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# Occupational Hazards to Pregnant Veterinarians

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## SUMMARY

Many women choose to continue practicing veterinary medicine while pregnant. With proper education, precautions can be taken so as to minimize the risk to the developing fetus. The primary areas of concern are anesthesia, radiation, toxoplasmosis, listeriosis, carbon monoxide, prostaglandins, physical exertion, and trauma to the fetus.

## ANESTHESIA

The idea that long term exposure to low levels of anesthetic gas might be dangerous to pregnancies is a relatively new one. Probably the earliest study was in 1967 when a Russian survey of female anesthesiologists revealed that of 31 pregnancies, 18 ended in spontaneous abortions, 2 in premature deliveries, and 1 child was born with a congenital abnormality.[1]

Several other studies, mostly in the form of retrospective questionnaires, have been conducted since that initial observation. All studies have shown an increased percentage of spontaneous miscarriages among women exposed to waste anesthetic gases when compared to control groups. For example, one investigation revealed 29.7% of conceptions in operating room nurses ended in spontaneous abortions compared with 8.8% miscarriages in the control group, while a similar study of anesthetists evidenced a comparison of 37.8% to 10.3%.[2] A third study conducted by a different research team caused the investigator to conclude that personnel exposed to low levels of anesthetic gas have a 1.3 to 2 times greater risk of spontaneous abortions than unexposed women.

However, spontaneous abortion is not the only obstetric risk of chronic anesthetic gas exposure. There is also reported a higher incidence of congenital abnormalities among liveborn babies of women exposed to surgical anesthetics during their pregnancy. Surveys of nurse anesthetists who had practiced during their pregnancies have shown significantly higher incidence of birth defects than anesthetists who hadn't practiced during the course of their pregnancies. The defects included hemangiomas, "strawberry" birthmarks, heart defects, hypospadias, pyloric stenosis, inguinal hernias, congenital hip dislocations, pectus excavatum, microcephaly, and mental retardation.[4] There is also an increased frequency of congenital abnormalities in the children of males chronically exposed to low levels of anesthetic gases.[3,5]

All of the studies previously mentioned concerned personnel working in unscavenged operating rooms. Scavenging can be defined as the capture of excess anesthetic gases at the pop-off area of the gas anesthetic machine, and then removing those gases to the atmosphere in such a manner that personnel working in the room are not exposed. Commercial scavenging devices are available[a] and scavenging is an effective and often economical method of reducing environmental gas concentrations. Other efforts can also be made to reduce anesthetic pollution such as frequently servicing the machines and checking for leaks, placing the machines as close to the room exhausts as possible, working as far away from the anesthetic machines as possible, using tight fitting endotracheal tubes with functional cuffs, and filling the anesthetic vaporizers with funnels at the end of the day when few people are around.[6]

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[a] North American Drager, Telford, Pennsylvania. Fraser-Sweatman-Medisheild, Lancaster, New York. Ohio Medical Products, Berkley, California.

Anesthetic techniques can also affect the amount of gas that escapes, and a few simple precautions can decrease gas pollution. These include avoiding turning on $N_2O$ or vaporizers until the patient is connected, disconnecting the patients as infrequently as possible, emptying the breathing bags into the scavenge system instead of into the room, and administering oxygen as long as possible at the ends of procedures to flush the anesthetic that is in the system into the scavenger.[6]

Evidence is strong that continual long term exposure to waste anesthetic gases during pregnancy does increase the chance that pregnancies will end in spontaneous abortions or that children will be born with congenital abnormalities. The first trimester is the most crucial period to avoid unnecessary anesthetic gases.[3] If women have histories of spontaneous abortions or of giving birth to children with congenital malformations, avoiding anesthetics during the entire pregnancy is especially important. Through the use of scavenger systems and proper anesthesia techniques, these risks can be minimized.

## RADIATION

Most veterinarians are aware of the fact that rapidly dividing cells are the most susceptible to ionizing radiation, and the developing embryo is no exception.

The most sensitive time of development is the pre-implantation period, which is about the first 8 to 10 days after conception in humans. A study which examined the affects of a single high (200 Roentgens) dose of radiation to mice in 3 different stages of pregnancy showed as many as 80% of the embryos irradiated in the pre-implantation stage died long before term. The percentage of deaths decreased as the age at irradiation of the embryos increased.[7]

When mice in the same experiment were exposed during the period of major organogenesis (equivalent to 6 to 7 weeks of gestation in humans), 100% of the mice that were subsequently born had congenital abnormalities. Of the malformations, a high percentage involved the skeletal and central nervous systems. Many of the abnormalities were so severe that they were not compatible with neonatal life and often resulted in fetal death close to term.[7]

The "fetal" period of development is defined as the time in which the fetus has the potential to survive if born at that time, and correlates roughly to 25 weeks of gestation or more in humans.[7,8] Mice irradiated at this time had almost no neonatal deaths or congenital abnormalities, which indicated that the fetuses were much more resistant to death and malformation from radiation in this period.[7]

Many specific congenital malformations have been documented in human, rat, and mouse offspring following fetal irradiation.[10] Most of the malformations have involved the three most radiosensitive systems: the central nervous system, the skeletal system, and optic tissues.

In addition, it is generally thought that children who were irradiated in utero have an increased chance of developing leukemia at a young age. One author feels those children have as much as a 5 to 40 times greater chance of contracting leukemia.[9]

It is apparent that there is very strong evidence that in utero irradiation can cause fetal death, congenital abnormalities, and an increase in childhood leukemia. The measure of risk is considered to be proportional to the dose of radiation received, but just what dose constitutes what amount of risk is somewhat uncertain.

Health physicists have attempted to identify a Maximum Permissible Dose (MPD) which represents, in theory, the maximum dose that, in light of present knowledge, would not be expected to produce significant radiation effects, yet does not indicate zero risk.[11] For a human fetus for an entire pregnancy the MPD is 500 mrem.

However, a review of Russian literature suggests that nervous tissue function may be altered by doses as low as 100 mrads,[10] while other papers have stated that a dose of 200–250 mrads received while in the womb significantly increased the frequency of neoplasms in those children.[12,13] A dose of 1–3 rads in utero has been documented to increase the leukemia rate in children 30–50%.[14] No safe (zero risk) level of radiation exposure has been established during pregnancy.

It is difficult, if not impossible, to predict the dosages of radiation a veterinarian would receive in her particular practice, as it depends on many variables ranging from how many radiographs she takes in a given time period, to the protection devices and procedures she uses, to the machine type and settings. However, one can estimate the dosages received in a practice by the use of film badges.

Film badges are small pieces of photographic

film worn as either clips, rings, or wrist badges for a period of time which can be calibrated for exposure in terms of gross blackening. The dose of radiation received can be measured as closely as 6 millirems of exposure, and the badge company[b] will send quarterly or annual exposure studies.[15]

By the use of film badges, a veterinarian could estimate the "average" amount of exposure she receives in a given period of time. Relating this to the doses which are known to cause problems to the unborn, she can adjust the amount of exposure she receives accordingly.

Efforts can be made to reduce exposure (in addition to the obvious precaution of taking fewer radiographs) and involve three general areas: 1) increasing the distance of the individual from the source of radiation, 2) reducing the duration and amount of exposure, and 3) use of protective barriers between the individual and the radiation source.[15] Distance from the primary beam is increased by using cassette holders, or preferably, the use of chemical and mechanical restraints in combination with self-supporting cassette holders. Various radiological techniques can be employed to reduce the duration and amount of exposure including the use of filters, collimators, and "faster" screen-type films. Protective barriers include lead aprons for partial shielding and lead glass windows that shield all of the body.[15]

It should be noted that the most susceptible stage of fetal development is the pre-implantation period which is the first eight to ten days after conception. Frequently, a woman does not know that she is pregnant at the time of pre-implantation. Hence, any female veterinarian who has the potential for being pregnant should practice as many precautions as possible when using radiographic equipment in the event she may be in the early stage of pregnancy.

## TOXOPLASMOSIS

Congenital toxoplasmosis starts as a fetal parasitemia and general infection that can have several outcomes. Spontaneous abortion or premature birth is possible, or some children are born live but manifest encephalitis at a few days to few weeks of age. Some are born with hydrocephalus, or it may develop later. Chorioretinitis in live-born infected children is common and there may also be fever, eruptions, hepatomegaly and splenomegaly. Sequelae of the infection while in utero can also include convulsions at birth or soon after. Other sequelae of the infection which may appear months or years later include neuropsychic retardation, chorioretinitis, hydrocephalus, microcephalia, epilepsy, and deafness.[16]

As serious as the disease is to the fetus, evidence shows that it is only a specific set of circumstances that lead to congenital infection. Intra-uterine infection can occur in any stage of pregnancy, but the most serious consequences usually result only when the mother acquires a primary infection (meaning she was seronegative prior to this) during the second trimester of pregnancy, and the fetus is infected through the placenta as a consequence of maternal parasitemia.[16] However, only about one-third of the females who acquire toxoplasmosis during pregnancy transmit the infection to their offspring.[17]

The woman who is already seropositive at the time of conception is immune to reinfection with toxoplasmosis, therefore, it poses no danger to her or her fetus, except in very few circumstances of chronic or recurrent maternal parasitemia.[16] Chronic parasitemia would already be present and would not be a problem that a pregnant woman would acquire in the practice of veterinary medicine. Therefore, the only women who need be concerned about congenital toxoplasmosis are those who are seronegative at the beginning of pregnancy.

A possible source of infection to veterinarians is *Toxoplasma gondii* sporulated oocysts present in the feces of cats. Cats shed the oocysts for approximately 2 weeks after initial infection,[18] and the oocysts are not infective until after sporulation which takes from one to five days.[19] Once sporulated, the oocysts are extremely resistant to physical and chemical factors and can survive in damp, shaded soil up to one year.[16] Human infection from oocysts most likely occurs from ingestion of the oocysts, which could probably be prevented by avoiding the handling of cat feces or by simple personal hygienic procedures such as washing one's hands after contact with cat feces and before eating.

However, another method of internalizing oocysts has been proposed in a retrospective study of an outbreak of toxoplasmosis among patrons of a horse riding stable. These in-

[b]RS Landauer, Jr and Co., Glenwood, Illinois. Searle Analytic, Inc., Des Plaines, Illinois.

vestigators speculated that the stable patrons may have inhaled oocysts (thought to have been excreted by infected cats) stirred up in dust by the horses in the enclosed arena.[19] If this is in fact a means of transmission, it could have implications for seronegative pregnant veterinarians working in dusty environments contaminated with cat feces such as dusty livestock barns, indoor horse arenas, livestock and horse show rings, sale barns, etc.

Another possible source of infection concerns veterinarians who are involved in meat inspection. One recent serologic study involving employees in a Brazilian abattoir pointed out that a relationship existed between the handling of meat and the prevalence of seropositivity. Of all the workers 72% were seropositive. But 92% of the meat inspectors were positive while only 60% of the corral workers were, hence the association with handling meat.[20]

Veterinarians who perform necropsies handle meat, brain tissue, diaphragms, and myocardial tissues that are preferential locations of true cysts which contain hundreds to thousands of infective bradyzoites. These cysts persist in infected animals for years and possibly for the entire lifetime of the host.[16] Although it is felt that almost all species of warm-blooded animals are susceptible to toxoplasmosis, the disease is more prevalent among cats, sheep, horses, and pigs. So extra preventive measures should be employed when performing necropsies on animals of these species.

One remote way a veterinarian might contract the infection involves ingesting the products of an ovine abortion,[21] as toxoplasmosis is one of the leading causes of sheep abortions. Since infection from bradyzoites probably occurs via ingestion, simple precautions can be employed to reduce the possibility of becoming infected from handling carcasses or aborted products of infected animals. Not wearing gloves, lab coats, or coveralls while eating helps, as does a thorough washing of one's hands before eating.

A pregnant veterinarian who is concerned about toxoplasmosis should have a blood sample drawn and a Sabin-Feldman dye test or the indirect immunofluorescent test[17] performed on the sample to obtain a titer of *T. gondii* antibodies. If she has a titer, she shouldn't have any concerns with respect to congenital toxoplasmosis and the practice of veterinary medicine. If she does not have a titer, she should be especially careful about personal hygiene particularly when handling aged cat feces, engaging in meat inspection, performing necropsies on species of animals who are especially susceptible to the disease, or examining sheep abortuses and aborted products. She should also be aware of the potential of inhaling *T. gondii* oocysts in dusty environments that could be contaminated with cat feces, and take necessary precautions like not entering such environments or wearing a surgical-type mask.

## LISTERIOSIS

If a pregnant woman contracts *Listeria monocytogenes* septicemia, one of several things may happen to the pregnancy. The fetus may die in utero, or parturition may ensue with delivery of a stillborn or acutely ill infant.[17] Infants born alive at birth often die of listerial septicemia within a short time or may be born with no apparent symptoms but develop meningitis within a few days to three weeks, a common sequela of which is hydrocephalus.[16]

The causal agent of the disease, *Listeria monocytogenes* can be isolated from many sources including several species of mammals and fowl, soil, plants, mud, pasture, manure, silage, and stream water; but the epidemiology is still not very well understood.[16] A few instances of human listeriosis have followed ingestion of contaminated milk or the inhalation of infected dust.[22]

Since there is a possibility of contracting the disease from infected animals and possibly from their secretions, a pregnant veterinarian should exercise caution when working with animals whose symptoms and clinical signs might point to listeriosis.

The animals most often affected by listeriosis are sheep, goats, cattle, and dogs (rarely).[16] The most common clinical manifestation is encephalitis in which the animals isolate themselves and show symptoms of depression, fever, incoordination, torticollis, spasmodic contractions, paralysis of the facial muscles and throat, profuse salivation, circling, and head pushing. In the final phase the fallen animals attempt to eat or make chewing movements.[16]

Abortion is also a symptom, occuring in the latter months of gestation and often without the dam showing any other symptoms. If a cow contracts listerial infection prior to the seventh week of pregnancy, the fetus usually dies and is often retained in utero for several days, giving it a macerated appearance when it is ex-

pelled. There may also be metritis and retained placenta associated with the abortion.[16]

As mentioned previously, the epidemiology is still not well understood, and some feel that listeriosis is a disease common to people and animals and not strictly a zoonosis.[16] It is probably wise, however, for a pregnant veterinarian to be aware that listeriosis in humans can have serious consequences to fetuses, and that there is a possibility of human infection from animals. Again, good personal hygiene such as frequent and thorough hand washing, wearing gloves while performing necropsies, wearing protective clothing such as laboratory coats or coveralls that are frequently laundered and not worn while eating, and wearing a surgical mask in some instances to prevent the possible inhalation of *L. monocytogenes* will decrease the chances of becoming infected. It is probably a good idea to exercise extra caution when working with *any* abortuses or aborted material when pregnant.

## CARBON MONOXIDE

Carbon monoxide is a colorless, odorless gas that is produced by inefficient combustion of any carbonaceous fuels. When inhaled, it quickly combines with blood hemoglobin to form carboxyhemoglobin, as hemoglobin has a much greater affinity for carbon monoxide than for oxygen.[23] Carboxyhemoglobin cannot carry oxygen and this lack of oxygen especially affects the fetus, which cannot increase its oxygen consumption.

High levels of fetal carboxyhemoglobin can therefore cause fetal anoxia which can have one of two outcomes: sudden fetal death and expulsion of the fetus; or a fetus that is live before birth but which is so stressed that the trauma of birth kills him/her.[24] Live-born offspring can develop neurological sequelae such as brain damage or mental retardation that can sometimes be so severe as to eventually be fatal.[23,24,25]

There is one situation in which veterinarians might find themselves where carbon monoxide might be a factor: while investigating the cause of late-term abortions in sows housed in a poorly ventilated, artificially heated farrowing house in the winter. It is possible that the heat source is, for instance, an LP gas radiant heater with the filter system by-passed and all the vents and ventilation systems closed to conserve heat, and large quantities of carbon monoxide being produced. If there is any possibility that the sows are aborting due to carbon monoxide intoxication, a pregnant veterinarian should not enter the farrowing house to investigate.

## PROSTAGLANDIN

Prostaglandins are drugs which are widely used for estrus synchronization of cattle, for aborting "mis-mated" pregnancies and for a host of other reproductive manipulations in animals.[26] $PGF_2$ is the analogue used in veterinary medicine because of its luteolytic activity.

The problem with $PGF_2$ preparations used in reproductive therapy is that in addition to their luteolytic activity, they also initiate smooth muscle cell contraction including the myometrial tissue of the uterus, and humans are especially sensitive.[27] This is compounded by the fact that they are readily absorbed through the skin.[28,29] The danger is that the product being handled could be spilled and absorbed through the skin causing myometrial contractions and labor. Labor can be induced in any stage of pregnancy,[30] causing abortion or causing the death of the fetus.[27] It is therefore recommended that pregnant women should not handle or administer prostaglandin products.[27,28,29]

## PHYSICAL EXERTION

The physical exertion involved in the practice of veterinary medicine (particularly in large animal practice) has the potential for adversely affecting a pregnancy. One possibility is that straining, especially a strong abdominal press in the last trimester, could cause the membranes to rupture. Ruptured membranes can induce premature labor, or if that doesn't happen, the fetus' primary defense mechanism against infection would be compromised, leaving the fetus and uterus much more susceptible to infection. This risk of straining causing membrane rupture is much greater in pregnant women who have an incompetent cervix.[31]

Another aspect of strenuous work during pregnancy is that it has been identified as a factor in the onset of premature labor.[32] This association has led to recommendations that any occupation subjecting the pregnant woman to severe physical strain should be avoided, and no work should be continued to the extent that fatigue develops. Women with previous complications of pregnancy that are likely to be repetitive (such as low-birth-weight infants and premature labor) should minimize such levels of physical work.[33]

## EXTERNAL TRAUMA TO THE FETUS

One other risk pregnant veterinarians encounter is that of external trauma to the fetus. This risk is especially prominent in large animal practices where such risks as being kicked by a horse, squeezed between a cow and a barn wall, or banged by a head-tossing horse or cow, exist.

The amniotic fluid normally absorbs most mechanical pressures and thereby protects the embryo from most external trauma, so it is generally accepted that congenital abnormalities caused by external injury to the mother are rare.[34] However, there was a documented case where a pregnant woman fell against a seat in a bus accident and later delivered an infant that had a skull fracture.[35] It has also been suggested that dislocation of hip and clubfoot may rarely be caused by mechanical forces, especially in the malformed uterus.[36]

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