exposure to the antibody-rich breast milk (Narayanaswamy et al., 2021).

Additional researchers found that individuals who received two doses of a messenger RNA COVID-19 vaccine while lactating attained adequate antibody levels in breast milk for up to 23 months after vaccination (Narayanaswamy et al., 2021; Ramírez et al., 2021; Vale et al., 2021). Narayanaswamy et al. (2021) also found higher levels of antibodies in the stools of infants whose mothers were vaccinated. Infants who receive breast milk from vaccinated mothers continued to receive antibodies during their early vulnerable months. These results are continuing to be investigated and studied. Encouraging women to breastfeed when possible and offering appropriate support might contribute to the prevention of COVID-19 in infants.

Further Management

It is important to be aware of the specific physiologic risks of COVID-19 during pregnancy. Nurses can be instrumental in monitoring the respiratory status of pregnant individuals, who are at increased risk of infection, acquiring COVID-19, and negative consequences related to hypoxia. Gathering a detailed health history and completing a thorough assessment can help identify those women who already have an increased risk for blood clotting disorders that may be compounded by COVID-19.

Although ACOG and the SMFM do not offer any specific guidance regarding the use of daily low-dose aspirin prophylactically, in light of the potential relationship between COVID-19, preeclampsia, and thrombophilia, they have stated that it is appropriate to use aspirin when clinically indicated (Eslamian et al., 2021). Some providers are considering SARS-CoV-2 a risk factor when contemplating initiating use of aspirin for prophylaxis of preeclampsia and its complications (ACOG, 2020; Eslamian et al., 2021). Because many patients do not consider over-the-counter medications significant enough to report, it is vital that nurses include questions about aspirin therapy when gathering a detailed health history.

The inflammation response related to COVID-19 has been shown to potentially cause long-term negative health effects. This may include problems for individuals who acquire COVID-19 during pregnancy as well as for their offspring. As the COVID-19 pandemic is becoming more endemic and affecting several aspects of daily life, nurses have a challenge in keeping up with all the new information that continues to be released daily about the virus, treatment, and potential long-term effects. As new research is published about COVID-19, interventions and treatment plans can be tailored to each unique individual for the best potential outcome.

COVID-19 Treatment in Pregnancy

Throughout the COVID-19 pandemic, treatment plans have changed based on best evidence and the response to each newly identified variant. The National Institutes of Health (NIH; 2021), ACOG (2022a), and SMFM (2022) have all recommended that vaccinations and treatment for pregnant women with COVID-19 should not be withheld and that other treatment options should be offered, even though there may be theoretical risks involved. So far, research has supported that early decision. As with all treatment management, individual patient concerns, comorbidities, preexisting risk factors, disease presentation, and risk for progression should be discussed between the care provider and patient so that informed, joint decision-making can occur to promote optimal outcomes. Regardless of the treatment option chosen, any patient with COVID-19 symptoms should have supportive care. As with any high-risk condition in pregnancy, appropriate intrapartum care and interventions for suspected preterm and high-risk pregnancies should be implemented based on current evidence-based recommendations for the care of pregnant individuals with COVID-19.

Monoclonal antibodies. When SARS-CoV-2 first began, emergency use authorization was given by the U.S. Food and Drug Administration for various intravenous monoclonal antibodies (mAbs), which must be initiated within 7 days of symptom onset. Bamlanivimab plus etesevimab, casirivimab plus imdevimab, and sotrovimab were mAbs recommended for use with the delta variant (NIH, 2022a). Because of newer mutations to SARS-CoV-2, bebtelovimab was the only recommended mAb for omicron. Bebtelovimab is no longer considered an appropriate treatment for current Coronavirus variants as of November 30, 2022 (NIH, 2022e). Because pregnant individuals were at greater risk for developing respiratory illnesses, they were eligible to receive mAb treatment (CDC, 2022b; NIH, 2022b). Researchers have not found mAb therapy in pregnancy to have serious side effects (for the pregnant individual or the fetus) and have found it effective for preventing COVID-19 progression for previous variants (Folkman et al., 2022; Hirshberg, 2021; Thilagar et al., 2022).

Antivirals. Remdesivir is a broad-spectrum antiviral drug that has received emergency use U.S. Food and Drug Administration approval for preventing progression of COVID-19. The drug is also used to treat those with mild to moderate symptoms in outpatient settings as well as for severe COVID-19 hospitalized adults and some children in the United States (NIH, 2022c). Like the mAb drugs, remdesivir should be initiated early within 7 days of symptom onset. Remdesivir is only given intravenously but requires three doses over 3 days to be effective. Pregnant individuals were eligible initially to receive remdesivir under compassionate use, and it is continued to be used for this population. Researchers in small studies have typically found improved clinical outcomes in

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BOX 1 SELECTED PROFESSIONAL ORGANIZATIONS AND THEIR COVID INFORMATION

American College of Nurse-Midwives (ACNM)
www.midwife.org
www.midwife.org/covid-19-vaccine-information
American College of Obstetricians and Gynecologists (ACOG)
www.acog.org
www.acog.org/clinical-information/physician-faqs/covid-19-faqs-for-ob-gyns-obstetrics
Association for Women's Health, Obstetric and Neonatal Nurses (AWHONN)
www.awhonn.org
www.awhonn.org/novel-coronavirus-covid-19/
Centers for Disease Control and Prevention (CDC)
www.cdc.gov
www.cdc.gov/coronavirus/2019-ncov/hcp/inpatient-obstetric-healthcare-guidance.html
National Association of Nurse Practitioners in Women's Health (NPWH)
www.npwh.org
cdn.ymaws.com/npwh.org/resource/resmgr/news/npwhandwhorecommendvaccinaio.pdf
Society for Maternal–Fetal Medicine (SMFM)
www.smfm.org
www.smfm.org/covidclinical

severe COVID-19 with minimal adverse effects (Budi et al., 2022; Burwick et al., 2021). The results of the NIH-sponsored study (NCT04582266) that began in 2021 to investigate remdesivir use during pregnancy has been completed, but the results have yet to be published (NIH, 2022a).

More recently, Paxlovid (Pfizer, Inc., New York, NY), a combination of antivirals nirmatrelvir and ritonavir, received emergency use authorization and has become the current drug of choice (at the time of this writing) for those high-risk COVID-19–positive individuals, including those who are pregnant (NIH, 2022d). Again, the goal of treatment is to prevent disease progression and prevent hospitalization for high-risk individuals. Paxlovid, oral tablets taken twice a day for 5 days, should be initiated within the first 5 days of symptom onset (NIH, 2022d). Ritonavir has previously been studied in pregnancy for HIV treatment and was not found to be teratogenic (Roberts et al., 2009; U.S. Department of Health and Human Services, 2021b); nirmatrelvir has not been studied, but it is thought to be relatively safe (NIH, 2022d). Paxlovid may be problematic for some patients because it is a strong cytochrome P-450 inhibitor and has many interactions with other drugs. The dose must also be adjusted for those with decreased kidney function.

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> Nurses who are well informed regarding current research are in the best position to offer support and to assist in pursuing appropriate interventions for this population at all levels of care

The SMFM (2022) and ACOG (2022a) both support the use of Paxlovid, remdesivir, and bebtelovimab for outpatient treatment of COVID-19, especially if a pregnant individual has more than one high-risk factor for disease progression. Paxlovid is the preferred drug of choice unless there are contraindications to its use or there are issues with access. The goals of all three antiviral treatments are to help manage symptoms and to reduce hospital admissions and disease progression, especially for those in high-risk categories.

Long COVID

Long COVID (also referred to as postacute sequelae of SARS-CoV-2) occurs in individuals who continue to have symptoms for more than 4 weeks after onset of the virus (CDC, 2022a); females have been found to have a threefold risk of continued symptoms (Bai et al., 2022). The persistent health problems experienced by those who have prolonged COVID symptoms have resulted in long COVID now being considered an accepted diagnosis under the Americans With Disabilities Act (U.S. Department of Health and Human Services, 2021a). Because of the increasing numbers of those with long COVID, this complication must be taken into consideration as well.

Del Brutto et al. (2022) compared Montreal Cognitive Assessment (MoCA) scores of those with COVID-19 and healthy individuals. They found a significant reduction in MoCA scores in infected individuals 6 months after the onset of symptoms; there was no difference in MoCA scores between the two groups 1 year later (Del Brutto et al., 2022). The researchers theorize that symptoms of long COVID related to cognition may improve over time; however, the

science in this area is continually evolving. Limited reports suggest that SARS-CoV-2 can interfere with the blood–brain barrier and affect brain function; this might explain increased "brain fog" and may affect future cognitive functioning in individuals who have had COVID-19 (Shook et al., 2022b). This may also need to be a consideration of care if the symptoms are severe.

Staying Current in An Evolving Situation

The coronavirus has been known to readily mutate, with new variants being identified worldwide with increasing frequency (Katopodis et al., 2022). With each new variant, symptoms and treatment recommendations may change. There is also growing concern that initial vaccinations designed to decrease mortality from SARS-CoV-2 may not be as effective against the emerging variants. Providing education about the virus and the sequalae can help promote the best potential outcomes for all involved.

Nurses can readily access up-to-date information and COVID-19 guidelines from professional organizations that promote the health and well-being of women and newborns (see Box 1). These organizations provide evidence-based information for consumer and professional audiences and frequently update treatment and nursing care recommendations on their websites. It is important for health care providers and health agencies to provide care that is the most up to date and effective.

Conclusion

The novel coronavirus SARS-CoV-2 has caused loss of life on a global scale, with an unprecedented impact on human behavior and society. The virus is known to be particularly virulent and to possess an increased rate of mutation. New variants continue to be reported worldwide. Ongoing research will be needed as we move from a pandemic to an endemic status. Known negative risks for pregnant individuals and their offspring include increased likelihood of acquiring SARS-CoV-2 infection; threat of developing severe COVID-19, resulting in increased risk for hospitalization; ICU admission; need for ventilation; and increased rates of stillbirth and preterm birth. Further potential sequalae may involve risks for placental damage, development of preeclampsia or preeclampsia-like syndrome, maternal anxiety and depression, maternal and neonatal neurological insults, and long COVID. Given their increased risk from COVID-19, as well as increased vulnerability in general, it is understandable that pregnant individuals will likely be concerned about the potential negative short- and long-term effects for themselves and their offspring. Because of the increased risk for these negative outcomes, it is important for health care professionals to remain current. Nurses who are well informed regarding current research are in the best position to offer support and to assist in pursuing appropriate interventions for this population at all levels of care.

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