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Drug use and pregnancy

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Drug Use and Pregnancy

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INTRODUCTION

Human development is a remarkably complex process whereby the union of two small cells can after a period of time give rise to a new human being, complete with vital organs, bones, muscles, nerves, blood vessels, and much more. Considering the intricacy of the developmental process, it is indeed miraculous that most babies are born healthy.

Some children, however, are born with abnormalities. Environmental agents, such as drugs, are responsible for some of these abnormalities. Unfortunately, social and therapeutic drugs are widely used among pregnant women. Many commonly used drugs are known to disrupt the normal developmental process and cause a wide range of birth defects, learning disabilities, and behavioral problems.

This paper will briefly summarize the normal process of human development and the roles of the fetal membranes and the placenta. It will also explain how teratogens can interfere with normal development and cause a variety of congenital abnormalities. In addition, this paper will describe some of the known and suspected teratogenic drugs and their harmful effects on a developing embryo/fetus. Finally, the last portion of the paper will describe the making of the accompanying pamphlet: the conceptual, research, and technical processes behind the final product.

The pamphlet was made with the intention of educating expectant mothers about the harmful effects of drug use during pregnancy and lactation. The pamphlet focuses on risks associated with drugs such as alcohol, cigarettes, marijuana, heroin, and cocaine, as well as prescription and over-the-counter medications. Many women are not aware of the potential dangers associated with prenatal drug exposure, and some women, although aware of the potential adverse effects of using drugs during pregnancy, have conditions which require

medication. Women receiving treatment need to understand the importance of consulting their doctors upon becoming pregnant, or planning to become pregnant, to determine the safest course of action for both themselves and their babies. Also, it is important for women to be aware of the possible risks associated with breastfeeding while taking drugs. Many drugs a mother uses ean be transmitted to her breastfed child. Breastfeeding is generally recommended because breastmilk contains numerous substances which defend a newborn against infections, and the act of breastfeeding helps create a bond between mother and child. However, maternal use of certain drugs may require the mother to stop nursing in order to minimize risk to the baby.

Further research in the field of teratology and increased public awareness regarding the harmful effects of drugs on a developing fetus promise to significantly reduce the rate of preventable birth defects.

CHAPTER ONE

Human Development

Human development begins with conception, the fertilization of a female ovum by a male sperm. The resulting conceptus, called a zygote, repeatedly divides by mitosis into smaller sized daughter cells called blastomeres. The group of blastomeres, in the form of a tight ball, leaves the fallopian tube and proceeds to the uterus. When the ball consists of 12 or more daughter cells it is known as a morula. The cells of the morula continue to divide and a large fluid-filled cavity forms inside the ball. At this point the morula is called a blastocyst. The blastocyst's outer cell layer is called the trophoblast and its internal cluster of cells is called the inner cell mass. The blastocyst, approximately seven days after fertilization, begins to implant itself into the endometrium of the uterus.

During the second week of development the blastocyst continues to embed itself further into the endometrium and the inner cell mass of the blastocyst arranges itself into two layers. These two layers, collectively called the bilaminar embryonic disc, will develop into the embryo, while the blastocyst's outer wall, the trophoblast, will form the fetal membranes.

During the third week, which marks the beginning of the six week embryonic period, the embryo develops rapidly and many important processes occur, including: the formation and development of the primitive streak, notochord, three germ layers, neural tube, neural crest, somites, embryonic body cavity, primitive cardiovascular system, and the development of the chorionic villi (the fetal component of the placenta). The three germ layers consist of the ectoderm, mesoderm, and endoderm, from which all the tissues and organs of the embryo are derived. Also, the proliferating trophoblast layer continues to invade the endometrium by

eroding maternal capillaries and glands, and "communication" is formed between maternal blood and the embryo. This begins the important exchange of materials between mother and developing embryo.

By week four, the embryo grows very rapidly and begins to bend; a head and tail are formed. The three germ layers begin to differentiate into their respective tissues and organs, the developing heart bulges below the head, limb buds appear, and four pairs of branchial arches, destined to form certain structures of the face and neck, are visible.

At five weeks, the body of the embryo is growing fast. The brain develops quickly and causes the head to enlarge significantly. Also, the extremities are taking on a "paddle-shape" and the primordial structures of the eyes and nose are visible.

During the sixth week, the upper and lower limbs become more defined and the hands develop digital rays which will later become fingers. The eyes become darker with the presence of retinal pigmentation, and the head and face continue to grow. The head of the embryo is still disproportionately large compared to the rest of the body due to the rapid development of the brain.

In the seventh week, increasing differentiation occurs within the limbs. The digital rays in the hands are interspersed by notches, and the rays in the feet are just beginning to appear. Also, at this time, the umbilical cord temporarily contains the embryo's herniated intestines.

The eighth week of human development is the last week of the embryonic period. By the end of the eighth week all the primitive organ systems have formed and the embryo looks quite human. The tail, which first appeared at four weeks, is now gone. The fingers and toes of the embryo are separated, the neck and the eyelids begin to take form, and internal sex organs are present, while the genitals (indistinguishable in terms of male or female) continue to differentiate.

The fetal period, following the embryonic period, lasts from the beginning of the ninth week of human development through the thirty-eighth week. During this long period the embryo,

now called a fetus, grows rapidly while its already present organs and tissues continue to develop and mature.

By the end of the third month of development, the fetal head is no longer so large in comparison to the body, differentiated genitalia reveal the sex of the fetus, lengthening of the upper and lower limbs occurs, the herniated intestines revert back into the abdomen, the fetus is capable of motion, the eyelids close, the eyes remain far apart from each other on the broad face, the skeleton and muscles are forming, the fetus produces urine, and the production of blood cells begins to occur in the fetal liver (and later in the spleen and bone marrow). The placenta, by this time, is very important in the exchange of nutrients and waste products between fetus and mother. The mother passes oxygen and nutrients to her baby via the placenta and fetal waste products and carbon dioxide are passed to the mother and then eliminated from her body.

During the fourth month, the face develops significantly. The eyes have moved more anteriorly on the face, fingernails begin to appear, lengthening of the lower limbs occurs, and the fetus continues to grow very rapidly.

By the fifth month the fetus has produced a layer of hair called lanugo and a protective waxy substance called vernix caseosa covers the body. The skin of the fetus is extremely thin and the underlying blood vessels are very visible. Hair appears on the head and eyebrows. Fetal growth begins to slow down, although significant weight gain is still necessary.

In the sixth month, the fetus begins to gain weight, but has yet to plump up. The fetal lungs are beginning to produce surfactant, fingernails are present, and the skin is wrinkled and translucent.

During the seventh month, the lungs have developed well enough for the fetus to have a chance at survival if born prematurely. The central nervous system has developed, so as to control body temperature and breathing. The eyes are open after weeks of being shut,

toenails have appeared, and the body of the fetus has begun to form a protective layer of fat under the skin.

By the end of the eighth month, the body has filled out due to the body's increasing supply of fat, and the skin is smooth and pink in color. Normally, at this time, the fetus takes on a head-down position in the mother's uterus, and will stay that way for the remainder of the pregnancy.

During this last month of development, the growth rate of the fetus slows down significantly. The amount of body fat continues to increase, most of the lanugo hair disappears, the fetus is now sensitive to light and dark, and the organs and bones have all formed (although the bones are still very soft and flexible). The chest and abdomen are large in size due to the major organs they house. By this time, the size ratio of fetal head to total body length is 1:4.

Fetal Membranes

Fetal or extraembryonic membranes also play an important role in human development. There are four fetal membranes: the chorion, amnion, allantois and yolk sac. The yolk sac and the allantois are the only two structures which will become part of the fetus.

The chorion will form the fetal portion of the placenta. The chorionic sac houses the embryo, all the other fetal membranes, and is the site of chorionic villi formation. The amnion forms in the second week of development, differentiating from the cytotrophoblast cells. It protects and promotes the normal development of the embryo/fetus during pregnancy. The aminiotic sac is a fluid-filled membrane in which the baby floats freely, connected to the placenta only by the umbilical cord. The fluid within the amniotic sac comes from the mother as well as from the fetus. Part of the fetal contribution to the amniotic fluid is urine, some of which the fetus swallows and passes to the mother through the placenta for elimination. The amniotic fluid has many important functions including, cushioning the embryo, providing an environment with a stable temperature, allowing free

movement, helping lung development, and keeping the baby safe from infection. The amniotic sac also forms the covering of the umbilical cord. The umbilical cord connects the fetus to the placenta. The cord contains two arteries and one vein which are embedded in a protective mucous tissue called Wharton's jelly. The life-sustaining nutrients and supply of oxygen are transported from the placenta to the baby through the umbilical vein and the waste products generated by the child are eliminated via the two umbilical arteries. The cord generally is spiral in appearance because the umbilical vessels are longer than the cord that houses them.

The yolk sac and allantois are important sites of early blood and blood vessel formation, and thus important sources of nutrition for the embryo. The allantois is an outpouching of the early yolk sac into the connecting stalk. It connects the urinary bladder to the umbilical cord and its blood vessels will form the umbilical arteries and vein. The allantois becomes the urachus (fetal urinary canal) in the fetus and the median umbilical ligament in the adult. A portion of the yolk sac becomes integrated with the embryo and forms the primitive gut. The walls of the yolk sac and allantois have blood vessels which produce blood cells. This extraembryonic blood formation occurs for about two weeks until the fetus begins to produce blood in the liver. The blood vessels produced in the chorion, yolk sac, and connecting stalk link to those developing within the embryo and together they form the primitive cardiovascular system.

The Placenta

The placenta is an organ which is formed by mother and child. Although it does not form any part of the fetus, it does play a crucial role in human development. The fetal portion of the placenta is the villous chorion and the maternal portion is the decidua basalis. As the villous chorion grows and thickens and the decidua basalis recedes, the fetal component of the placenta eventually becomes larger than the maternal component.

The placenta begins to form soon after conception. Within the second week of development, as the blastocyst embeds itself into the uterus, a group of multinucleated trophoblast cells called the syncytiotrophoblast, invades the endometrium by eroding maternal tissues. Spaces called lacunae begin to form in the syncytiotrophoblast and they become filled with maternal blood and glandular secretions. The invasive synctiotrophoblast continues to form lacunae until the spaces become interconnected, making lacunae networks which will become the future intervillous spaces of the placenta.

During the third week, the cells of the cytotrophoblast, the other part of the trophoblast, begin to layer themselves into cords and push their way into the syncytiotrophoblast. Together the cytotrophoblast cord and the surrounding syncytiotrophoblast form a pillar, which is called a primary chorionic villous. Later, mesenchymal cells push their way into the villous, forming a delicate connective tissue core, at which point the villous becomes a secondary chorionic villous. These secondary villi develop along the entire chorion. Once the secondary villi form blood vessels, which differentiated from the mesenchymal cells, they are called tertiary chorionic villi. These chorionic villi will branch out to maximize the amount of surface area used for the exchange of materials between mother and child. To ensure a firm anchoring of the villi, cytotrophoblast cells break through the tips of the outermost villi, multiplying and spreading to form an outer perimeter layer known as the cytotrophoblastic shell, which attaches itself to the endometrium. However, openings do exist in the cytotrophoblastic shell, and it is through these holes that maternal arteries and veins are able to receive and deliver blood to and from the intervillous spaces.

The chorionic villi become attached to the primitive cardiovascular system of the embryo by the development of blood vessels within the mesenchymal portion of the chorion and connecting stalk. Then the exchange of materials between fetus and mother begins. Maternal blood in the intervillous spaces bathes the chorionic villi, which take in oxygen and nourishment, sending them through the umbilical cord to the fetus. Fetal waste products and

carbon dioxide are passed back to the mother, so that they can be eliminated from her body through her urine. This life-supporting process continues until birth.

Although the early placenta has villi uniformly covering the entire surface of the chorion, by the third month the chorionic villi near the attachment of the umbilical cord begin to flourish and the villi located on the rest of the chorion disappear. The portion of the chorion with enlarged and abundant villi is known as the chorion frondosum, or villous chorion, and the bare section of the chorion is called the smooth chorion. After the villous chorion is formed, it continues to grow and thicken by the branching of the villi.

The maternal portion of the placenta, the decidua basalis, is the site to which the fetal portion of the placenta is attached. Decidua is the name given to the endometrium during pregnancy. There are three parts of the decidua: decidua basalis (the portion of the decidua lying directly under the villous chorion), decidua capsularis (the portion which covers the implanted conceptus), and the decidua parietalis (the portion which lines the wall of the uterus). The two components, the decidua basalis and the villous chorion, constitute the placenta.

Blood from the endometrium passes through spiral arteries (the terminal branches of arteries supplying the endometrium) and enters the intervillous spaces. Although the mother's blood never comes in direct contact with fetal circulation, materials are exchanged. The placental membrane, (the wall of the villous, its connective-tissue core, and the endothelium of the villous capillary) is the thin tissue separating the two bloodstreams. Only by the processes of diffusion, active transport, and pinocytosis are materials transferred across the placental membrane. Harmful substances can permeate the membrane just as easily as the essential nutritional materials.

The placenta is a very complex organ with many important functions including: nutrition, respiration, excretion, selective straining, and synthesis. Early in pregnancy, the placenta synthesizes cholesterol, fatty acids, and glycogen which are used as nutrients and energy by

the growing embryo. The placenta also produces hormones, including estrogens, progesterone, and protein hormones, which maintain pregnancy and support the growth of the embryo/fetus. In addition, the placenta has an extremely important role in the transfer of substances between mother and child. Oxygen passes through the placenta and umbilical cord and enters the bloodstream of the fetus. The oxygen-rich blood is then distributed to the growing organs, including the brain, heart, kidneys, and liver. The lungs at this time do not receive a large amount of oxygen, as one might expect, since they are not used for breathing until the baby is born. One could say that the placenta acts as the lungs for the fetus until birth. Nutrients, such as fatty acids, proteins, amino acids, water, glucose, electrolytes, vitamins, and minerals are also passed from the mother to the fetus via the placenta. Antibodies pass through as well, and can protect the developing fetus against disease. Going the other direction, the fetus passes waste products such as carbon dioxide, urea, uric acid, electrolytes, water, and bilirubin to the mother for disposal. It is essential for the growth and survival of the fetus that the mother excrete these waste products for the child during pregnancy. A build-up of these products would be very harmful to the fetus. Adequate blood flow through the placenta is very important to the normal development of the fetus. The reduction of normal blood flow, for whatever reason, could lead to low birth weight, mental and/or physical defects, or even the death of the fetus.

For a long time the placenta was believed to be a protective barrier for the fetus. It was thought that the placenta would keep all harmful substances from reaching the fetus while only allowing nutrients to pass through. But now we know that harmful materials, including drugs, viruses, bacteria, microorganisms, metals etc. can be passed from mother to child through the placenta. The transfer of one or more of these materials to a developing baby can cause a variety of abnormalities, including a wide range of birth defects, learning difficulties, and behavioral problems.

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CHAPTER TWO

Teratogens

The causes of human birth defects are divided into three categories: unknown, genetic, and environmental. Unknown causes are responsible for the majority of defects, while genetic and environmental causes account for a relatively small portion of them. Genetic factors are responsible for most of the known causes of birth defects. Because human development is such a complicated process, there are many opportunities for "errors" to occur. Chromosomal abnormalities and mutant genes account for many of these errors. Environmental factors are also responsible for children with birth defects. Embryonic/fetal exposure to environmental agents including drugs, infections, chemicals, and radiation can interfere with normal development and produce congenital malformations as well as reduced mental capacity in children. Environmental agents such as these are called teratogens. "A teratogen is any environmental agent that permanently harms the developing fetus."[1] Teratogens alone are responsible for approximately 7-10 % of major congenital anomalies.[2] However, usually it is a combination of genetic and environmental factors that is responsible for many of the common birth defects.

Although the field of genetic engineering is rapidly progressing, it is fair to say that in general, we cannot prevent genetic abnormalities. However, abnormalities as a result of teratogenic exposure are potentially preventable. Embryonic/fetal exposure to teratogens, such as drugs for example, can cause stillbirths, miscarriages, congenital malformations, and

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[1] Elizabeth Conover, "Hazardous Exposures During Pregnancy," *Journal of Obstetric, Gynecologic, and Neonatal Nursing* 23, no.6 (July/August 1994): 524.

mental retardation. The are a number of factors involved in determining whether a specific agent will cause a birth defect, including: the genetic susceptibility of the embryo/fetus to the agent, the dose and duration of the exposure, the characteristics of the agent, and the stage of pregnancy when exposure occurs. A substance causing anomalies in one baby may not cause harm to another. Also, the type of malformation can differ depending on the timing of exposure. Each of a child's developing structures has a period of time when it is most vulnerable to terotegenic insults. A vulnerable, or critical period, is a time of rapid proliferation and differentiation of cells into the child's developing organs and tissues. Disturbances during the critical period of a particular structure may cause damage to that structure.

During the first two weeks after conception, before the blastocyst has completed implanting itself into the mother's endometrium, teratogenic exposure usually results in a lost pregnancy or, ironically, no harmful effects at all. Some believe that exposure during this time causes such severe damage that the conceptus fails to implant itself in the uterus and thus is eliminated from the mothers body. (A spontaneous miscarriage can easily go unnoticed since a woman's next monthly period is not yet late at this point). Others believe that because there is no communication between the circulatory systems of mother and child at this early stage in the pregnancy, potentially harmful teratogenic exposure is often avoided. Yet, others suspect that teratogenic exposure damages only a few cells of the conceptus which are able to repair themselves, thereby not causing any permanent defects in the child.

During the embryonic period, rapid cell growth, cell migration, and cell differentiation occur. As organs and limbs are forming, the fetus is extremely sensitive to teratogens. Harmful substances in the mother's system can easily enter the fetus' bloodstream through the

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[2] Keith L. Moore and T.V.N. Persaud, *Before We Are Born: Essentials of Embryology and Birth Defects* (Philadelphia: W.B. Saunders Company, 1993), 118.

placenta. If teratogenic insults to the embryo occur at this critical time, there is a strong chance that the child will have or will develop major physical and/or functional defects. Because each developing organ has its own specific critical period, teratogens have windows of opportunity to cause specific types of birth defects. For example, the most vulnerable time for the heart is the third through the sixth week after conception. Exposure of the embryo to certain teratogens at this time could cause major cardiac defects.
Although most critical periods for the different developing organs and structures occur during the embryonic period, the fetus is susceptible to damage throughout the pregnancy. Since the fetal period is a time for rapid growth and maturation of organs, interruption of development during this time can result in growth retardation and minor morphological and functional abnormalities. There are even a few organs which extend their critical periods into the fetal stage of development. The central nervous system, for example, continues to rapidly grow through the sixteenth week. During this long period of time it is very vulnerable to teratogenic insults. Children who are exposed to certain harmful materials during this time can be severely retarded or show signs of learning disabilities and/or behavioral problems in childhood.

Although it is important to understand the effects of various infectious agents, maternal disease, mechanical influences, chemicals, and radiation on a developing embryo/fetus, this paper will not focus on these types of environmental teratogens. Rather, it will describe the deleterious effects of commonly used teratogenic drugs including, alcohol, tobacco, marijuana, heroin, cocaine, as well as some prescription and non-prescription medications during pregnancy.

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CHAPTER THREE

Many women take drugs during pregnancy. A drug is defined as "Any substance that when taken into the living organism may modify one or more of its functions."[3] Alcohol, tobacco, marijuana, heroin, cocaine, prescription medications, as well as over-the-counter medications are examples of different types of drugs. An expectant mother who is snorting cocaine or even just swallowing a few aspirin can cause harm to her baby.

When a drug is taken, the body absorbs it and then tries to eliminate it. Water-soluble drugs are eliminated by the kidneys and excreted in urine. Fat-soluble drugs are first broken down into metabolites, primarily by enzymes in the liver, in order to become water-soluble, so they too can be eliminated in urine. Usually the metabolites are less dangerous to the body than the drug itself; however, there are some drugs that become more harmful when broken down. Thalidomide is one of these drugs. Commonly used as a sedative in the 1960's, it caused severe limb deformities and cardiac defects in children whose mothers had taken the drug during pregnancy. Drugs taken by an expectant mother enter her bloodstream and pass to the embryo/fetus through the placenta. The unborn child's body then metabolizes the drug, a process which takes longer in the embryo/fetus (whose organs are just developing) than in the mother. Drugs can also remain in the amniotic fluid for quite some time, increasing fetal exposure to dangerous substances. Some drugs can have adverse effects on the placenta, indirectly harming the child.

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[3] Clayton L. Thomas, ed., *Taber's Cyclopedic Medical Dictionary* , 15th ed., (Philadelphia: F.A. Davis Company, 1985), 494.

Research on repeated patterns of deformities has allowed scientists to identify many teratogenic drugs and understand their adverse effects on the developing human being. There are also drugs which have not been proven to be teratogenic in humans, but are suspected to have minor effects on children who have been exposed to them prenatally or even postnatally. The following portion of this paper will name some of the more commonly used drugs and describe their known effects.

Alcohol

Alcohol is the most commonly used drug in the United States. Alcohol contains a drug, ethanol, which if ingested by the mother, is absorbed into the bloodstream and quickly transferred to the developing fetus. Unfortunately, the blood alcohol level of the fetus will be the same as that of the mother. In other words, if the mother is drunk, the unborn baby will be drunk as well. Heavy use of alcohol by an expectant mother often causes Fetal Alcohol Syndrome (FAS) in the child, a pattern of abnormalities which includes specific physical and mental defects. The three categories of features which define FAS are prenatal and postnatal growth retardation, facial malformations, and central nervous system dysfunction. However, there are a few other severe birth defects which are commonly seen among FAS infants such as cardiac defects, joint anomalies, genital anomalies, and cleft palate. Infants born with growth retardation are of reduced weight for their gestational age, and are usually short in length with small head and chest circumferences. Infants born with a birth weight that is at or below the tenth percentile of body weight for their gestational age are diagnosed as having intrauterine growth retardation or IUGR. Children with IUGR not only have a greater risk of serious infections and death during infancy, but they also usually fail to catch up and reach a "normal size" for their age in childhood. The facial abnormalities found in children with FAS fit a particular pattern. The typical facial defects include: short palprebal fissures, flattened midface, short nose, sunken bridge of the nose, flattened and elongated

philtrum, thin and elongated upper lip, low set ears, and a small jaw and head. The central nervous system defects associated with FAS include: mental retardation, problems with optical and auditory systems, poor coordination and motor development, learning disabilities, short attention span, poor sucking response, and hyperactivity. Infants born to mothers who drank heavily during pregnancy may also suffer from alcohol withdrawal. These infants may experience tremors, abnormal muscle tension, restlessness, irritability, abnormal sleep patterns, inconsolable crying, and reflex abnormalities. Spontaneous abortion, abruptio placentae (premature placental separation), and stillbirth are also consequences of heavy drinking during pregnancy.

Those infants who do not display all of the characteristics of FAS, but do suffer from a few of the abnormalities are defined as having "Fetal Alcohol Effects" (FAE), or they are said to have alcohol related birth defects. Mothers who drink even a moderate amount of alcohol during pregnancy may have a child with FAE. Many of these children may have poor motor development, behavioral and/or learning disabilities and sometimes mental retardation.

Unfortunately, alcohol use is so prevalent in our society that FAS is the leading preventable cause of mental retardation. Alcohol can interrupt fetal placental circulation, causing hypoxia, a deficiency in oxygen which damages the brain of the fetus, thereby causing mental retardation. Many pregnant women who drink alcohol also smoke cigarettes and/or take other drugs, and the combination of multiple can cause more severe abnormalities. In addition, drinking during pregnancy is sometimes accompanied by malnourishment and inadequate prenatal care, which also puts the fetus at greater risk for complications. There is a direct relationship with the amount of alcohol consumed by a drinking mother and the abnormalities produced in the child. However, the types of anomalies and their severity do not only depend on the dose and duration of alcohol exposure, but on the stage of development and on the genetic susceptibility of the embryo/fetus as well. The level of alcohol that is harmless to one child may cause birth defects in another. Since no "safe"

amount of alcohol consumption during pregnancy has been established, it is strongly recommended that pregnant women and those trying to conceive abstain from alcohol completely. Those who will not abstain, should have no more than two drinks per day, (for example: two mixed drinks, two cans of beer, or two glasses of wine) although even this moderate level of consumption may interfere with normal fetal development. Periodic binge drinking is believed to be even more harmful to the fetus than a consistent moderate intake of alcohol and therefore should always be avoided during pregnancy.

Maternal alcohol consumption while breastfeeding should also be avoided. Alcohol does reach the breastmilk and can be transmitted to the nursing child. Large amounts of alcohol can interfere with nursing by reducing the mother's milk supply and by inhibiting the milk-ejection reflex. Infants may also become irritable, drowsy, and may be slower to acquire motor skills.

The estimated incidence of fetal alcohol syndrome is anywhere between 1/300- 1/2000 live births.[4] Among chronic alcoholic women FAS occurs in 30% - 40% of infants.[5] Researchers have found that many of the children diagnosed with FAS or FAE at birth have not only short-term problems, but many long-term problems as well, including dental, skeletal, and morphologic anomalies, growth delays, and low IQs. FAS victims as adults have severe psychological and behavioral problems and are usually incapable of independent living. Sadly, the effects of FAS last a lifetime.

Cigarettes

A woman who smokes cigarettes during pregnancy puts her child at risk. Although maternal cigarette smoking is not believed to cause major congenital defects, it can cause intrauterine growth retardation (IUGR), respiratory problems, behavioral and learning difficulties, as well as obstetrical complications. In addition, maternal smoking is associated with

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[4] Laurie H. Seaver and Eugene Hoyme, "Teratology in Pediatric Practice," *The Pediatric Clinics of North America* 39, no.1 (February 1992): 119.

spontaneous abortion, stillbirth, premature deliveries, and sudden infant death syndrome (SIDS). SIDS is the sudden, unexpected, and unexplained death of an apparently healthy child, most commonly between the ages of one and four months.[6]

Many of the harmful toxins found in tobacco smoke, including numerous carcinogens, metals, irritants, and gases can be harmful to the unborn child. Carbon monoxide and nicotine, for example, interfere with the transport of oxygen between mother and child. Carbon monoxide quickly bonds to the hemoglobin found in red blood cells and prevents the binding of oxygen. The resulting carboxyhemoglobin travels through the mother's bloodstream and is passed via the placenta to the fetus, causing the fetus to receive inadequate oxygen levels for normal development. Nicotine, another chemical in cigarette smoke, is known to cause blood vessel constriction which also reduces the amount of oxygen reaching the fetus. In addition, smoking during pregnancy may cause adverse effects on the structure and function of the placenta, thus interfering with the transfer of vital, growth-sustaining nutrients and oxygen to the fetus. The placenta may develop infarcts (necrosis of tissue due to cessation of blood supply), narrow uterine vessels, smaller intervillous spaces, and a reduction of blood flow into these spaces.
Insufficient oxygen and nutrient transport to the fetus can lead to infants born with IUGR. These low weight babies are on average 200 grams (7 oz.) lighter than those born to non-smokers. The reduced size and weight of an infant born to a mother who smoked during pregnancy has a direct relationship with the number of cigarettes smoked each day. However, if a woman can stop smoking during the fourth month of pregnancy she has a greater chance of delivering a baby with a normal birth weight. Research shows that passive smoking, or exposure to environmental cigarette smoke, may also influence low birth weight.

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[5] Seaver, 120.

Smoking during pregnancy is known to cause maternal vaginal bleeding which can lead to premature delivery. Premature birth increases the risk of early infant illness or death. In addition, obstetrical complications such as abruptio placentae and placenta previa (the attachment of the placenta too low in the uterus) commonly occur among smokers. Both of these conditions prevent oxygen from reaching the child and can lead to premature delivery or stillbirth.

Postnatal smoking can also have harmful effects. Since smoking can suppress lactation, women should avoid cigarettes while trying to breastfeed. Women who smoked during pregnancy and after, also have a greater number of infants with SIDS than non-smokers. Studies also show that infants born to smokers, or to those who live in a smoke-filled environment, also have an increased risk of pneumonia, bronchitis, colds, asthma, and other respiratory problems.

In order to reduce the risk of IUGR and other complications it is recommended that women abstain from cigarette smoking during pregnancy and that prenatal and postnatal exposure to environmental smoke be avoided.

Caffeine

While there is no evidence of an association between caffeine and congenital birth defects, it is recommended that pregnant women avoid products which contain caffeine. Some of the more common products with caffeine include soft drinks, chocolate, coffee and tea. There is the possibility that caffeine may cause harm to a fetus, but due to the common practice of combining tobacco, alcohol and caffeine use, analysis on the effects of caffeine alone on an unborn child has been difficult.

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[6] Patrick Young, *Drugs and Pregnancy* (New York: Chelsea House Publishers, 1987), 56.

Marijuana

Marijuana, also known as pot or grass, is a commonly used illicit drug in our society. It consists of the dried flowering parts of a plant called Cannabis sativa. Marijuana is usually smoked in the form of a cigarette or smoked in a pipe. The smoke contains many of the same components as tobacco smoke and can cause similar health hazards. In addition, marijuana smoke contains a psychoactive constituent called delta-9-tetrahydrocannabinol (THC) which produces a state of mild euphoria in the user. Marijuana can impair short term memory and psychomotor coordination as well as alter the mood of the user.

Marijuana is thought to be a potential teratogen, but there has been substantial controversy over whether or not it produces physical abnormalities in children born to women who smoked it during pregnancy. Marijuana readily crosses the placenta and reaches the fetus. Although no specific pattern of birth defects are associated with the use of marijuana, heavy marijuana smoking during pregnancy seems to cause low birth height and weight (IUGR), decreased heart rate, as well as nervous system abnormalities in the child. Newborns exposed to marijuana in utero may exhibit increased tremulousness, altered visual response patterns to light stimuli, and may have altered sleep and arousal patterns.

Marijuana is often used in conjunction with other harmful agents, such as alcohol and cigarettes. Combined usage of these drugs can increase the chances of adverse effects on the developing fetus. Marijuana is transmitted into breastmilk and will reach the nursing baby. However, due to inconsistent findings, the effects of marijuana on a nursing infant are not certain. Some studies suggest that it may cause drowsiness in the infant. Long-term effects of prenatal marijuana exposure are unknown. Much additional research is needed to give healthcare professionals and parents a better understanding of the consequences of marijuana use during pregnancy.

Heroin

Heroin is a narcotic derived from the juice of the opium poppy. Opioids are natural and synthetic drugs which act on the central nervous system. In addition to heroin, drugs such as morphine, codeine, methadone, meperidine (Demerol), and pentazocine (Talwin) are members of the opioid group. While most drugs from this group are prescribed for therapeutic purposes, often they are used illegally. The focus here will be on heroin, one of the most widely used illicit drugs in our society.

Heroin is a dangerously addictive narcotic. It induces a euphoric state which its users find very appealing. However, there are serious consequences involved with the use of this mind-altering drug. Heroin can be taken intravenously, orally, nasally, and subcutaneously. Intravenous heroin use is especially risky not only because of the adverse effects of the drug, but also because of the common practice of using unsterile paraphenalia to inject the drug. AIDS contracted by sharing contaminated needles is an increasing problem among heroin addicts. In addition AIDS can be acquired from the risky lifestyle of the heroin abuser. Many addicts, most commonly women, sell sex to buy their next "high". Not only are these women at risk of acquiring AIDS, but they often acquire sexually transmitted diseases such as syphilis and gonorrhea. Addicts are often malnourished and tend to neglect their general healthcare. Medical complications including hepatitis, endocarditis, thrombophlebitis, cellulitis, tetanus, toxemia, nephrotic syndrome, and anemia are not uncommon among heroin abusers.

Heroin not only causes severe problems in the person who abuses the drug, but also can endanger a fetus. Many heroin-dependent women experience irregular menstrual cycles and therefore fail to recognize when they are pregnant. It is not unusual for an addict to notice her pregnancy as far along as three or four months, having exposed her baby to the addictive drug for a long period of time. Like alcohol, heroin rapidly crosses the placenta and has an addictive response on the unborn baby. When the mother experiences overdoses and withdrawals, the fetus does too. The inconsistent doses and the erratic use of heroin by

the addict can lead to many episodes of overdose and withdrawal. Unfortunately, both types of episodes can cause hypoxia in the developing fetus, and ultimately can lead to the death of the baby.

Obstetrical complications are also prevalent among heroin-dependent women. Spontaneous abortion, abruptio placentae, amnionitis, chorioamnionitis, premature rupture of the fetal membranes, eclampsia, premature birth, breech birth, stillbirth, and an increased number of Ceasarian sections are associated with heroin use during pregnancy. The infants who survive generally have low birthweights, a small head size (IUGR), optical and auditory problems, increased risk of infections, increased risk of SIDS, and they commonly suffer from withdrawal symptoms. Withdrawal symptoms can be very dangerous, even fatal to an infant. Withdrawal symptoms include irritability, hyperactivity, wakefulness, twitches, tremors, high-pitched cry, rapid heart rate, fever, diarrhea, vomiting, and seizures.

The use of heroin while nursing can also be harmful to the baby. Heroin is transmitted to the baby in breastmilk and can cause heroin dependency in the infant. Studies have shown that the effects of maternal heroin use during pregnancy can last into early childhood. Heroin-exposed children can have behavioral problems such as hyperactivity, short attention spans, temper tantrums, as well as slow motor and speech development.

It is essential that a pregnant heroin-dependent woman seek medical assistance when trying to come off heroin. The harmful withdrawal symptoms which would result from quitting the drug "cold turkey" could kill the unborn child. Medical professionals can treat the addiction by using a synthetic opioid called methadone. Methadone treatment provides a constant drug level in the bloodstreams of mother and child. Also, the drug fails to produce a euphoric state, thereby controlling the urge to "shoot up." Methadone treatment allows addicts to lead more stable lives. Maternal healthcare and prenatal care are greatly improved by regular contact with healthcare workers. Mothers on methadone have better nutritional habits and the use of unsterile needles, along with associated problems, are greatly reduced.

Although the use of methadone can have some adverse effects on the fetus, is successful in treating heroin-dependency and reducing the risk of obstetrical complications and fetal death. For example, although the birth weight of an infant born to a woman in methadone-maintenance is low, it is still higher than an infant whose mother was on heroin throughout her pregnancy. While the mortality rate of infants is higher among methadone users than nonaddicts, the death rate is still lower than among untreated heroin users. Also, while withdrawal is still common for infants whose mothers are treated with methadone, severity of the symptoms, the risk of early infant death, and the presence of childhood behavioral problems are significantly reduced.

Cocaine

Cocaine, derived from the coca plant, is another illicit drug widely used for the euphoric state it can induce. Feelings of confidence, high energy, and mental alertness with increased sensory awareness are also frequently experienced among cocaine users. Large doses of cocaine may cause paranoia and violent behavior. The euphoria produced by cocaine lasts only a short period of time and then it is followed by a "crash," which leaves the user depressed and despondent. Some people repeat the use of the drug several times a day in attempt to dodge the unpleasant feelings that occur from crashing. It is also not uncommon for individuals to combine cocaine use with the use of other drugs, such as alcohol and/or heroin, in order to alleviate the pains of withdrawal. However, this dangerous practice of combining drugs can be lethal.

Cocaine is a white powder, generally snorted through the nostrils. Those interested in getting a faster and more intense "high" inject or smoke different forms of the drug. Crack, the smokable type of cocaine, is in the form of white crystals. It is less expensive than the powdered form of the drug, in addition to being much more potent and addictive.

Women addicted to cocaine/crack face many of the same health concerns as women who are addicted to heroin. The exchange of sex for crack puts women at risk of acquiring AIDS and sexually transmitted diseases (STDs).

Obstetrical complications associated with cocaine use include spontaneous abortion, abruptio placentae, stillbirth, and premature delivery. In addition, a woman using cocaine may experience seizures, myocardial infarction, cardiac arrhythmia, rupture of the ascending aorta, and central nervous system complications.

Cocaine affects the fetus as well. The fetus, like the mother, is at risk of contracting AIDS and STDs. Also, maternal cocaine use causes a constriction of the mother's blood vessels, including the uterine vessels, thus reducing blood flow and nutrient transport through the placenta. Babies exposed to cocaine in utero may be born with a small head (microcephaly), which prevents the normal growth of the brain. They also have an increased risk of IUGR, due to the combination of insufficient blood reaching the fetus and the appetite-suppressing effects of cocaine on the mother. Cocaine exposed babies are also believed to have a higher risk of SIDS. Some studies suggest that cocaine may cause structural birth defects of the genitourinary tract, cardiovascular system, central nervous system and extremities. Although, there seems to be an increased rate of birth defects associated with maternal use of cocaine, currently there is no conclusive evidence on the subject. Further research is necessary to determine the extent of the abnormalities caused by the use of the drug during pregnancy.

Infants born to cocaine-abusing mothers often exhibit various behavioral problems. Some of the more common problems include irritability, tremors, poor feeding, frantic fist sucking, abnormal sleep patterns, increased startles, poor visual processing, and fretfulness. Some infants, as late as 8 months of age, have abnormalities of muscle tone, reflexes, and movement. Further long-term effects are unknown. Nursing babies also show some of the same behavioral abnormalities as newborns who were exposed to the drug in utero. Tremulousness, irritability, and startled responses are believed to be caused by maternal use

of cocaine while breastfeeding. But long-term effects of cocaine exposure to the infant are not known at this time.

In addition to alcohol, cigarettes, and numerous types of illicit drugs often used by women of childbearing age, there are many prescription medications used as treatments which can be harmful to an unborn child. It is important for healthcare professionals to inform women who use prescribed drugs about the potential hazards of these substances on a developing embryo, fetus, or nursing baby. Certain maternal disorders can be very serious and require prolonged treatment with medication, even throughout pregnancy. Although drug use among pregnant women is discouraged, sometimes the benefit of controlling the disorder outweighs the risk associated with medication. It is, however, important for a woman who is on medication to inform her doctor immediately if she is planning a pregnancy, or if she discovers that she is pregnant. The doctor will want to treat the condition using only one drug at the lowest possible therapeutic dose in order to minimize the risk of harm to the baby.

Although some drugs have been proven teratogenic in humans, the potential harm to embryonic/fetal development from most drugs is at this time unknown. This section of the paper will focus on some of these substances which are used, or have been used, to treat specific disorders, but are now known to be potentially dangerous to an unborn or nursing child.

Anticonvulsants

Phenytoin (Dilantin) is an anticonvulsant agent used to treat epilepsy. It has been proven to be teratogenic and may, in some cases, even cause fetal death. There is a particular pattern of anomalies associated with this drug, ealled fetal hydantoin syndrome (FHS). Newborns with the condition exhibit characteristic facial features, heart disease, IUGR, and most commonly, nail and digital hypoplasia. The expression of the syndrome can range from the

entire group of characteristic anomalies to minor cranio-facial and peripheral anomalies. The characteristic facial features include short nose with low nasal bridge, ocular hypertelorism, low-set ears, wide mouth with prominent lips, cleft lip and palate, and microcephaly. Mental retardation and bleeding disorders also may result from in utero exposure to the drug. Since phenytoin is transmitted to breastmilk, a woman who is taking the anticonvulsant is advised against breastfeeding.

Valproic Acid is another drug used to treat seizure disorders. Maternal use of this drug also causes a syndrome. Fetal valproate syndrome includes craniofacial abnormalities such as epicanthal folds, flat nasal bridge, high forehead, short anteverted nose, long philtrum, thin upper lip, cleft lip, midfacial hypoplasia, and small mouth. Exposure to this drug may also cause neural tube defects (such as spina bifida), cardiovascular defects, and developmental delays. Studies have also shown that children born to mothers who used Valproic acid during pregnancy have low "Apgar" scores. (The test, which rates an infant's physical condition one minute after birth, checks the baby's heart rate, respiration, muscle tone, color, and response to stimuli.)

The anticonvulsant Carbamazepine has also been associated with congenital defects. Some of the common malformations caused by the drug include microcephaly, nail hypoplasia, neural tube defects, prenatal and postnatal growth deficiency, cardiac defects, epicanthal folds, upslanting palprebal fissures, short nose, and long philtrum. The severity of the defects is dose-dependent. Children exposed to carbamazepine in utero often share a similar phenotype as those with fetal hydantoin syndrome.

Trimethadione (Tridione), another anticonvulsant agent used to treat certain types of epilepsy, has been proven to be teratogenic in humans. It, too, has an associated pattern of anomalies, called fetal trimethadione syndrome. Babies exposed to trimethadione exhibit craniofacial anomalies, cleft lip and palate, and cardiac defects. They also tend to be delayed in growth and psychomotor development and have an increased risk of fetal and infant death.

Unfortunately, there are no known safe anticonvulsants on the market at this time. When anticonvulsant medication is required during pregnancy, the doctor will prescribe one drug to be taken at the lowest possible dose necessary to treat the disorder. Discontinuing the use of anticonvulsant medication during pregnancy is not recommended. Lack of treatment may result in seizures which can be harmful to both the fetus and the mother.

Anticoagulants

Sodium Warfarin (Coumarin) is an anticoagulant which can easily cross the placenta and cause congenital defects in exposed offspring. Sodium Warfarin is a blood thinner, used to prevent potentially fatal blood clots. It is prescribed to patients who, for example, have undergone surgery, who have prosthetic heart valves, or who have thromboembolitic disease.

Warfarin, if used in the first trimester of pregnancy, can cause facial and skeletal anomalies, such as nasal hypoplasia, epiphyseal calcification of long bones and vertebrae, IUGR, short broad hands, short distal phalanges, and eye anomalies, including optic atrophy.

Maternal use of Warfarin during the second and third trimester may result in CNS defects and mental retardation. The more common CNS anomalies include absent corpus callosum, hydrocephalus (Dandy-Walker malformation), and asymmetric brain hypoplasia. There is also an increased risk of pregnancy loss with the use of this drug.

Heparin is the anticoagulant of choice during pregnancy. It does not cross the placenta due to its high molecular weight. While exposure to heparin still increases the risk of pregnancy loss and premature delivery, at this time it is not known to cause any congenital defects.

Antineoplastics

Aminopterin, used to treat leukemia, is a known teratogen in humans causing growth retardation, skeletal defects, and facial abnormalities. The consistent pattern of deformities

among the drug's users are IUGR, abnormal cranial ossification, delayed frontanel closure, ocular hypertelorism, broad nasal ridge, prominent eyes, heart defects, cleft lip and palate, CNS damage (including microcephaly, hydrocephalus, and mental retardation), pancytopenia, small low set ears, severe microganthia, and limb abnormalities (including absent bones or positional abnormalities). Aminopterin use early in the first trimester of pregnancy is lethal to the embryo. This cancer-fighting drug destroys rapidly dividing cells, found in tumors, for example. Therefore it is not surprising that fetal exposure to Aminopterin would be harmful, since fetal cells are also rapidly dividing and differentiating. Aminopterin and another antineoplastic agent, called methotrexate, are both folic acid antagonists. A sufficient level of folic acid is necessary for the normal development of a baby. Folic acid is a B-complex vitamin necessary for the production of DNA, RNA, and red blood cells. Folic acid deficiency, whether caused by the use of a folic acid antagonist or by malnutrition, is teratogenic in humans. In order to help prevent many neural tube defects, The Food and Drug Administration, as of January 1998, requires the manufacturers of grain-based foods to add folate (folic acid) to their products. Now foods such as flour, bread, pasta, and cereal are fortified with this essential B-vitamin, so that women who have unplanned pregnancies have a sufficient level of folic acid in their bodies before becoming pregnant.

Hormones

Birth control pills taken during pregnancy can be detrimental to the well-being of a developing child. Embryonic/fetal exposure to birth control pills during the first four months of gestation results in an increased risk of congenital abnormalities, including heart and limb reduction defects.

In utero exposure to Diethylstilboestrol (DES), a synthetic estrogen which was used years ago to prevent miscarriage, is believed to have caused uterine, cervical, and/or vaginal

abnormalities, including cancer, in mature female offspring. In addition, high doses of DES have been reported to cause masculinization of the female fetus as well as decreased fertility. Physicians recommend that women who are planning to become pregnant wait at least three months after stopping the use of birth control pills before they try to conceive. The hormones from the pills which remain in a woman's body for quite some time, can pose a threat to an unborn child.

Antibiotics

The antibiotics tetracycline and streptomycin can adversely affects the developing fetus. Tetracycline taken during pregnancy can slow bone growth and discolor a baby's deciduous teeth. Teeth may grow in yellow and eventually turn gray or brown. Also, higher doses of the antibiotic can cause hypoplastic tooth enamel and other tooth anomalies. Streptomycin use during pregnancy can cause serious hearing deficiencies in children exposed to the drug in utero. There is evidence that the drug damages the eighth cranial nerve, the vestibulocochlear nerve, which innervates the ear.

At this time, the use of penicillin, amoxicillan, and erythromycin during pregnancy seems to present minimal risk to the fetus.

Retinoic Acid (Vitamin A)

Although vitamin A is necessary for normal human development, excess vitamin A can be teratogenic. Isotretinoin (Accutane), a vitamin A derivative, is a drug used to treat severe cystic acne. Accutane is a very potent teratogen and can cause serious congenital abnormalities and increase the risk of spontaneous abortion. The use of Accutane in the first trimester of pregnancy can result in craniofacial malformations, as well as cardiac, thymic, and CNS defects. Some of the brain abnormalities associated with Accutane are hydrocephalus, microcephaly, and lissencephaly, all of which can cause mental retardation in

the child. It is estimated that up to 50 % of the exposed offspring have cognitive deficits.[7] Some of the more common cardiac defects found in children whose mothers took the drug are ventricular, atrial, and septal defects, and aortic arch abnormalities. The craniofacial abnormalities can include, microganthia, cleft palate, ocular hypertelorism, narrow sloping forehead, flat nasal bridge, and defects of the external and inner ear. Other miscellaneous defects associated with Accutane include limb reductions, decreased muscle tone, and behavioral abnormalities.

In addition to the great risk associated with the use of Accutane, a high percentage of the drug's users are of childbearing age. It is estimated that 38% of Accutane users are women between the ages of 13 and 19 years.[8] This drug should never be taken during pregnancy or if planning to become pregnant. If absolutely necessary, topical medications, including Benzoyl peroxide and Erythromycin, are the preferred acne treatment methods during pregnancy.

Psychiatric Drugs

Lithium, which is useful in treating manic depressive illness, is associated with increased risk of congenital abnormalities. It interferes with cardiogenesis and causes heart defects such as Ebstein's anomaly (which effects the organ's tricuspid valve). After the completion of cardiogenesis, approximately 6 weeks after conception, maternal use of lithium during gestation presents decreased risk of malformations to the fetus. However, the drug has been reported to cause low birth weight and premature birth.

Diazepam (Valium), a sedative and anti-anxiety drug, readily crosses the placenta. If exposure to the child occurs in the first trimester, serious congenital anomalies result, including cleft lip and palate, inguinal hernia, heart defects, and pyloric stenosis. If Valium is taken during the second trimester of pregnancy the fetus may develop circulatory and

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[7] Conover, 527.

cardiac defects and hemangiomas. Use of the drug before delivery will generally result in low Apgar scores, hypertonia, and reluctance to feed. The infant may also suffer withdrawal symptoms including tremors, irritability, hypertonicity, diarrhea, and vigorous sucking. Fluoxetine (Prozac) is now a commonly prescribed antidepressant which is currently believed to be safe for use during pregnancy. Studies show that there was no increase in birth-defects, spontaneous abortions, stillbirths, or premature deliveries among women who took the drug during pregnancy compared to those who did not.

Thyroid and Antithyroid Drugs

The thyroid gland produces hormones which regulate the body's metabolism. An excess or a deficiency of thyroid hormone production can be harmful to a person and should be treated with medication.

Propylthiouracil is a commonly used antithyroid drug for the treatment of hyperthyroidism, overactive thyroid hormone production. The drug blocks maternal production of thyroid hormone. Propylthiouracil taken at the end of pregnancy can interfere with fetal production of thyroxin and cause a temporary case of mild hypothyroidism and/or congenital goiter in a child. However, the goiters induced by Propylthiouracil are usually small and do not compress the baby's trachea.

Iodide-containing medications, used in other antithyroid drugs as well as in some cough syrups, are known to present an increased risk to a fetus. Iodides cross the placenta, and can cause hyperthyroidism and goiter in the fetus which can lead to tracheal compression, asphyxiation, and death.

Thyroid hormone substitutions are used to treat a disease called hypothyroidism, which is characterized by an underactive thyroid gland. Synthetic thyroid hormones, such as Levoxyl or Synthroid help maintain the body's necessary thyroid hormone levels. When taken at the

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[8] Joanne McManus Kuller, "Effects on the Fetus and Newborn of Medications Commonly Used During Pregnancy," *Journal of Perinatal and Neonatal Nursing* 3, no.4, (April 1990): 80.

proper dosage, fetal exposure to the hormone does not appear to cause adverse effects. A deficiency of thyroid hormone secretion, for example, as a result of untreated hypothyroidism, can cause a congenital condition called cretinism which is characterized by "arrested physical and mental development, dystrophy of bones and soft parts."[9]

Asthma Medications

Some asthmatic individuals use bronchodilators to relieve their attacks. Bronchodilators, such as Aminophylline (Aminodur), relax and widen narrowed air passages of the lungs, making it easier to breath.

Although asthma medications are not believed to be harmful to a developing fetus, they have not been proven to be safe either. Currently, the medical community feels that the potential benefit of controlling asthma attacks during pregnancy outweighs the risk of uncontrolled asthmatic episodes. If breastfeeding, it is recommended that a mother nurse her baby before taking the asthma drug, in order to reduce exposure to high concentrations of the medication. Any asthma medications containing iodides should also be avoided. (As mentioned earlier iodides can have adverse effects on the thyroid gland.)

Tranquilizers

Thalidomide is a sedative and hypnotic agent which was widely prescribed to pregnant women in Europe during the early 1960's. It was later discovered to be a teratogen. Thousands of women who took thalidomide during pregnancy gave birth to severely deformed children. The malformations associated with the drug include limb abnormalities (such as phocomelia, amelia, polydactyly, and syndactyly); facial hemangiomas; hydrocephalus, intestinal, cardiovascular and renal anomalies; and eye and ear defects.

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[9]Moore, 136.

Although thalidomide is a known teratogen, the FDA has recently proposed to allow restricted use of the drug in order to treat specific conditions, including leprosy, lupus, and AIDS-related ulcers.

In addition to numerous prescription medications, there are many non-prescription or over-the-counter drugs found in drugstores and supermarkets. Some of the pills and syrups used to relieve common aches and pains, such as colds, allergies, sore throats, and headaches are potentially harmful to an unborn child. It is extremely important that women who are planning to become pregnant or are pregnant consult their doctor before taking even commonly used pain relievers and decongestants. If it becomes necessary to treat ailments during pregnancy, a doctor will know which drugs on the market are safest for the baby. Certain medications are known to pose less of a risk to a fetus than others.

Analgesics

Aspirin, a commonly used bloodthinner, painkiller, and antipyretic, is not teratogenic if taken in normal therapeutic doses. However, maternal use of aspirin (for example: Bufferin, Anacin, Emperin) and aspirin-containing medications, near the end of pregnancy can interfere with the body's clotting mechanism and cause maternal and neonatal bleeding. It can also prolong pregnancy and delivery, as well as cause the baby to have a low birth weight. There have been reports that aspirin and another analgesic, Ibuprofen, are both associated with premature closure of the fetal ductus arteriosis. Long-term or heavy use of Aspirin during pregnancy should be avoided.

Acetaminophen (Tylenol), when taken in the proper doses, is the analgesic of choice during pregnancy.

Antihistamines

Antihistamines are used to relieve symptoms of congestion caused by allergies or the common cold. There are many types of antihistamines on the market. So far, antihistamines have not been associated with congenital abnormalities in humans. However, this does not mean that they are safe to take during pregnancy. Additional research is necessary in this area.

Cold Medications

Many cold medications (including Robitussin, Sucrets, Vicks) can contain antihistamines, aspirin, caffeine, iodides, and alcohol. Antitussives (cough suppressants) often contain codeine, which is derived from opium, and many expectorants contain iodides. Therefore it is recommended that the use of cold medication be avoided during pregnancy.

The "thalidomide tragedy" sparked a new interest in teratology, "the study of environmentally-induced congenital anomalies."[10] Researchers began testing the safety of a variety of agents, especially prescription and over-the-counter medications, and the affect these agents may have on a developing fetus. Animal studies, as well as controlled studies in humans, are used to determine the safety of new drugs before they are marketed. While, not every drug that is teratogenic in animals is teratogenic in humans, animal studies help identify the possible harmful effects different drugs may have on humans. In human studies, men make up the majority of the participants, so there is less data on the effects of many new drugs on women. And, since drug testing is virtually never done on pregnant women, the effects of most new drugs on an embryo/fetus are not known before marketing a new product. This uncertainty of risk potential can make prescribing medication difficult for many physicians.

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[10] Seaver, 111.

In an effort to advise physicians about the teratogenicity associated with different drugs, The Food and Drug Administration began requiring that all prescription drugs be classified according to the level of risk they can have on an embryo/fetus. (Categories include A, B, C, D, and X.) For example, category A indicates no known risk to a fetus. Category C drugs should only be used during pregnancy if the "potential benefit justifies the potential risk to the fetus."[11] Category X marks evidence of fetal risk, therefore drugs in this category should not be used by women who are or may become pregnant. Despite the FDA's requirement of risk categories for drugs, as mentioned earlier, the risk potential of most prescription drugs has not been established, so there are many drugs on the market classified as category C, the "limbo" category.

The FDA also encourages the consumer to be advised of potential risks associated with drug products. They require information to be printed on product labels. This information discloses any suspected or confirmed fetal risks associated with each particular product. As a result, consumers can make more informed decisions regarding the products they use. Although it is important to read the product labels, it is always advised that a woman who is pregnant or is planning to become pregnant inform her doctor of any and all drugs she is taking.

Additional research in the field of teratology is necessary, especially long-term studies which would reveal the harmful effects of drugs on brain development and behavior rather than just the more apparent structural anomalies. In addition, the education of physicians, nurses, public health authorities, and parents about teratogens is essential in decreasing the incidence of drug-induced birth defects. Also, because many babies are born to teen mothers, information on known and suspected teratogens should be disseminated in school sex education curriculums. Ideally, a woman should learn about potentially dangerous substances before she becomes pregnant. This would allow her time to, for example, consult

[11] Kuller, 74.

with her physician and change her current medication, fight an addiction to alcohol, cigarettes, or narcotics, or just improve her nutritional habits before conception. Awareness is the key to eliminating the majority of preventable birth-defects.

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CHAPTER FOUR

In an effort to increase public awareness about the harmful effects of drugs and to encourage responsible behavior during pregnancy, I have created this pamphlet for distribution to women's healthcare clinics around the country.
The illustrations throughout the pamphlet are designed to entice a patient to read the text and to try to understand why it is important to practice a healthy lifestyle during pregnancy. By using simple, straightforward descriptions of some of the harmful effects drugs can have on a fetus the information should be easily understandable to all women regardless of their educational level. In areas where other languages, such as Spanish may be the dominant language, a translated version could be distributed.

A variety of sources were used to create the illustrations within the pamphlet. The series of embryos and fetuses representing the nine month gestational period were drawn from a number of photographic and illustrative sources. A combination of three or four images were sometimes used to create one of the embryo/fetus illustrations. In the case of the fifth and seventh month fetuses, I used my sketches and photographs of two preserved babies at the University of Rochester as sources. The drawing of a woman drinking with a cigarette in hand was created by using photographs of my mother, posed with a glass of wine and a cigarette. Photographs found in magazines from a local library as well as photographs I had

taken of my mother's hands served as sources for the image of the mother breastfeeding her child. The sources for the doctor and expectant mother were pictures from three or four different magazines and my own imagination. Magazine and catalogue photographs were used as sources for the image of a newborn in an incubator. Textbook photographs were used for the drawing of the mother holding her sleeping child. A number of illustrations were used as sources for the drawings depicting follicular development, ovulation, fertilization, cell division, and implantation and a model was used for the drawing of the female pelvis. The sources for the placenta, umbilical cord, and developing baby were multiple illustrations of the placenta, textbook photographs of umbilical cords and my imagination. I sketched cough syrup, pill bottles, glasses containing alcohol, and a pack of cigarettes, and I used other magazine photographs as sources for the images of illicit drugs.

All illustrations were created in graphite pencil on paper, scanned into the computer and brought into Adobe Photoshop 5.0. Each image was then turned into an RGB file, and transformed into sepia tone. (The option for choosing sepia toning is found in the Actions window.) After changing the color of the images, all images were flattened and then "cleaned up", by eliminating any unwanted "background" pixels and by "airbrushing" any harsh lines of the drawings into a fade with the use of the eraser tool at a low opacity. After the desired editing, all files were saved in the Photoshop format, in which multiple layers can be preserved, and then in the TIFF format which can be placed into the layout program QuarkXPress 3.2.

I placed the images in an order which would tell a story as one turns the pages. Each of the nine months of development is represented by a drawing. The baby's growth progresses throughout the pamphlet. The doctor and patient drawing is placed next to images of the first two trimesters to reinforce the importance of receiving prenatal care in the early stages of pregnancy. The drawings of drug and alcohol abuse follow the illustration and

description of the placenta, the organ which transfers substances from the mother to the child. The back of the pamphlet shows a peaceful mother and child, reinforcing to the reader that an appropriate lifestyle during pregnancy, without the use of drugs, will increase her chances of having a healthy baby.

Once the images were placed on the page I incorporated the text in Quark. I did not want to crowd the pamphlet with too much text, making it intimidating to read, so I decided to leave plenty of white space on each double-page layout. The warm peach/pink tones of the pages and the Times regular and italicized fonts are meant to appeal to female readers. Ultimately, I hope that the visual and written information provides the reader with a greater awareness of the effects of drug use during pregnancy and the inspiration to practice responsible behavior while carrying and breastfeeding a child.