

## Employment in Nuclear Medicine During Pregnancy

A nuclear medicine technologist typically has invested a great deal of time and effort in achieving her/his professional status—two or more years of college, two or more years of clinical experience, the anxiety and agony of registry examinations. Finding a good job, especially in today's troubled economic times, can also be challenging and difficult. It is perfectly understandable, therefore, that technologists will be anxious and apprehensive about anything that threatens their job security.

### AN ECONOMIC DILEMMA

You are pregnant now, or you are planning to become pregnant in the near future. How will your pregnancy affect your ability to do your job as a nuclear medicine technologist? How will your job affect your pregnancy? You're a little nervous about eluting generators, reconstituting kits, and preparing therapy dosages, but you are the only technologist in a small clinic—how can you continue to do your job but still reduce your unborn's radiation dose?

Perhaps you are the supervisor of a pregnant technologist. Can she continue to perform her usual duties without adversely affecting the pregnancy? What changes can be made to reduce her radiation dose if she is concerned about certain high-dose duties she usually performs? If she is so nervous about radiation exposure during pregnancy that she can't perform most of her routine duties and there's no way for you to shift her duties to other technologists, can you fire her and hire a replacement?

These are tough questions. The answers to them are difficult, not clear-cut, and different for every affected technologist or supervisor. There isn't a checklist that we can go through to come up with a solution. Each technologist and each supervisor must grapple with these questions to arrive at a mutually acceptable redefinition of the technologist's job description for the duration of the pregnancy. This commentary will provide background information on current estimates of radiation risks to the unborn, a brief description of the current positions of advisory and regulatory bodies, and recommendations for technologists and supervisors in addressing the issue of the pregnant nuclear medicine technologist.

### RADIATION AS AN ADDITIONAL RISK FACTOR DURING PREGNANCY

Pregnancy and motherhood are so romanticized in our modern culture that we tend to forget that pregnancy is a condition requiring medical supervision and that adverse effects can occur in both the mother and the unborn. Exposure of a pregnant woman to the German measles can lead to cataracts, microcephaly, and deafness (1). Mothers who took diethylstilbesterol during pregnancy begat daughters who developed a high prevalence of vaginal cancer at a young age (2). The incidence of genetic abnormalities such as Down's syndrome increases with increasing age of the mother (3). Pregnant women are at increased risk of high blood pressure, intestinal complaints, and other serious complications themselves (4). The unborn can become tangled in the umbilical cord and can die in utero (4). But too often these well-known risks of pregnancy are forgotten or underestimated in the romantic glow of becoming a parent. Table 1 summarizes the more important risks of pregnancy to all women.

A nuclear medicine technologist is exposed to a broader range of attacks on her pregnancy simply because she works (5) and additionally because she works around patients (6), and these additional risks should be considered in relation to those listed in Table 1 for a non-health care worker. Back strains may occur more easily in a woman whose pregnancy is far enough advanced for her stomach to interfere with her normal lifting techniques. A technologist is on her feet a large fraction of the day, which can aggravate back problems and can exacerbate the retention of fluids in the legs and ankles. The pregnant technologist could be exposed to a variety of infectious organisms that can cross the placental barrier or cause systemic problems in the mother that adversely affect the unborn.

You've just decided to become pregnant for the first time; you've answered the obvious questions, such as "Is there enough money to afford a child?" and "Is there room enough in the apartment or house for a child?" As with any working woman, the impact of your pregnancy on your job, and your job on your pregnancy, will arise as a concern. The first work-related question that popped into your mind was probably whether the radiation to which you are exposed during your usual duties will cause any problems for your unborn child. Questions about the risk factors cited in the previous two paragraphs probably didn't occur to you until much later, if ever.

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**TABLE 1. Complications Arising During Pregnancy in the Absence of Occupational Exposure to Radiation**

Condition	Occurrence Rate in All Pregnancies (%)
Unspecified abnormal condition (20)	40
Abnormal placenta (20)	30
Anemia (20)	26
Toxemia (20)	24
Vaginal bleeding (20)	24
Fetal death (after 8th week of gestation) (21)	10
Fetal death during labor & delivery (22)	0.4
Stillbirths (20)	1-4
Malformations (20)	2-4
Breech deliveries (4)	3-6
Premature rupture of fetal membrane (4)	5
Neonatal death (21)	12

Yet all of the scientific evidence tells us that the small radiation dose you receive as a well-trained, safety-conscious nuclear medicine technologist adds only a tiny amount of additional risk to the much larger inherent risks of pregnancy, risks of which most women either are not aware or consider acceptable.

Most of the advisory bodies discussed in the next section recommend that the unborn be exposed to no more radiation than an individual member of the general public, i.e., 0.5 rem (5 mSv). Radiation delivered to the uterus and the unborn during pregnancy can cause four categories of injury at sufficiently high doses. These effects have *not* been observed at the recommended 0.5 rem or less level (7).

### Spontaneous Abortion

If the conceptus is irradiated with large doses during the preimplantation period, it is highly likely that it will die and will be spontaneously aborted. The mother probably would not even know that an ovum had been fertilized. At lower doses, the pregnancy usually proceeds normally and concludes with a normal child. This is the so-called all-or-none effect.

### Malformations

There is a very short period of time (approximately the second to fourth weeks of gestation) during which the fetus is particularly sensitive to radiation (8). Large doses delivered during this time may cause abnormal development of the central nervous system (such as microcephaly and exophthalmia), polydactyly, and other detectable mishaps. Increases in the dose cause increased severity of the abnormality at high doses, but *none* of these effects has been found at occupational dose levels.

### Reduced Intrauterine Growth Rate

Irradiation after the period of major organogenesis does not result in morphologic abnormalities, even at high doses. The

major effect of radiation during the late stages of pregnancy seems to be mildly decreased birth weight and head size. It is interesting to note that these conditions are observed in mothers who drink alcoholic beverages and smoke cigarettes during pregnancy.

### Postnatal Cancer

Acknowledging that the human data are controversial, the BEIR III report (9) adopted risk estimates of about 50 excess fatal cancers per million exposed children per year per rad. The increased risk appeared to last for about 10-12 years after birth. Leukemia and solid tumors were about equally likely. For comparison, the natural incidence of leukemia is about 235 per million single births.

The risk of abnormalities appearing in the newborn child as a result of low-level in utero radiation is essentially the same as is observed in women who have not been exposed to radiation (8,10). If there is additional risk, it is small and most radiation experts consider it to be negligible and therefore acceptable. Is this an acceptable risk to you? No one can answer that question for you, because your system of deciding what is risky is going to be different from mine, from your supervisor's, from your Radiation Safety Officer's (RSO's), and from a governmental regulatory body. For example, you may feel that sky diving and hang gliding are perfectly safe—I would disagree strongly! What I can tell you is that numerous national and international radiation advisory bodies have concluded that the small additional risk from your controlled occupational exposure to radiation is negligible compared to the inherent, natural risks of pregnancy.

## RADIATION PROTECTION PHILOSOPHIES AND GUIDELINES

### ALARA

The harmful effects of radiation were discovered very soon after the discovery of x-rays and natural radioactivity. Early radiation safety experts assumed, to be on the safe side, that the effects of radiation might be cumulative and that even small amounts might be harmful if received repeatedly. Modern radiation biologists have affirmed the wisdom of these assumptions, resulting in the current philosophy of allowing a person to be exposed to radiation only if the benefit from the exposure exceeds its risk.

The current embodiment of this philosophy is ALARA, which stands for *as low as reasonably achievable*, taking social and economic concerns into account (11). From a practical standpoint, ALARA means that some minimal amount of risk is associated with any given task involving radiation and that any amount of radiation above that level is unnecessary and should be reduced. It is not possible to work with radiation every day and receive zero dose. In fact, reduction of dose below some minimum level may not be possible at all, regardless of what additional resources are used. ALARA simply means that radiation doses to workers, patients, the public, and the environment should be kept as low as possible, but that additional resources should not be expended to further reduce doses if the benefit to be achieved by that reduction is

not large enough to justify it. All of the documents mentioned in the remainder of this section are based on the ALARA philosophy.

### **ICRP Publication 26**

In 1977 the International Commission on Radiological Protection (ICRP) concluded a complete revision of its basic radiation protection recommendations by publishing ICRP Publication 26 (12). The ICRP affirmed its support of the ALARA concept (see previous subsection). It determined that the total effect of the radiation doses from external irradiation and from irradiation by radionuclides contained in the person's own body must be considered; in the past, only external irradiation was subjected to numerical radiation protection guidelines. ICRP Publication 26 further recommended that a pregnant mother not receive doses in excess of 30% of the 5 rem annual guideline, or 1.5 rem (15 mSv). No specific guideline was given for uterine dose.

The Environmental Protection Agency (EPA), which is the lead agency for establishing federal radiation protection guidance, recommended in a Proposed Rule that most of the concepts embodied in ICRP Publication 26 be adopted (13). A noticeable exception was the guidance for exposure of the pregnant worker and the unborn, in which instance EPA selected the NCRP Report No. 39 recommendation (next subsection).

### **NCRP Report No. 39**

All current federal radiation protection regulations are based on this 1971 report (14) of the National Council on Radiation Protection and Measurements (NCRP). NCRP Report No. 39 recommended that the unborn not receive more than 0.5 rem (5 mSv) during the period of gestation. The NCRP further stated that the increased risk due to an accidental dose of 5 rem (50 mSv) was not sufficiently great for a physician to recommend a therapeutic abortion. The NCRP felt that there was enough increased risk at doses above 10 rem (100 mSv) that the risks of continuing the pregnancy (relative to effects that might be expressed in the newborn) should be carefully discussed with the mother and that therapeutic abortion should be considered. NCRP Reports 53 and 54 (7,15) affirmed the recommendations of NCRP Report No. 39 and provided an amplified discussion of radiation risks during pregnancy.

### **United States Nuclear Regulatory Commission Regulations**

Recommendations of the ICRP and the NCRP are of the "thou shouldst" variety, whereas federal and state regulations are of the "thou shalt" variety. The Nuclear Regulatory Commission (NRC) is the only federal agency that establishes radiation protection regulations. The NRC publishes its radiation protection guidelines in Part 20 of Title 10, Code of Federal Regulations (10 CFR Part 20). The current Part 20 does not contain any reference to exposure during pregnancy. The NRC staff position on this subject was first published in NRC Regulatory Guide 8.13 (16), but Regulatory Guides are not regulations—they are only suggestions of policies that NRC staff finds acceptable. Most licensees had already adopted the recommendation of NCRP Report No. 39 prior to the publication

of Regulatory Guide 8.13.

On January 9, 1986 (17), the NRC proposed a complete revision of various parts of Title 10, including Part 20, to bring NRC regulations into alignment with the Proposed EPA guidance, which in turn was based on ICRP Publication 26. A new paragraph 20.208 is proposed, which would adopt the NCRP Report No. 39 recommendation of 0.5 rem dose to the unborn during the entire gestational period. This is considered to be a noncontroversial portion of the Proposed Rule and is expected to appear unaltered in the Final Rule, which will probably be published in late 1986 or early 1987.

## **MINIMIZING RADIATION EXPOSURE FOR THE PREGNANT TECHNOLOGIST**

You are pregnant, or you expect to be soon, and you wish to continue working as a nuclear medicine technologist throughout the pregnancy. What should your employer do in terms of counseling you about your decision, and how should the employer modify your working conditions to assure him and you that your radiation exposure will be consistent with the ALARA concept and within the NCRP's 0.5 rem guideline? What can you do as an individual to reduce your own radiation exposure? What are the employer's responsibilities to the technologist, and what must the technologist do to assist the employer in carrying out those responsibilities? My recommendations are as follows.

### **The Employer's Responsibilities**

The employer has three main responsibilities to any pregnant worker exposed to working conditions that could endanger the pregnancy: discussion of the risks involved, modification of the working conditions or duties (if necessary or if desired by employer or employee), and monitoring of the modified working conditions to assess their effectiveness. The technologist's role in this process is central and vital and will be discussed more fully in the next subsection.

**Discussion of risks.** Every nuclear medicine technologist should receive training in the risks of in utero irradiation of an unborn child (18,19). This training should occur during the initial classroom portion of the two-year technologist schooling and at least annually during technologist inservice education sessions; the inservice training should be along the lines suggested in Regulatory Guide 8.13 (16). All nuclear medicine technical personnel should attend, including supervisors, as all of the employees will be affected in some way by the modified work rules that are implemented to accommodate a pregnant technologist. A technologist should therefore have at least an acquaintance with the risks to a pregnancy of working with radiation at the time she is making the decision about whether or not to become pregnant (or to forego birth control techniques and thus not protect against becoming pregnant).

I recommend that the technologist who becomes (or intends to become) pregnant be asked to participate in an hour-long meeting with her supervisor, the physician in charge of the nuclear medicine clinic, a nuclear medicine scientist knowledgeable in the effects of in utero irradiation, and (optionally)

the institution's Radiation Safety Officer. The following topics should be discussed in sufficient depth to provide the technologist with a sound basis for a decision about continuing to work while pregnant.

*Risk perspective.* The risks of being pregnant in the absence of radiation and the incremental risk of radiation should be explained. The technologist should be encouraged to ask questions and each question should be answered as fully and honestly as possible. If an answer is not known, someone should find the answer later and convey it to the technologist. The depth and breadth of this discussion of risks will depend on a number of factors, but the most important is probably the technologist's anxiety. Some technologists are very anxious about being exposed to any radiation, and others find the risks acceptable after only minimal explanation. Enough time must be allowed so that all of the technologist's concerns can be aired and resolved.

*Exposure history.* The technologist's monthly radiation exposure history should be reviewed by the RSO and other employer representatives before this meeting. In a safety-conscious clinic that actively practices the ALARA concept, the average technologist should be receiving on the order of 20–30 mrem per month whole body dose; the most heavily exposed technologist should only occasionally exceed 40 mrem. The purpose for reviewing the exposure history is to determine whether any extraordinary work rule changes might be necessary.

Nine months of exposure at the 20–40 mrem level would yield a total dose to the mother of 0.18–0.48 rem and a much smaller dose to the uterus. Are changes in work rules called for if the technologist's doses are already below the 0.5 rem guideline? Work rule changes are discussed more fully below, but it should be noted here that most pregnant technologists prefer to avoid working with therapy patients and as the radiopharmacy technologist.

*Analysis of duties.* This part of the discussion may be very short in the one-technologist clinic—if she continues to work during pregnancy, she continues to do everything that must be done. There may be little flexibility for shifting duties to another person temporarily. Every effort should be made to accommodate the technologist's concerns. If the technologist's concerns can't be satisfactorily addressed, the specter of potential sexual discrimination begins to rear its ugly head and the employer's personnel department and its Equal Employment Opportunity (EEO) counselor should be consulted immediately. Sexual discrimination litigation is a fairly recent phenomenon, so there is very little case law and precedent to guide us. A good first approximation is for the employer to put himself in the technologist's shoes and ask himself how he would like to be treated. Larger clinics with many technologists usually have far less trouble adjusting to the need for modified work rules. The supervisor should be prepared to discuss at this meeting the duties the technologist would have performed if not pregnant. This analysis may be easy in the clinic where everyone does the same job year round, or it may be more involved if technologists rotate among the various work areas of the clinic.

*Potential modification of duties.* Up to this point the meeting should have been relatively noncontroversial and straightforward, as the topics have been science, scientific opinion, history, and a job analysis. Now this information must be assimilated by the technologist and the employer in order to decide on what duty modifications would be acceptable to both parties. The discussion becomes subjective rather than objective, emotional rather than logical, and potentially frustrating when issues are difficult to resolve. All of the participants must make a conscious effort to make sure this informational meeting doesn't degenerate into an angry confrontation. The technologist should be asked to discuss her concerns about her routine duties in light of the pregnancy. Most technologists would prefer to avoid handling therapeutic quantities and eluting generators and preparing radiopharmaceuticals from kits; many prefer to not inject large activities of diagnostic radiopharmaceuticals. As discussed earlier, these changes will probably be easy to accomplish in a large clinic and difficult in a small clinic.

The meeting should conclude with one of three possible outcomes: 1) employer and employee both agree on modifications to duties; 2) employer and employee agree on basics, but a few minor issues remain to be resolved later; or, 3) the employer is unable to accommodate one or more major concerns of the technologist. In all three cases, a document should be prepared by the employer that describes the meeting, lists the attendees, and summarizes the important points of agreement and disagreement about modification of duties. This document should be signed by the nuclear medicine physician and the technologist, and a copy should be provided to the technologist, the supervisor, the hospital's Radiation Safety Committee, and the personnel department. The document should be prepared after the duty modifications are resolved or within two working days, whichever is earlier. When major disagreements occur and attempts at reconciliation prove futile, documentation of the unresolved questions should be sent to the personnel department and the EEO official for resolution. Legal counsel may be needed to establish each party's rights and obligations, and this is clearly beyond the scope of expertise of most nuclear medicine physicians, scientists, and technologists.

*Modification of working conditions and duties.* The ALARA philosophy applies not only to individual doses, but also to collective doses, i.e., the total dose received by all of the people working in the nuclear medicine clinic. Releasing a pregnant technologist from her usual duties in the radiopharmacy will reduce her radiation burden, but the other technologists will be forced to assume not only her reassigned duties but also her radiation burden. Care must be taken by the supervisor that the total collective dose of all technologists does not increase significantly during the pregnancy of one of the technologists. The following recommendations are based on a desire to reduce the pregnant technologist's doses even lower than her current levels and to minimize the chances that she might be involved in an accident that would deliver unusually high doses. These recommendations are my professional opinion, and as such they may differ from those of other health

physicists, RSOs and regulatory bodies. But they have all been tested clinically, and all of the technologist pregnancies with which I have been associated have ended in full-term pregnancies and normal babies.

**Modification of duties.** In our large clinic (10 technologists qualified to do imaging), we routinely remove a pregnant technologist from any duties involving the handling of therapeutic dosages, the elution of generators and preparation of radiopharmaceuticals from kits, and the injection of diagnostic dosages above 15 mCi of  $^{99m}\text{Tc}$ . She is expected to continue to carry her share of the workload; we have not encountered any difficulties so long as her attitude reflects her intent to do so. Goldbrickers, laggards, and sloughers are not tolerated, whether pregnant or not. Appropriate minor adjustments in duties may be necessary late in the pregnancy when the belly starts getting in the way or if medical complications arise.

A small clinic has very limited flexibility to modify duties, especially if there is only one qualified nuclear medicine technologist. If the nuclear medicine clinic is affiliated with a radiology clinic, perhaps an x-ray technologist could be cross-trained and assigned on a part-time basis. Many small clinics use unit-dose radiopharmaceuticals from centralized radiopharmacies, and they usually do not perform radionuclide therapy. When this is the case, it should not be difficult to find another qualified technologist or nurse to assist with injections of large dosages.

**Use of protective equipment and clothing.** Some of the following recommendations are required by regulation or license conditions, but they are all consistent with an aggressive ALARA Program.

- **Shielding.** Generators should be stored in the customized lead shield provided by the manufacturer, and this assembly should be surrounded by enough lead bricks so that no portion of the torso of a radiation worker can receive a dose rate of more than 2 mrad/hr, including during elution. Generator elution vials should be placed into a lead or lead glass vial shield before elution and should be removed only for the initial assay in the dose calibrator and for disposal after at least overnight decay.

Radiopharmaceutical kit vials should be kept in a vial shield at all times except during the initial dose calibrator assay. When radiopharmaceuticals must be prepared in a way that doesn't allow the use of a vial shield (e.g., sulfur colloid, leukocytes, in vitro RBCs), the work area should be surrounded by lead bricks. Lead shields with lead glass windows should be used for all manipulations of radioactive materials. Waste storage areas should be shielded well and should not cause radiation levels of greater than 2 mrad/hr at any normally accessible location.

Vial shields are almost universally accepted, but syringe shields are more controversial. Syringe shields should always be used when bulk quantities of radioactive material are being handled, such as in the preparation of radiopharmaceutical kits. They should be used during quality assurance testing and as much as possible during the injection of patients. Some syringe shield designs are poor, but the experience in most clinics committed to the use of syringe shields is that the vast

majority of injections can be performed with syringe shields if the technologist makes the extra effort to become proficient using them. But the patient shouldn't be subjected to a lot of fumbling around and multiple sticks if the veins are simply no good. Furthermore, when small volumes of a radiopharmaceutical are drawn up into large syringes, most of the radiopharmaceutical will be in the shaft of the needle and in the needle hub, both of which are completely unshielded in most syringe shield designs. The judgment must be made individually on each patient whether or not to remove the syringe shield when the injection is difficult.

Syringes drawn from multidose vials should be mounted in a syringe shield at all times except during dose calibrator assay. If the syringes must be carried from the radiopharmacy to any other room, they should be carried in a lead syringe carrier; these are made in single syringe or multisyringe models.

- **Protective clothing.** The purpose of protective clothing in nuclear medicine is to minimize the internal deposition of radioactive materials by absorption through the skin. Laboratory coats should be worn at all times, and they should be fully buttoned whenever working around patients or liquid radioactive materials. Disposable gloves should be worn on both hands when handling syringes, urine, stock vials, waste, or incontinent patients, especially during injection. Surgical masks and footcovers are rarely needed, except that footcovers should be used when cleaning up after a spill.

Lead aprons are only minimally effective at reducing the radiation from  $^{99m}\text{Tc}$  and the other common radionuclides. Most contain 0.25 mm Pb, and a few contain 0.5 mm Pb. The major drawbacks to wearing a front-only apron are an unprotected backside, a minimally protected frontside, and a sore back from the unbalanced weight. In fluoroscopy the apron is worn only during the actual procedure, so it is worn for only a few hours per day. In nuclear medicine, however, radioactive patients are around all day long and therefore the apron must be worn all day long. If the pregnant technologist elects to wear a lead apron, use a 0.5 mm Pb apron that covers front, back, and sides.

- **Ventilation.** All handling of gases and large activities should be performed inside a 100 linear feet per minute or greater fume hood and in a well-ventilated laboratory. Radiopharmaceutical vials, especially sodium iodide, should be opened only in a fume hood and behind an L shield. Radioactive gases should be stored and handled in a fume hood.

If radioactive gases used in pulmonary ventilation or regional cerebral blood flow studies are vented directly to the outside of the building, a pregnant technologist should not handle the large balloon-like bags that are still occasionally used to collect exhaled gas. A charcoal gas trap should be used when the gas is to be collected and retained for decay. The alarm circuit on the gas trap should be functional and its proper operation should be verified periodically.

- **Radiation protection principles.** Continually remind the technologist of time, distance, shielding, and contamination control. *Time* should remind her to plan ahead so that she spends the least amount of time near radioactive materials and

radioactive patients. It may mean a reduced work day or being removed temporarily from the emergency call roster. It also means doing as much manipulation of the patient as possible before the administration of the radiopharmaceutical, e.g., for a gated cardiac study the ECG electrodes should be applied while the stannous pyrophosphate is tinning the erythrocytes. *Distance* means using 12 in. forceps rather than tweezers or her fingers. She should sit as far away from the patient as feasible during imaging. When transporting waste, she should use a cart rather than carrying it by hand. *Shielding and contamination control* were discussed in earlier paragraphs.

- *Miscellaneous.* Consider switching temporarily to unit-dose delivery from a centralized radiopharmacy instead of in-house preparation. Minimize the use of flood phantoms and SPECT phantoms that are used with the collimator on and with 20–30 mCi of  $^{99m}\text{Tc}$ . Consider performing the daily field uniformity quality control tests with the collimator off and a point source of 100  $\mu\text{Ci}$  positioned five crystal diameters away.

*Monitoring for effectiveness.* The employer must assure himself that all of the modified working conditions and duties are in place and are being faithfully observed. The employer can be reasonably confident that the modifications suggested by the pregnant technologist will be observed by her, but some may be out of her control. Some of the modifications may have been requested by the employer, so compliance may be less assured. During pregnancy the whole-body film or TLD badge should be worn at waist level to give a more accurate picture of the radiation exposure of the abdomen. An abdomen badge should be used as a supplement if the technologist or the RSO wishes to retain the use of a collar badge. This becomes especially important if the nuclear medicine technologist also performs fluoroscopy. A collar badge worn outside the lead apron must not be used to estimate uterine dose.

Self-reading pocket dosimeters are not recommended because of their inherent inaccuracies and design problems. Every pocket dosimeter loses charge naturally, even in the absence of radiation, and the loss of charge will appear to be a real radiation dose. A more unmanageable problem is the tendency of pocket dosimeters to discharge partially or completely if they are dropped on the floor or subjected to a strong bump.

### The Employee's Responsibilities

The employee who is or intends to become pregnant has three important responsibilities to herself and to her employer.

*Notification to supervisor.* A good employer will wish to do everything reasonable to help you have an uneventful pregnancy and a healthy child, but he can't initiate any necessary changes until he knows you are pregnant. You must (by reason of logic, not because of regulations) notify your supervisor immediately upon receiving medical confirmation. I recommend preliminary discussions as soon as you decide that you are going to attempt to become pregnant; work changes probably won't be made right away if you are not yet pregnant, as pregnancy may take months or even years to accomplish. For your own protection, you should keep a written record of when you notified your supervisor of your pregnancy.

*Compliance with modifications of working conditions and duties.* The person most concerned about your pregnancy, your unborn child, and your general welfare is you. Your supervisor, fellow technologists, and friends also are concerned about you, but only you are in a position to insure that you are doing everything possible to make the pregnancy proceed normally and healthily. Both from a selfish viewpoint and from a legal stance, make sure you adhere to every radiation safety rule and to every special requirement that your employer has imposed. Insist that your supervisor hold up the employer's end of the deal. Document any serious instances where the system breaks down. This need not and will not deteriorate into an adversary relationship if everyone keeps in mind that the ultimate goals are a healthy child and mother and top quality patient care.

Your employer cannot insist that you take advantage of prenatal medical care, but it would be foolish of you to refuse it. Many of the problems encountered during pregnancy (Table 1) can be eased or eliminated if detected promptly. If you are worried about the small additional risk of radiation, you should be even more concerned about eliminating nicotine intake and reducing alcohol intake, both of which lead to smaller babies. You should eliminate use of marijuana, cocaine, heroin, and all other illegal drugs. Tell your obstetrician that you work with radiation, but keep reminding yourself that reduction of your exposure to radiation is only one of a large number of actions you can take to help yourself have a healthy baby.

*Interactions with fellow technologists.* Your fellow technologists are probably your friends, but even friends get angry at each other from time to time. The people who are having to take on the extra duties from which you have been excused are going to be aware of that extra burden every day, and when they have bad days they may resent your special treatment. Every morning, when you come to work, tell yourself that a lot of people are being very nice to you and that you should show your appreciation for their kindness at every opportunity. A frequent "thank you," an occasional cake or doughnuts for the group, or for someone who is extra nice will ease any tension and acknowledge your appreciation.

### CONCLUSION

A nuclear medicine technologist can work throughout a pregnancy with high confidence that her occupational radiation exposure will not add any significant risk to her chances of having a normal pregnancy and child. All that is required is for the employer to provide an ALARA work place and for the technologist to observe carefully all radiation safety guidelines and to maintain her occupational exposure ALARA. Current guidance is that the total uterine dose during gestation be less than 0.5 rem (5 mSv). The vast majority of nuclear medicine technologists can achieve this dose level easily, with no modifications of duties or work practices. Technologists working with generators and radiopharmaceutical kits may wish to temporarily transfer to other duties within the clinic, not necessarily to reduce routine exposures but to minimize the chances of an accident having high-dose or high-

contamination potential. All of the available human data show that there is small additional risk to the fetus or neonate due to occupational radiation exposure compared to naturally occurring risks so long as the dose is within recommended guidelines.

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