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Reproductive Effects of Occupational Exposures

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Family physicians are often asked to advise the pregnant patient on the feasibility of continuing to work. The physician must be aware of reproductive hazards in the workplace, as well as the employment laws now in effect or being considered. Useful information can be found in the guidelines on pregnancy and work prepared by the American College of Obstetricians and Gynecologists. Many toxins may affect the reproductive functions of both men and women.

The term "occupational disease" most often brings to mind acute illnesses, visible changes (such as dermatitis) or diseases that may develop late in life, such as cancer or respiratory disorders. The impact of various occupations on reproductive capacity is only now beginning to be delineated by studies of workers with common exposures. The effects in terms of societal costs and human suffering at least equal and possibly surpass those of chronic disease development in middle and old age.

Employment Trends

U.S. Department of Labor statistics for 1978 show that about 80 percent of men aged 18 to 64 are employed, and this percentage has remained relatively stable since the end of World War II. In contrast, the number of employed women has been rising continuously since the 1940s. Last year, for the first time, more than 50 percent of all women aged 16 to 64 were employed outside the home. In addition, nearly 60 percent of women bearing

their first child were employed during at least six months of their pregnancy; 25 percent of women bearing second, third and subsequent children were also employed. With the expansion of flexible work schedules and child-care facilities, the number of working women of childbearing age will continue to rise in the foreseeable future.

In addition to these trends in employment, new attitudes toward pregnancy have emerged. More women are determining the timing of their pregnancies, and those who choose to remain employed are seeking more information about the effects of their work on their own health and the health of their unborn children. Recently, men have begun to demand more information on the effect that their work may have on their ability to father healthy children. Increasingly often, the family physician may be asked about the reproductive hazards of occupational exposures.

Pregnancy and Work

In the past, the belief that pregnant women were unable to work led to company policies terminating employment at a certain point in pregnancy. Such rules are no longer medically or legally justifiable. The pregnancy disability amendment to Title VII of the Civil Rights Act of 1964 now bars disparate treatment of pregnant workers for all employment-related purposes. Specifically, it requires that pregnancy and childbirth be given the same status as any other temporary disability under all fringe benefit plans. The law prohibits employers from terminating or refusing to hire

or promote a woman solely because she is pregnant, and it bars mandatory leaves that are arbitrarily set at a certain time in pregnancy rather than based on ability to work. Finally, the law protects the reinstatement rights of women on leave for pregnancy-related reasons, including accumulated seniority and accrued retirement benefits.

Termination of employment during pregnancy is a woman's option, but it is rarely a health necessity. Any decision about the capacity of a pregnant woman to continue working should be made jointly by the woman and her physician, after each has evaluated the job requirements and the possible hazardous exposures in her workplace. It is important that both the physician and the patient obtain accurate information from the employer. Vague statements from a physician that "all chemicals are to be avoided" are of no use to anyone. Worker anxiety and loss of wages do not constitute optimal patient management.

In 1977, the National Institute of Occupational Safety and Health (NIOSH) funded a study to develop guidelines on pregnancy and work. A group of occupational physicians and obstetricians concluded in its report that: "The normal woman with an uncomplicated pregnancy in a job that represents no greater potential hazards than those encountered in normal daily life in the community and home may continue to work without interruption until the onset of labor, and may resume working as early as several weeks after an uncomplicated delivery."

This recommendation applies to normal, healthy women with no known exposure to demonstrated toxins and takes into account the known physiologic changes that occur in pregnancy. In more than 90 percent of all pregnancies, the cardiovascular, pulmonary and endocrine changes, as well as fatigue, nausea and musculoskeletal complaints, need not be disabling, according to the Amer-

ican College of Obstetricians and Gynecologists (ACOG).

PERIODIC REAPPRAISAL

Certain environments may present particular concerns to pregnant women. The recognized hazards of the patient's workplace must be considered in the course of regular prenatal care. Reliable information about these hazards may warrant: (1) continued employment with no modifications; (2) continued employment with specific modifications, or (3) a recommendation not to work.

In terms of time lost and administrative effort required, the work modifications suggested for a pregnant employee with a complicated pregnancy or a hazardous work environment can be likened to those suggested for men after some common procedures, such as hernia repair or prostatectomy, or after a myocardial infarction.

For a woman who wants to continue working, recommended modifications may be re-evaluated at every subsequent prenatal visit and altered as indicated. The importance of regular periodic prenatal care cannot be over-emphasized. Ideally, this periodic reappraisal, with feedback to managers in the workplace, can smooth the process of altering working conditions during this temporary period—if any modifications are necessary. Neither a specific diagnosis nor any confidential details of the patient's medical status need be made available to employers. However, appropriate recommendations on working status should be specific and concise.

FACTORS OUTSIDE THE WORK ENVIRONMENT

All men and women should be made aware that certain factors independent of the work environment, such as lack of exercise, smoking, excessive use of alcohol, use of certain medications and poor nutrition, constitute major hazards to an optimal outcome of pregnancy in normal women. The effects of

these factors, including fetal wastage, low birth weight, prematurity and congenital defects, are as serious as those of known occupational hazards.

Susceptibility to Environmental Factors

The full range of possible effects of environmental agents on reproduction is still unknown. The rates of reproductive events in the general population are used as a yardstick to estimate increased risks. Background data indicate that up to 30 percent of all fertilized ova never implant in the uterus, that spontaneous abortions occur in 15 percent of all pregnancies and that 7 percent of all newborn infants have some form of birth defect. These estimates must be kept in mind in gauging the possibility of increased risk to certain workers and their spouses.

Because of skewed exposure and monitoring patterns in the past, the possible health effects of most environmental agents have been more clearly defined for one sex than for the other. Often, it is assumed that an ex-

posure is more hazardous to one sex when in actuality its effects on the other sex have not been investigated.

The human reproductive system is susceptible to environmental factors at six stages (Figure 1). A physician should consider all of these stages of susceptibility before labeling a substance as "safe" or "hazardous" in relation to the reproductive capacity of men or women.

EFFECTS ON OVA AND SPERM

In the first stage of susceptibility to environmental factors, the production or release of adequate numbers of viable sperm or ova may be affected. Women, of course, are born with a full complement of ova, whereas men continue to undergo spermatogenesis throughout their lives. The effects of exposure to substances that can reduce sperm production may be detectable as soon as four to five weeks after the exposure. With some of the toxins, the impaired spermatogenesis has been shown to be reversible. Many other

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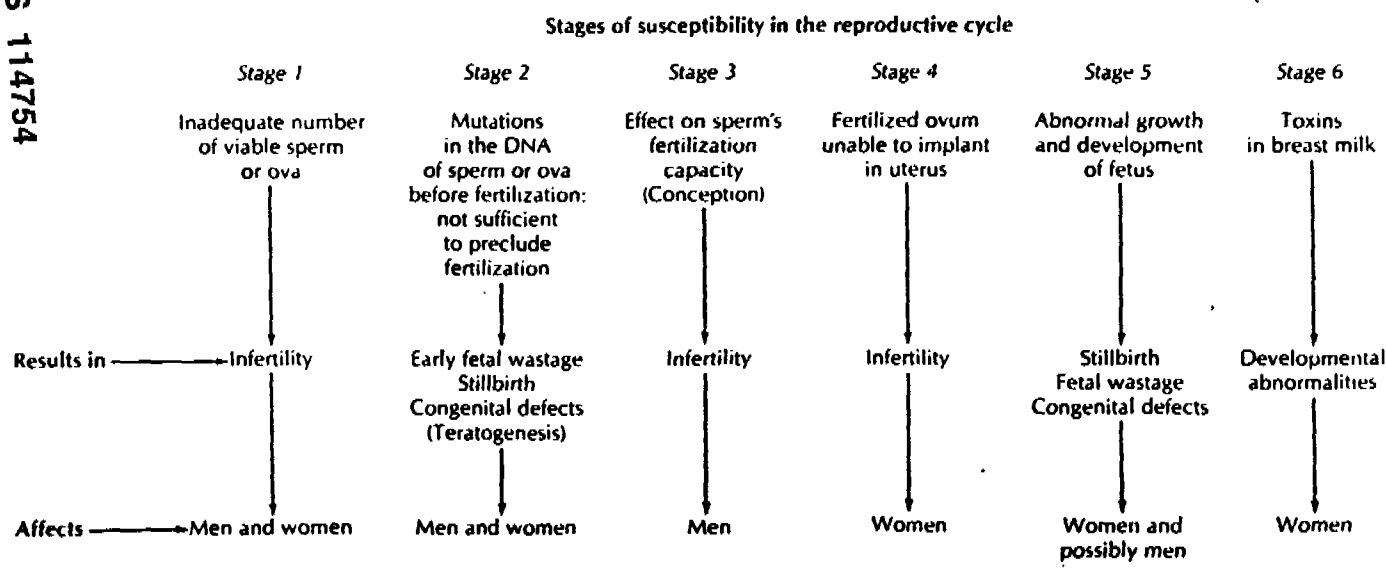


FIGURE 1. Mechanisms of adverse reproductive outcomes.

toxins are now being evaluated, but the data are not yet complete. Dibromochloropropane (DBCP) is an example.

In the second stage, mutations or chromosomal damage may occur in the ova or sperm before fertilization. These alterations in the genetic material may not be sufficient to prevent fertilization but may cause early fetal wastage, stillbirth or congenital defects. This may be the case in exposures to vinyl chloride and to waste anesthetic gas.

In the third stage, environmental factors may interfere with fertilization itself. For example, fertilization may be prevented by a toxic effect of the secretions in the male reproductive tract. Substances that are known to be secreted into the seminal fluid include alcohol, steroid hormones, pesticides, narcotics and certain antimicrobial agents. The possibility of a significant transfer of these substances to the female, through ejaculation, is currently being investigated. Other factors that may prevent fertilization are changes in sperm morphology or motility. Smoking affects sperm motility.

EFFECTS ON IMPLANTATION AND FETAL DEVELOPMENT

In the fourth stage, implantation of the ovum in the uterus may be prevented by a hostile local chemical environment. Some toxins may be secreted into the endometrial

tissue; this may explain the reduced fertility noted in women exposed to trichloroethylene.

In the fifth stage, environmental toxins may impair the growth and development of the embryo through maternal-fetoplacental effects. The teratogenic potential of organic mercury compounds is an example. Concerns about possible male-mediated teratology through exposure from handling work clothes brought home or from contaminated ejaculate are being discussed and litigated, but little scientific evidence is available.

The early weeks of pregnancy are a particularly vulnerable period for the embryo. The placental barrier is immature, and the embryo contains few cells with rapid rates of proliferation and a higher proportion of undifferentiated cells. Also, normal development during this period requires precise temporal-spatial sequencing, which may be affected by toxins. The unique metabolism of the embryonic cells includes immature repair and detoxification mechanisms. Transient tissue sensitivities can occur, and there may be concern about the immaturity of the immunosurveillance mechanisms.

A great deal of research in animal teratology is being carried out in an attempt to find a model that will be useful and can be extrapolated to man. To date, however, no known human teratogen has first been described in animals. Instead, teratogens have been identified in man, and the animal models have been used to determine the probable mechanisms. Therefore, while animal teratology is useful for elucidating mechanisms, it should not allow significant complacency as a screening method.

Finally, offspring can be affected even after birth by the presence of chemicals or toxins, such as polychlorinated biphenyls (PCB), in maternal breast milk. At present, subtle effects on both fetal and infant growth and development are difficult to measure. Possible causal relationships between toxins

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TABLE 1

Known Human Reproductive Toxins and Their Effects

Agents	Reproductive effects
Alcohol*	Reduced fertility, neonatal morbidity
Anesthetic gases*	Reduced fertility, spontaneous abortion, mutagenesis, teratogenesis
Benzene	Carcinogenesis, teratogenesis
Cadmium	Reduced fertility, teratogenesis
Carbon disulfide*	Reduced fertility, spontaneous abortion, teratogenesis
Carbon monoxide	Teratogenesis
Chloroprene*	Reduced fertility, spontaneous abortion, mutagenesis
Cigarettes*	Low birth weight, increased neonatal mortality
Dibromochloropropane (DBCP)*	Reduced fertility in men
Diethylstilbestrol (DES)	Reduced fertility, teratogenesis, transplacental effects on both male and female offspring
Epichlorohydrin	Reduced fertility
Ethylene dibromide	Reduced fertility
Ethylene oxide	Mutagenesis
Ionizing radiation*	Reduced fertility, spontaneous abortion, mutagenesis, teratogenesis
Lead*	Reduced fertility, spontaneous abortion, teratogenesis
Mercury	Spontaneous abortion, teratogenesis
Microwaves*	Abnormal spermatogenesis
Pesticides	
Carbaryl	Reduced fertility
Chlorinated hydrocarbons*	Mutagenesis
Kepone*	Reduced fertility in men
Polychlorinated biphenyls (PCB)	Reduced fertility, spontaneous abortion
Trichloroethylene	Mutagenesis, teratogenesis
Vinyl chloride*	Mutagenesis

* Effect also seen after paternal exposure only.

in the workplace and adverse health effects in employees and their offspring are only beginning to be examined.

Since individual physicians seeing individual patients have been instrumental in initially identifying occupational illness, including toxic effects on reproductive organs and fetuses, it is imperative that clinicians continue to study the literature on the subject and to respond to patient needs in this area. Certainly, the medical history obtained from employed persons should include essential information about the patient's workplace.

Known Environmental Toxins

Table 1 lists currently recognized environmental toxins and their documented effects on human reproduction. Known hazards to either sex are included; in many instances, however, data for both sexes are unavailable. Lifestyle factors, prescribed medications and infectious agents may also alter reproductive outcome. The list of toxins may be

expanded significantly in the future as resources are allocated for additional studies of reproductive hazards.

Final Comment

Although much research is required, there is reason for optimism. Studies using scaled epidemiologic methods to evaluate groups of workers with common exposures for objective outcomes, such as fertility and congenital malformations, are being undertaken. Another encouraging sign is the willingness of organized labor, industry, workers, private physicians and occupational health personnel to discuss and explore these problems together. Making insurance records available to epidemiologists to facilitate this evaluation will be a major breakthrough. Efforts to complete the evaluation of reproductive effects on both sexes, rather than women only, are resulting in a safer workplace for both men and women. ■

SUGGESTED READING

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