A pregnant nurse takes a break. Opportunities for adequate nutrition and breaks increase the health and work satisfaction of pregnant nurses. Photos by Alison Bulman.

Occupational Hazards for Pregnant Nurses

Finding a balance between service and safety.

By Marion Rita Alex, RN, MN, CNM

OVERVIEW: Depending on her working environment, specific immunities, and stage of pregnancy, a pregnant nurse may find it difficult to avoid teratogenic and fetotoxic exposures, as well as working conditions that could jeopardize her pregnancy. A clinical review of the occupational hazards faced by pregnant nurses can be useful to the concerned nurse or health care system, as can suggestions on ways to reduce risk and a list of pertinent occupational safety resources.

KEYWORDS: nurses, occupational hazards, occupational health, occupational safety, pregnant nurses, reproductive health, women's health, worker safety

Becky Turner, a nursing student, confides to her instructor that she's nine weeks pregnant. Although Ms. Turner wants to be a nurse, she's concerned that the requisite rotations through medical–surgical, pediatric, and public health care settings could jeopardize her pregnancy or the health of her fetus by exposing her to certain pathogens or drugs. "Yesterday, I was assigned to care for a patient with pneumonia," she explains, "and two weeks ago, I was sent to work at a day care center where several of the children had colds."

Although only Ms. Turner can decide whether or not to continue her studies at this point, she'll require complete information to make an informed choice. If you were her instructor, what would you tell her about what is and isn't known about occupational risks to pregnant nurses?

Helen Roberts, an RN working as shift supervisor in a nursing home, was 35 weeks pregnant with her third child when two of her staff members had to take sick leave. In their absence, Ms. Roberts helped out with physical care—that is, until she sustained a back injury while helping a debilitated and agitated elderly patient through a narrow doorway. The injury left her unable to work and dependent on others to care for her two preschoolers for the remainder of her pregnancy. What could have been done to prevent Ms. Roberts's incapacitating injury?

Grace Scott, an RN, worked in an ED. When her baby was stillborn, the autopsy showed that the baby had hepatomegaly associated with cytomegalovirus (CMV) infection. Ms. Scott wonders whether some occupational exposure had resulted in her baby's death. "Most of our patients are really ill," she explains. "I believe I always followed universal precautions, but I wonder if I may have broken with protocol in an emergency." If her baby's CMV infection was related to Ms. Scott's work in an ED, how might this tragedy have been avoided?

Nurses' work is more than just a source of income; it's a source of satisfaction. At the same time, experienced nurses are a precious commodity and their retention is imperative to the proper functioning of the workplace. But the scenarios above, which are composites based on cases I've encountered in clinical practice, illustrate a common dilemma in nursing practice: many nurses are women of childbearing age, and finding a balance between work and family, service and safety, may be challenging for the pregnant nurse.

Like other professional women, pregnant nurses experience considerable pressure to minimize family-related work disruption and continue working throughout pregnancy. But given a nurse's potential exposure to environmental risks such as radiation, infectious agents, teratogenic chemicals, and drugs, as well as the heavy lifting, prolonged standing, long work hours, and shift work nursing often entails, can pregnant nurses continue their professional work without risking adverse outcomes such as congenital malformations, pregnancy loss, preterm birth, prenatal growth restriction, and pregnancy-associated injury?

As a nursing teacher, I found myself fielding such questions and undertook an extensive clinical review to get a clearer picture of the available evidence. I was able to identify relevant studies and review articles by searching electronic databases, using the following keywords: pregnancy, workplace, safety, hazards, occupational health, and nursing. The databases consisted of EBSCO CINAHL, the Cumulative Index to Nursing and Allied Health Literature; the National Library of Medicine's PubMed; ProQuest; and the National Institute for Occupational Safety and Health (NIOSH) Web site. In addition, I reviewed government publications, textbook chapters, and the references upon which they were based. For the most part, this search turned up general literature about occupational and environmental health in pregnancy, although a few articles addressed specific occupational hazards faced by pregnant nurses and hospital workers. This review helps to clarify what we currently know about the

This pregnant OR nurse protects herself from musculoskeletal injury by working with extra staff, using a transfer board, and lifting the patient's feet (rather than a heavier part of the body) during a patient transfer.

occupational hazards pregnant nurses frequently confront, shedding light on the pregnancy risks associated with working in a health care setting, ways to reduce such risks, and relevant occupational safety resources for pregnant nurses and health care facility administrators (see *Staying Safe During Pregnancy*). In order to promote occupational and maternal–child health, health care professionals must turn their attention to the environment in which pregnant health care workers typically spend eight to 12 hours per day and educate themselves on workplace safety in pregnancy.

INFECTIOUS DISEASES

Because nursing involves intimate bodily contact with others, including those with infectious diseases, occupational exposure to pathogens is common. In the absence of titer-confirmed immunity to hepatitis B virus, influenza, measles, mumps, rubella, and varicella zoster, nurses and other health care providers are strongly advised to receive applicable immunizations.[1] In addition to conferring immunity to the pregnant nurse, immunization may transfer protective antibodies through the placenta to her fetus, providing short-term, passive, fetal immunity. Hepatitis B and influenza vaccines may be safely administered during pregnancy; other vaccines, such as those for measles, mumps, rubella, and varicella zoster, are considered unsafe during pregnancy and, ideally, are received prior to conception.[1]

To prevent infection with pathogens for which vaccines are unavailable, consistent adherence to universal precautions is the first line of defense.[2] Likewise, it's important to minimize work-to-home contamination by changing out of contaminated clothing before entering the home and laundering and storing work and nonwork clothing separately.[3] Depending on her working environment, specific immunity profile, and stage of pregnancy, a pregnant nurse may wish to reduce her occupational risks by working in lower-risk settings throughout the duration of her pregnancy.

CMV, a herpesvirus, is the most common intrauterine infection in the United States and other developed areas of the world.[4] Frequently found in urine, stool, blood, breast milk, saliva, semen, vaginal secretions, and body tissues, CMV can be spread through contact with bodily secretions and can pass through the placenta. Although healthy adults and older children who contract CMV either have no symptoms or very mild symptoms, such as malaise, sore throat, myalgia, or nausea, infants and people with a compromised immune system are at risk for severe or fatal complications.[4] Each year in the United States, about 27,000 pregnant women develop a primary CMV infection.[5] The greatest risk factor for pregnant women is frequent and prolonged contact with young children, as occurs in day care centers.[6] In health care workers serving pediatric or immunocompromised adult populations, CMV seroprevalence rates have been found to be highest among those whose work involves close contact with patients—such as bathing, feeding, and toileting.[7] Pediatric nurses and nursing students, like Ms. Turner, who rotate through pediatric settings, must practice strict hygiene to avoid infection or reinfection during pregnancy. This includes frequent handwashing and disinfection of all surfaces that may come into contact with bodily secretions, including saliva.[8]

The Institute of Medicine reports that maternal CMV causes an estimated 400 infant deaths and 3,240 cases of severe sequelae (including hearing, visual, or cognitive impairment) in U.S. children annually.[9] A recent study of hearing-impaired infants in Texas found 6% to be infected with CMV.[10] Despite the prevalence of CMV and the potentially devastating consequences of becoming infected during pregnancy, pregnant women are often unaware of the risks and fail to take appropriate precautions.[11]

In pregnancy, CMV inflames the placenta, impairing its ability to provide oxygen and nutrients to the developing fetus.[12] About 10% of CMV-infected infants are symptomatic at birth,[13] with outcomes that can include intrauterine growth restriction, hydrocephalus, microcephaly, intracranial calcifications, hearing loss, hepatomegaly, splenomegaly, and thrombocytopenic purpura. The CMV-infected infants who are asymptomatic may have various degrees of sensory impairment or neurodevelopmental difficulties, which may not be fully recognized until later in infancy or childhood. In children with congenital CMV infection, Noyola and colleagues found a particularly strong relationship between microcephaly at birth and subsequent development of neurocognitive problems.[14]

Like other members of the herpesvirus family, CMV is characterized by a primary outbreak followed by a

series of recurrent infections. The risk of transplacental transmission is greatest when the primary outbreak occurs during pregnancy and much lower with recurrent infection, although recurrent infection can still harm a developing fetus.[15,16] Some research suggests that first-trimester infection produces greater fetal harm, but congenital infection can harm the fetus even in late pregnancy.[17] Fortunately, at least half of pregnant women have some immunity to CMV from prior exposure, and in most cases, maternal CMV infection doesn't harm the fetus. Nevertheless, universal precautions should be taken to reduce occupational risk in pregnant health care workers.

Ms. Scott may never know whether her stillbirth resulted from occupational exposure to CMV. Although CMV is a known teratogen, it's difficult to establish a direct cause-and-effect relationship between exposure and congenital abnormalities.[18] Nevertheless, because nurses (particularly those who work with pediatric or immunocompromised populations) are at risk for occupational exposure to CMV,[7] congenital CMV infection should be considered anytime a nurse experiences a pregnancy loss.[16]

UNIVERSAL PRECAUTIONS SHOULD BE TAKEN TO REDUCE OCCUPATIONAL CMV RISK IN PREGNANT HEALTH CARE WORKERS.

To date, no CMV vaccines are available, and no treatment has been found to be both effective against CMV and safe during pregnancy, so focusing on prevention of primary infection and subsequent reinfection is paramount. Cases such as that of Ms. Scott, however, illustrate the vulnerability of pregnant nurses to pathogens in the workplace and the challenges they often face in following universal precautions. Workplaces and workplace assignments must be structured to provide nurses easy access to handwashing equipment—even during patient care emergencies—and with frequent reminders that careful and consistent attention to hygiene is the cornerstone of infection control in practice environments.

Parvovirus B19 is a common, usually benign childhood virus that causes erythema infectiosum, also known as "fifth disease" or "slapped cheek syndrome." Most people are exposed between ages five and 15. To date, there are no human vaccines to prevent infection, nor are there available antiviral drugs effective in treating it.[19]

Parvovirus B19 is common throughout the world and is easily transmitted through contact with respiratory secretions of an infected person. Outbreaks, which are more common in northern climates and in the winter and spring, persist over months within a community. Symptoms may include one to four days of fever, malaise, myalgia, and a characteristic symmetrical rash on the face, arms, trunk, buttocks, or thighs, although in healthy people these may be mild or go unnoticed. At greatest risk for harmful sequelae are pregnant women and people with immunodeficiency or anemia.[20]

Acute infection during pregnancy can affect erythrocyte development in the fetal bone marrow, liver, and spleen, causing blood cell aplasia and fetal anemia. If severe anemia occurs, it can result in hydrops fetalis and fetal death. Fortunately, most infections are transient and don't result in teratogenic effects. The overall risk of a fetus acquiring hydrops after maternal parvovirus B19 infection is about 1%.[21] Within that group, roughly 33% of all cases resolve spontaneously.[22]

Because prior infection confers immunity, and about half of all adults were infected in childhood, roughly half of all pregnant women are immune before they conceive. Pregnant women concerned about possible exposure to parvovirus B19 should be tested for immunity, especially if they develop a new rash or arthralgia. Negative immunoglobulin (Ig) G titers in conjunction with positive IgM titers suggest primary infection. Close fetal surveillance with serial ultrasound is indicated in such cases.

As with CMV, children are the greatest source of exposure to parvovirus B19. Pregnant health care workers are at no greater risk for acquiring the virus than nonpregnant personnel, but nonimmune pregnant women and women who are hoping to conceive should try to minimize occupational risk through strict adherence to good hygiene.

Influenza. During the winter months, influenza epidemics occur commonly throughout the world. Spread by respiratory droplets when an infected person coughs or sneezes, influenza causes fever, myalgia, malaise, headache, sore throat, rhinitis, and vomiting but in uncomplicated cases subsides within a week. In vulnerable populations, influenza can involve serious complications. In the United States, influenza epidemics are associated with roughly 36,000 deaths per year. Common influenza-related complications include pneumonia in elderly adults, febrile seizures in children, and exacerbation of underlying illness in those with a chronic disease. Less frequent pediatric complications include encephalopathy, pericarditis, and Reye's syndrome. Pregnant women who contract influenza are at risk for exacerbation of asthma requiring hospitalization[23] and cardiopulmonary complications.[24] Patients with influenza complications are commonly hospitalized while ill, thereby exposing nonimmune

health care workers, who subsequently become vectors of influenza to vulnerable populations. The Centers for Disease Control and Prevention strongly encourages health care workers to be immunized annually.[25]

Inactivated influenza vaccine (the flu shot) is safe for all pregnant women at all stages of pregnancy and for breastfeeding mothers.[26] Live attenuated influenza vaccine (the nasal spray) is contraindicated in pregnancy.[26] Pregnant nurses who receive a flu shot reduce the risk of harm to themselves, their children, and their patients. Influenza-specific antibody is transmitted to the fetus and, should postnatal exposure to influenza occur, reduces the risk of influenza infection significantly in infants up to six months of age (one small study showed a reduction of 63% in the number of infections[27]).

Concerns about the 2009 H1N1 pandemic influenza resulted in widespread immunization campaigns before and during the last flu season. Some pregnant women infected with H1N1 became seriously ill, and although only about 1% of the population is pregnant at any time, about 6% of confirmed H1N1 influenza deaths in the United States involved pregnant women.[26] For this reason, pregnant women and health care workers were given priority in public health efforts to immunize the population against H1N1.

care personnel. Pregnant nurses and nurses hoping to conceive should seriously weigh the risks and benefits of working with such hazardous drugs.

Possible routes of drug exposure include dermal absorption from handling drugs or drug-contaminated materials, inhalation from breathing contaminated air (as can occur with aerosolized drugs), ingestion of contaminated food or drink, other hand-to-mouth contact, and accidental injection as can occur with needlestick injuries.[30] Medication may leak from syringes or IV lines onto workspace surfaces or directly onto nurses' hands or splash into nurses' faces during preparation; it can also be found in patient excrement and on soiled linens. (For more on the dangers to nurses of exposure to neoplastic agents, see the November 2010 *AJN Reports*.)

The likelihood of an adverse event resulting from occupational exposure to a hazardous drug varies with the amount and frequency of the exposure, the degree to which safe work practices have been followed,[29] and the point during pregnancy and fetal development at which the exposure occurs.[18] NIOSH published a statement outlining precautions health care workers and their employers should take to protect against exposures to hazardous drugs in health care settings (see "Preventing Occupational Exposures to Antineoplastic and Other Hazardous Drugs in Health Care Settings," at http://bit.ly/cmBrpc). The NIOSH statement emphasizes that all materials that come in contact with hazardous drugs—such as work surfaces, personal protective equipment, IV bags and tubing, and patient excrement—are possible sources of exposure. Exposure risks can be greatly reduced through staff education and an investment in equipment such as external ventilation systems and personal protective equipment.

IN ADDITION TO GLOVES AND GOWNS, PREGNANT HEALTH CARE WORKERS EXPOSED TO AEROSOLIZED DRUGS SHOULD WEAR PARTICULATE FILTER RESPIRATOR MASKS.

PHARMACEUTICAL AGENTS

Ever since the catastrophic association between thalidomide and birth defects was discovered in the 1950s, the impact of specific drugs on reproductive and fetal development has been studied extensively. The Food and Drug Administration developed a system for rating pharmaceuticals according to their potential fetotoxicity. Research, however, has focused on pregnant patients, and there's a paucity of evidence-based recommendations on protecting pregnant health care workers from drugs with known fetotoxicity, particularly noninjectable drugs.[28] Nurses who prepare or administer hazardous drugs or work in areas where these drugs are used may be exposed to these agents in the workplace, which can result in skin rashes, infertility, miscarriage, birth defects, or cancer.[29]

Cancer chemotherapy. Antineoplastic agents are the most frequently used hazardous drugs in health care.[2] Created to kill cancer cells, these cytotoxins kill other rapidly dividing cells as well. Working with antineoplastic agents and other hazardous drugs is an acknowledged occupational hazard to health

Aerosolized drugs. Aerosolized pentamidine is used to treat pneumocystis pneumonia, and aerosolized ribavirin is used to treat respiratory syncytial virus bronchiolitis and pneumonia in children, severe lung disease in immunocompromised children requiring ventilatory support, and recently, severe acute respiratory syndrome.[31] It's unclear what level or timing of exposure could harm a developing fetus, but because these drugs can interfere with DNA and RNA, there may be teratogenic risks to pregnant nurses who work with them.[32-34]

Protective measures include treating patients in isolation rooms with observation windows, which

minimize the amount of time health care workers must spend in the room, and air exchange systems that either direct exhaust outside or filter it through a high efficiency particulate air filter. In addition to gloves and gowns, pregnant health care workers should wear particulate filter respirator masks, such as the N95 variety; surgical masks provide insufficient protection from inhalation.[35,36] Pregnant health care workers should be counseled on ways to minimize exposure and should be given the option of assuming alternative work responsibilities that don't require them to administer aerosolized drugs.[37]

Waste anesthetic gases are small amounts of volatile anesthetic gases, such as nitrous oxide or halothane, that enter operating rooms (ORs) during the delivery of anesthesia or are expired by patients recovering from anesthesia.[38] Studies in the 1970s suggested a relationship between anesthetic gases and spontaneous abortions in OR staff, but the application of these findings to current OR conditions is limited because those studies were conducted before hospitals were required to use scavenging systems for waste anesthetic gases (for more, see "Anesthetic Gases: Guidelines for Workplace Exposures" at http://bit.ly/bIzRtn).[39]

In 1995 Rowland and colleagues found that, among female dental assistants who worked with nitrous oxide for three or more hours per week in offices that didn't use scavenging systems, there was an elevated risk of miscarriage, although the risk wasn't higher among those who worked with nitrous oxide in offices that used scavenging systems.[40] Although existing evidence doesn't support an association between occupational exposure to waste anesthetic gas and an increased risk of major fetal malformations, the risk of spontaneous abortion may be slightly increased by exposure to waste anesthetic gases—a risk that can be mitigated with gas-scavenging systems.[41]

Even when scavenging systems are in place, however, there may be clinical situations in which the exposure to waste anesthetic gas is greater—for example, in recovery rooms and postanesthesia care units, where staff work closely with patients who are exhaling anesthetic gases. The Occupational Safety and Health Administration suggests that nonrecirculating ventilation systems be used in such areas to reduce exposure.[39] Workers may also be exposed to these gases through leaks that occur when anesthesia masks fit poorly, when gases escape during the connection or disconnection of systems, and during induction of anesthesia.[38]

Cuffed endotracheal tubes reduce leakage of waste anesthetic gases. In addition, OR staff should test equipment for gas leaks on a regular basis and replace worn components promptly. Pregnant staff shouldn't fill or empty vaporizers.[41]

A pregnant nurse uses protective personal equipment while disposing of the diaper from a patient undergoing chemotherapy.

ORGANIC SOLVENTS

Nurses may face occupational exposure to organic solvents when using products that clean or sterilize and when working with laboratory reagents. Examples of organic solvents are acetone, benzene, chloroform, ethanol, methanol, formaldehyde, gasoline, and industrial glues, which are known to be neurotoxic in high concentrations. It's difficult to prove that exposure to organic solvents is harmful to human reproductive health, or to quantify the degree to which it is, because such exposure is so common in everyday life—in gasoline vapors, spot removal products, aerosol sprays, and paints. Short-duration, low-level incidental exposures often go undetected, and we really don't know which solvents are more harmful, how much exposure is required to cause harm, and the effects of exposure at various gestational ages. Nevertheless, because many organic solvents are teratogenic and embryotoxic in laboratory animals, pregnant women have reason to be cautious about using them.

Maternal occupational exposure to organic solvents has been associated with increased risks of spontaneous abortion and preterm birth,[42,43] as well as impaired neurocognition, language, and behavior in children who

Staying Safe During Pregnancy

Some resources for nurses.

The following Web sites post pertinent guidelines, articles, and other suggestions for avoiding occupational hazards during pregnancy.

National Institute for Occupational Safety and Health (NIOSH)
www.cdc.gov/niosh

"Preventing Occupational Exposures to Antineoplastic and Other Hazardous Drugs in Health Care Settings"
www.cdc.gov/niosh/docs/2004-165/#sum

"Safe Patient Handling and Movement"
www.cdc.gov/niosh/review/public/safe-patient/patienthandling2.html

"The Effects of Workplace Hazards on Female Reproductive Health"
www.cdc.gov/niosh/docs/99-104

Occupational Safety and Health Administration (OSHA)
www.osha.gov/index.html

"Anesthetic Gases: Guidelines for Workplace Exposures"
www.osha.gov/dts/osta/anestheticgases/index.html#E2

Association of periOperative Registered Nurses (AORN)
www.aorn.org

"AORN Workplace Safety"
www.aorn.org/PracticeResources/SafetyResources/WorkplaceSafety

American Nurses Association (ANA)
www.nursingworld.org

"Safe Handling of Hazardous Drugs," by Polovich M. *Online J Issues Nurs* 2004;9(3).

"Healthy Choices: Transforming Our Hospitals into Environmentally Healthy and Safe Places," by Sattler B, Hall K. *Online J Issues Nurs* 2007;12(2).

Health Canada
www.hc-sc.gc.ca

"Occupational Exposure to Radiation"
www.hc-sc.gc.ca/hl-vs/iyh-vsv/environ/expos-eng.php

March of Dimes Foundation
www.marchofdimes.com

"Environmental Risks and Pregnancy"
www.marchofdimes.com/professionals/14332_9146.asp

"Cytomegalovirus"
www.marchofdimes.com/professionals/14332_1195.asp

Motherisk program at the Hospital for Sick Children (SickKids), Toronto, Canada
www.motherisk.org

were exposed in utero.[44] Prenatal exposure to organic solvents has also been linked to intrauterine growth restriction,[45] as well as vision abnormalities such as diminished contrast sensitivity and abnormal response to red–green stimuli.[46]

Many chemical solvents have been in existence for only a few generations, and their long-term impact on human reproduction and neurodevelopment remains poorly understood. Most chemicals used in the workplace haven't been evaluated for reproductive toxicity.[47] Pregnant nurses can limit their exposure to organic solvents by wearing solvent-resistant gloves and protective clothing, working in well-ventilated areas when using solvents, and substituting less toxic "green" cleaners when possible.[48]

IONIZING RADIATION

The use of radiation for diagnostic and therapeutic purposes is common in hospital environments. Radiology, nuclear medicine, positron emission tomography, gamma-ray cancer therapy, and cardiac catheterization all emit ionizing radiation. With advances in medical technology has come a better understanding of the value of ionizing radiation in diagnosis and treatment, as well as the need to protect patients, staff, and the public from its carcinogenic and fetotoxic effects. Everyone is exposed to some natural background radiation, but the high levels of radiation generated in nuclear medicine increase a pregnant woman's risk of miscarriage and stillbirth and the risks in the fetus of congenital malformation, growth restriction, neurobehavioral impairment, and cancer.[49]

The effects of radiation on the fetus are determined in large part by gestational age and radiation dose.[49] Although we know that exposure to high-dose radiation is fetotoxic, the threshold of safe exposure and the effects of lower-dose exposures aren't as well understood.

Evidence suggests that in the first two weeks of gestation, significant exposures are likely to result in an "all-or-none" effect, wherein the pregnancy is either lost or there is no effect.[49] Exposures are most lethal during gestational weeks 3 and 4; are most likely to cause malformation and growth restriction from week 4 to week 8; are associated with microcephaly, whole body growth restriction, and cognitive impairment from week 8 to week 15; and continue to pose a risk of growth restriction and intellectual impairment from week 16 through term, although effects tend not to be as severe as those of similar exposures at earlier points during gestation.[49]

Those who work in nuclear medicine departments are subject to precautionary occupational safety standards that include using dosimetry to measure occupational radiation and monitoring worker exposure to ensure that it remains below established limits.[50] What is usually less well monitored is exposure that occurs outside of nuclear medicine departments, such as exposure to the ionizing radiation scattered when

portable X-ray machines are used in acute care settings.[51] Teschke and colleagues found that nurses working in emergency and pediatric departments faced many potential exposures to ionizing radiation and were rarely monitored.[51] Some researchers have called for pregnant staff to be excluded from situations in which such accidental or unpredictable exposures can arise.[52]

SHIFT WORK AND WORK LOAD

Little is known about the effects of disturbed circadian rhythms on reproductive health. Whereas a 1998 review of epidemiologic studies concerned with the effects of shift work on women's reproductive health found evidence to be inconclusive,[53] a 2005 prospective cohort study by Pompeii and colleagues found that working at night increased a woman's risk of preterm delivery,[54] and a survey by Lawson and colleagues of participants in the Nurses' Health Study II found that night work increased a woman's risk of delivering early preterm (at less than 32 weeks) but not late preterm (at 32 to 36 weeks).[55] Croteau and colleagues found that irregular or shift work alone elevated the risk of having a small-for-gestational-age infant, and the risk increased cumulatively with the addition of the following occupational conditions: night hours, standing, lifting loads, noise, and high psychological demand combined with low social support.[56] Night work and long work hours have also been associated with an elevated risk of spontaneous abortion; both must be studied further to determine the effects of each on hormones and uterine activity during pregnancy.[54, 57]

Neither Lawson nor Pompeii found physically demanding work predictive of preterm birth,[54, 55] but a meta-analysis by Mozurkewich and colleagues of 29 studies involving a total of 160,988 women found significant associations between physically demanding work and preterm birth, small-for-gestational-age babies, and gestational hypertension.[58] They also found significant associations between preterm birth and prolonged standing, shift and night work, and high cumulative work fatigue scores.[58]

Although arguments over cause and effect remain, the findings of these studies and literature reviews underscore the need to provide pregnant women with reasonable workloads, opportunities to rest when fatigued, and support for avoiding extreme physical exertion or long periods of standing.

ERGONOMIC CONSIDERATIONS

In later pregnancy, the body's center of gravity is altered and movement is awkward. High serum levels of progesterone and relaxin loosen muscles, ligaments, and connective tissues in preparation for birthing but also raise the risk of musculoskeletal injury, particularly during the performance of heavy, repetitive work, such as lifting, pulling, or pushing. Relying on "proper" body mechanics, such as keeping the knees bent when lifting or avoiding twisting while carrying, won't prevent back injury, even among nonpregnant nurses who manually lift or transfer a debilitated patient or heavy equipment.[59]

Nurses are among the professionals with the highest rates of work-related low back pain,[60] and every year about 12% of nurses leave the profession as a result of back injury.[61] Occupational risk factors for musculoskeletal back injuries include manual patient handling (made more difficult by the increasing frequency of obesity in the patient population), the pushing and pulling of beds and trolleys, the awkward positioning that's often required during patient care, and long working hours.[59] In pregnant nurses in the later weeks of pregnancy, all such risks are exacerbated.

A SURVEY OF PARTICIPANTS IN THE NURSES' HEALTH STUDY II FOUND THAT NIGHT WORK INCREASED A WOMAN'S RISK OF DELIVERING EARLY PRETERM (AT LESS THAN 32 WEEKS).

Solutions to these problems involve the use of patient lifting and transferring apparatus, biomechanical training, larger rooms, and additional staff to help with patient transfers.[62] Such approaches would have helped prevent the type of back injury Ms. Roberts sustained while helping a resident negotiate a doorway. As is evident in her case, staff shortages can precipitate incapacitating staff injuries, which in turn compound problems associated with staff shortages. Nursing researchers have pointed out that implementing a minimal- or no-lifting practice within health care institutions is associated with significant cost savings, as well as greater patient satisfaction and reductions in the number of staff injuries.[61]

JOB MODIFICATION DURING PREGNANCY

Pregnant nurses may rightfully request some job modification to minimize exposure to certain drugs, patient populations, gases, and solvents. For example, a pregnant student nurse in a community pediatric setting might ask to avoid day care assignments and instead work in a school with teens. A pregnant OR or recovery room nurse, particularly one in her first trimester, might ask to be more involved in preoperative care than immediate postoperative care, in order to avoid contact with the waste anesthetic gases postoperative patients expire. A pregnant oncology nurse must strictly adhere to guidelines on handling and administering cytotoxic drugs,[29] although she might also request temporary alternative duty.

Most developed nations have regulations protecting the right of women to maintain employment during

pregnancy; there are fewer regulations concerning the modification of workplace environments to accommodate the special needs of pregnant women. In the United States, when a pregnancy complication temporarily prevents a woman from performing her usual working duties, the Pregnancy Discrimination Act requires that the pregnancy complication be treated as any other disabling condition that temporarily prevents a person from working—but the act does *not* require special treatment for *healthy* pregnant women.[63] In contrast, many other developed nations provide protection for expectant and nursing mothers by prohibiting night work or by accommodating a woman's request to be removed from the night shift.[64]

In Canada and the United Kingdom, families who meet eligibility requirements are entitled to up to a year of maternity or parental leave with state-funded financial support.[65,66] In the United States, federally mandated maternity leave with job protection is 12 weeks unpaid.[67] Even in nations with relatively generous maternity leave practices, not all women are eligible for benefits, and many work well into their third trimester in order to have more time off with their baby.

Safe workplace environments that serve both the professional and personal needs of nurses contribute to the retention of experienced nurses, whom we can ill afford to lose. Ethical and humane accommodations allow most women to continue working throughout pregnancy. Shortening work hours, providing assistance with lifting, accommodating the need for frequent nutrition and bathroom breaks, and considering pregnancy risks when making assignments can also promote health and satisfaction among pregnant employees. ▼

For 5 additional continuing nursing education articles on the topic of reproductive health, go to www.nursingcenter.com/ce.

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REFERENCES

1. Centers for Disease Control and Prevention. Appendix B: immunizations strongly recommended for health-care personnel (HCP). *MMWR Recomm Rep* 2003;52(RR-17):65. http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5217a3.htm.
2. Hood J. The pregnant health care worker—an evidence-based approach to job assignment and reassignment. *AAOHN J* 2008;56(8):329-33.
3. National Institute for Occupational Safety and Health. *The effects of workplace hazards on female reproductive health*. Atlanta: Centers for Disease Control and Prevention; 1999. 99-104. http://www.cdc.gov/niosh/docs/99-104/pdfs/99-104.pdf.
4. Arvin AM, et al. Vaccine development to prevent cytomegalovirus disease: report from the National Vaccine Advisory Committee. *Clin Infect Dis* 2004;39(2):233-9.
5. Colugnati FA, et al. Incidence of cytomegalovirus infection among the general population and pregnant women in the United States. *BMC Infect Dis* 2007;7:71.
6. Adler SP. Molecular epidemiology of cytomegalovirus: viral transmission among children attending a day care center, their parents, and caretakers. *J Pediatr* 1988;112(3):366-72.
7. Sobaszek A, et al. Prevalence of cytomegalovirus infection among health care workers in pediatric and immunosuppressed adult units. *J Occup Environ Med* 2000;42(11):1109-14.
8. Cannon MJ, Davis KF. Washing our hands of the congenital cytomegalovirus disease epidemic. *BMC Public Health* 2005;5:70.
9. Stratton KR, et al., editors. *Vaccines for the 21st century: a tool for decisionmaking*. Washington, DC: National Academy Press; 2000.
10. Stehel EK, et al. Newborn hearing screening and detection of congenital cytomegalovirus infection. *Pediatrics* 2008;121(5):970-5.
11. Harvey J, Dennis CL. Hygiene interventions for prevention of cytomegalovirus infection among childbearing women: systematic review. *J Adv Nurs* 2008;63(5):440-50.
12. Adler SP, et al. Recent advances in the prevention and treatment of congenital cytomegalovirus infections. *Semin Perinatol* 2007;31(1):10-8.
13. Stagno S, Whitley RJ. Herpesvirus infections of pregnancy. Part I: cytomegalovirus and Epstein-Barr virus infections. *N Engl J Med* 1985;313(20):1270-4.
14. Noyola DE, et al. Early predictors of neurodevelopmental outcome in symptomatic congenital cytomegalovirus infection. *J Pediatr* 2001;138(3):325-31.
15. Boppana SB, et al. Intrauterine transmission of cytomegalovirus to infants of women with preconceptional immunity. *N Engl J Med* 2001;344(18):1366-71.
16. Gaytant MA, et al. Congenital cytomegalovirus infection after recurrent infection: case reports and review of the literature. *Eur J Pediatr* 2003;162(4):248-53.
17. Pass RF, et al. Congenital cytomegalovirus infection following first trimester maternal infection: symptoms at birth and outcome. *J Clin Virol* 2006;35(2):216-20.
18. Brent RL. Environmental causes of human congenital malformations: the pediatrician's role in dealing with these complex clinical problems caused by a multiplicity of environmental and genetic factors. *Pediatrics* 2004;113(4 Suppl):957-68.
19. Staroselsky A, et al. Exposure to fifth disease in pregnancy. *Can Fam Physician* 2009;55(12):1195-8.
20. Centers for Disease Control and Prevention. *Parvovirus B19 (fifth disease) fact sheet*. 2005. http://www.cdc.gov/ncidod/dvrd/revb/respiratory/parvo_b19.htm.
21. Markenson GR, Yancey MK. Parvovirus B19 infections in pregnancy. *Semin Perinatol* 1998;22(4):309-17.
22. Gilbert GL. Parvovirus B19 infection and its significance in pregnancy. *Commun Dis Intell* 2000;24 (Suppl):69-71.
23. Hartert TV, et al. Maternal morbidity and perinatal outcomes among pregnant women with respiratory hospitalizations during influenza season. *Am J Obstet Gynecol* 2003;189(6):1705-12.
24. Neuzil KM, et al. Impact of influenza on acute cardiopulmonary hospitalizations in pregnant women. *Am J Epidemiol* 1998;148(11):1094-102.
25. Centers for Disease Control and Prevention. *Seasonal influenza. Information for health professionals*. 2010. http://www.cdc.gov/flu/professionals.
26. Centers for Disease Control and Prevention. *2009 H1N1 influenza vaccine and pregnant women: information for healthcare providers*. Atlanta. 2010. http://www.cdc.gov/h1n1flu/vaccination/providers_qa.htm.

27. Zaman K, et al. Effectiveness of maternal influenza immunization in mothers and infants. *N Engl J Med* 2008;359(15): 1555-64.
28. Timpe EM, et al. Environmental exposure of health care workers to category D and X medications. *Am J Health Syst Pharm* 2004;61(15):1556-7, 1560-1.
29. National Institute for Occupational Safety and Health. *Preventing occupational exposures to antineoplastic and other hazardous drugs in health care settings*. Atlanta: Centers for Disease Control and Prevention; 2004 Sept. 2004-165. NIOSH Alert.
30. Polovich M. Developing a hazardous drug safe-handling program. *Community Oncology* 2005;2(5):403-5.
31. Koren G, et al. Ribavirin in the treatment of SARS: a new trick for an old drug? *CMAJ* 2003;168(10):1289-92.
32. Ito S, Koren G. Exposure of pregnant women to ribavirin-contaminated air: risk assessment and recommendations. *Pediatr Infect Dis J* 1993;12(1):2-5.
33. Ito S, Koren G. Estimation of fetal risk from aerosolized pentamidine in pregnant healthcare workers. *Chest* 1994; 106(5):1460-2.
34. Lerner-Durjava L. Safeguarding your unborn baby. *Nursing* 1999;29(6):32.
35. Decker J. *Health hazard evaluation report: the Children's Hospital, Denver, Colorado*. Atlanta: National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention; 1998. HETA 98-00480-2688. Health Hazard Evaluation; http://www.cdc.gov/niosh/hhe/reports/pdfs/1998-0048-2688.pdf.
36. Seitz TA, Deitchman S. *Health hazard evaluation report: George Washington University Medical Center, Washington, D.C.* Atlanta: National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention; 1992 May. HETA 90-140-2221. Health Hazard Evaluation; http://www.cdc.gov/niosh/hhe/reports/pdfs/1990-0140-2221.pdf.
37. Centers for Disease Control and Prevention. Assessing exposures of health-care personnel to aerosols of ribavirin—California. *MMWR Morb Mortal Wkly Rep* 1988;37(36): 560-3.
38. National Institute for Occupational Safety and Health. *Waste anesthetic gases: occupational hazards in hospitals*. Atlanta: Centers for Disease Control and Prevention; 2007. 2007-151. http://www.cdc.gov/niosh/docs/2007-151/pdfs/2007-151.pdf.
39. OSHA Directorate for Technical Support, Office of Science and Technical Assessment. *Anesthetic gases: guidelines for workplace exposures*. U.S. Department of Labor, Occupational Safety and Health Administration. 1999. http://www.osha.gov/dts/osta/anestheticgases/index.html.
40. Rowland AS, et al. Nitrous oxide and spontaneous abortion in female dental assistants. *Am J Epidemiol* 1995;141(6): 531-8.
41. Shuhaiber S, Koren G. Occupational exposure to inhaled anesthetic. Is it a concern for pregnant women? *Can Fam Physician* 2000;46:2391-2.
42. McMartin KI, et al. Pregnancy outcome following maternal organic solvent exposure: a meta-analysis of epidemiologic studies. *Am J Ind Med* 1998;34(3):288-92.
43. Wennborg H, et al. Adverse reproduction outcomes among employees working in biomedical research laboratories. *Scand J Work Environ Health* 2002;28(1):5-11.
44. Laslo-Baker D, et al. Child neurodevelopmental outcome and maternal occupational exposure to solvents. *Arch Pediatr Adolesc Med* 2004;158(10):956-61.
45. Ahmed P, Jaakkola JJ. Exposure to organic solvents and adverse pregnancy outcomes. *Hum Reprod* 2007;22(10): 2751-7.
46. Till C, et al. Vision abnormalities in young children exposed prenatally to organic solvents. *Neurotoxicology* 2005;26(4): 599-613.
47. McDiarmid MA, Gehle K. Preconception brief: occupational/environmental exposures. *Matern Child Health J* 2006; 10(5 Suppl):S123-S128.
48. Canadian Centre for Occupational Health and Safety. *Hazards of occupational exposure to solvents during pregnancy*. n.d. http://www.ccohs.ca/headlines/text77.html.
49. Brent RL. Saving lives and changing family histories: appropriate counseling of pregnant women and men and women of reproductive age, concerning the risk of diagnostic radiation exposures during and before pregnancy. *Am J Obstet Gynecol* 2009;200(1):4-24.
50. Gomez-Palacios M, et al. Radiation doses in the surroundings of patients undergoing nuclear medicine diagnostic studies. *Health Phys* 2005;89(2 Suppl): S27-S34.
51. Teschke K, et al. Estimating nurses' exposures to ionizing radiation: the elusive gold standard. *J Occup Environ Hyg* 2008;5(2):75-84.
52. Barber RW, et al. Is it safe to work with iodine-131 if you are pregnant? A risk assessment for nuclear medicine staff involved with cleaning and decontamination. *Nucl Med Commun* 2003;24(5):571-4.
53. Nurminen T. Shift work and reproductive health. *Scand J Work Environ Health* 1998;24 (Suppl 3):28-34.
54. Pompeii LA, et al. Physical exertion at work and the risk of preterm delivery and small-for-gestational-age birth. *Obstet Gynecol* 2005;106(6):1279-88.
55. Lawson CC, et al. Occupational factors and risk of preterm birth in nurses. *Am J Obstet Gynecol* 2009;200(1): 51.e1-8. Epub 2008 Oct 30.
56. Croteau A, et al. Work activity in pregnancy, preventive measures, and the risk of delivering a small-for-gestational-age infant. *Am J Public Health* 2006;96(5):846-55.
57. Whelan EA, et al. Work schedule during pregnancy and spontaneous abortion. *Epidemiology* 2007;18(3):350-5.
58. Mozurkewich EL, et al. Working conditions and adverse pregnancy outcome: a meta-analysis. *Obstet Gynecol* 2000;95(4):623-35.
59. Waters T, et al. NIOSH research efforts to prevent musculoskeletal disorders in the healthcare industry. *Orthop Nurs* 2006;25(6):380-9.
60. Bureau of Labor Statistics. *Survey of occupational injuries and illnesses, 2002. Incidence rates of nonfatal occupational injuries and illnesses by industry and case types*. Washington, DC: U.S. Department of Labor; 2004 Mar. http://www.bls.gov/iif/oshwc/osh/os/ossm0013.pdf.
61. Hunter B, et al. Saving costs, saving health care providers' backs, and creating a safe patient environment. *Nurs Econ* 2010;28(2):130-4.
62. Vieira ER, et al. Low back problems and possible improvements in nursing jobs. *J Adv Nurs* 2006;55(1): 79-89.
63. U.S. Equal Employment Opportunity Commission. *Pregnancy discrimination* n.d. http://www.eeoc.gov/laws/types/pregnancy.cfm.
64. Politakis GP. Night work of women in industry: standards and sensibility. *International Labour Review* 2001;140(4): 403-28.
65. Department for Business Innovation and Skills (UK). *Maternity entitlements and responsibilities: a guide. Babies due on or after 1 April 2007*. n.d. http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/employment/employment-legislation/employment-guidance/page34031.html.
66. Human Resources and Skills Development Canada. *Workplace programs, policies and practices*. 2007. http://www.hrsdc.gc.ca/eng/lp/spila/wlb/11programs_policies_practices.shtml.
67. Alewell D, Pull K. An international comparison and assessment of maternity leave policy. *Comparative Labor Law and Policy Journal* 2005;22:297-326.