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Possible Reproductive Detriment in LSD Users

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One hundred forty women and their consorts, admitting to the use of lysergic acid diethylamide (LSD) prior to or during pregnancy were observed through 148 pregnancies. There were 83 live newborns; 8 had major congenital defects. There were 65 abortions; 53 therapeutic and 12 spontaneous. Four of 14 embryos from therapeutic abortions showed gross anomalies. Forty-three percent of first-trimester pregnancies ended in spontaneous abortions. Four of eight serial pregnancies resulted in defective embryos or infants. Eight of 12 women have been unable to conceive again over an 18-month period.

The ingestion of other illicit drugs, the presence of infectious disease, and marginal maternal nutrition preclude a definitive correlation of increased reproductive risk with LSD ingestion. The presence of LSD ingestion, coupled with studies in animals and supported by DNA studies, suggests that LSD might be hazardous to human reproduction.

In 1967, Cohen and co-workers first demonstrated chromosome damage in human leukocyte cultures after in vitro addition of lysergic acid diethylamide (LSD).[1] This finding was quickly extended to leukocyte cultures of patients admitting to the prior ingestion of LSD. Since these initial reports, there have been at least nine other published studies concerning the possibility of chromosome damage after exposure to LSD. These studies are in conflict, four supporting the original observation of Cohen, but five finding no increased damage over controls. In spite of this controversy, there does exist concern that LSD, if it does cause chromosome damage, might therefore possess teratogenic, mutagenic, or carcinogenic effects.

The possible teratogenic effect of LSD has been explored in studies done in animals, with conflicting results. Alexander et al[2] have reported an increased incidence of embryo resorptions, stunted fetuses, and stillbirths in rats. Administration of LSD to pregnant hamsters resulted in an increase in the percentage of resorptions, stillbirths, runts, and congenital abnormalities in offspring (exencephalia, myelomeningocele, hydrocephalus, and omphalocele).[3] These results have not been supported by other workers using the same species.[4]

There have been several retrospective reports of congenital anomalies in infants following parental ingestion of LSD. These infants have had both skeletal and central nervous system (CNS) anomalies.[5,6] In all reported cases, the LSD ingested was illicit, and in some cases, mothers (as well as fathers) had been exposed to other drugs before and during pregnancy.

A series of ten pregnancies involving maternal ingestion of LSD during gestation produced ten normal infants, although three were premature (less than 36 weeks gestation).[7] The large series reported retrospectively by McGlothlin et al[8] was remarkable for an increased abortion rate of 37% with parental exposure to both medically administered and illicit LSD. However, one patient accounted for five abortions, and if her case is deleted, the abortion rate falls to 24%. With medically administered LSD exposure only (82% of patients), the abortion rate was 15%, which is within the normal range of 15% to 20%. Fourteen of 120 live births produced infants with medical problems, none of which could be with certainty attributed to genetic damage.

In order to investigate the role of LSD as a possible mutagen, a prospective study was begun in 1968 at the George Washington University School of Medicine. (In this communication "prospective" means ascertainment of LSD exposure *prior* to delivery.)

Patient Population

Pregnant women who volunteered

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a history of the use of LSD either by themselves or their consort prior to or after conception were accepted into the study. Patients were referred by a variety of channels: clergy, physicians, adoption agencies, underground newspaper ads, and other drug users. One hundred forty-eight pregnancies in 140 women were ascertained prior to delivery. Each woman (and her consort if available) had an extensive social and medical interview. Besides a careful drug history, particular attention was paid to the following areas: pedigree analysis, infection during pregnancy, venereal disease, exposure to other potentially mutagenic and teratogenic agents, and prenatal nutrition. She was then referred either to the obstetric clinic or a private physician for prenatal care. Periodic visits were made to our clinic for blood and skin samples for chromosome analysis. On these visits the drug history was reviewed and updated if necessary. Whenever possible, samples of LSD were obtained from these patients and submitted for analysis. Five of six samples analyzed contained LSD (range was 50μg to 125μg per sample); the sixth sample contained only α-methyltryptamine. Table 1 shows the pattern of LSD use by the mother or the reputed father, or both. Since only ten of 141 pregnancies occurred with only paternal drug use, all descriptions below refer to the pregnant mother unless otherwise mentioned.

The patients came from a white, middle- to upper-middle-class population. Approximately one half of the pregnant women had adopted a "hippie" life style (communal living, use of psychedelic drugs, introspection, antimaterialism, and opposition to established social order). The other one half of the population, while largely in sympathy with this life style, chose to remain in the suburbs, either with parents or with a spouse in a conventional setting.

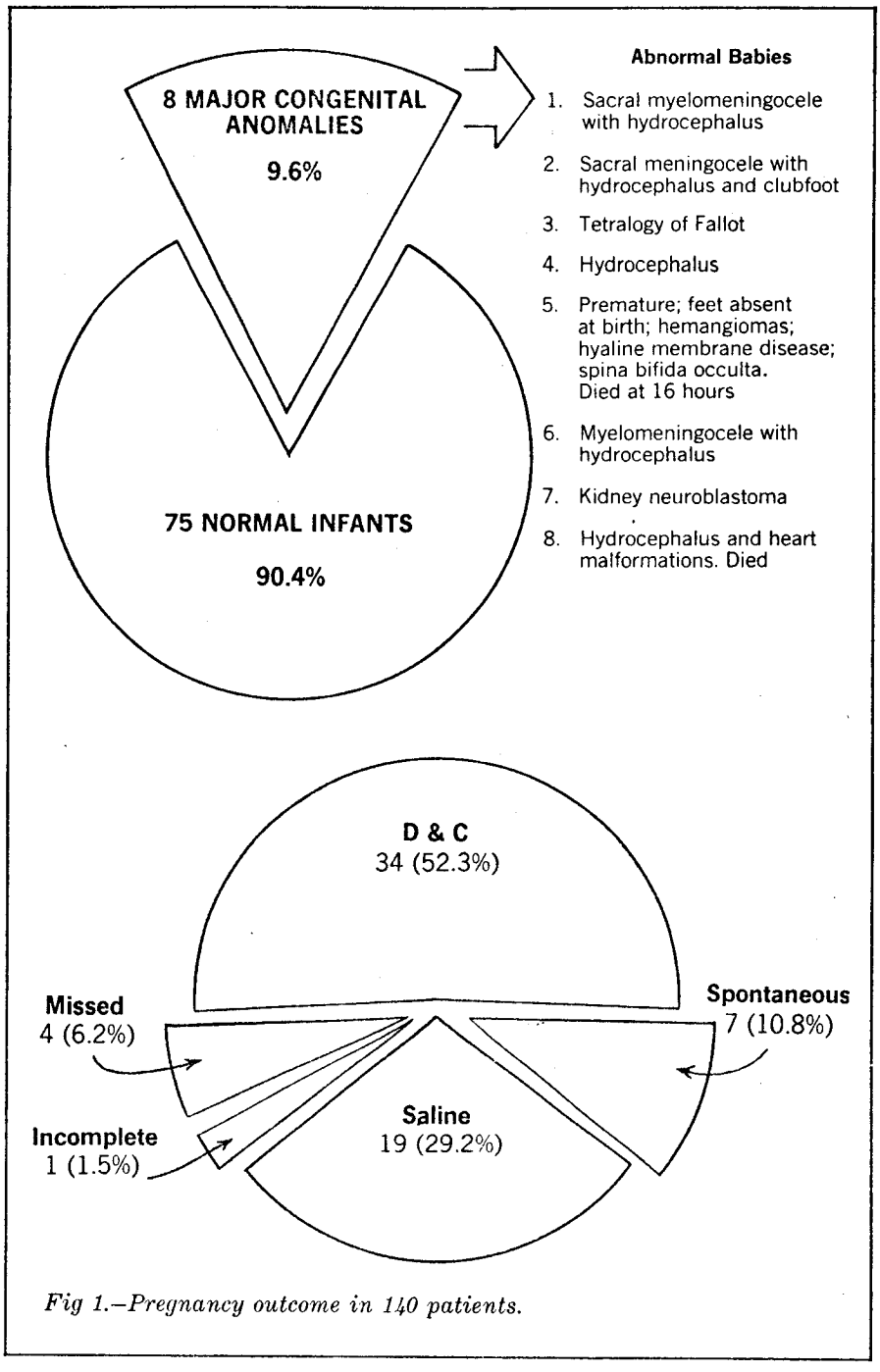

Fig 1.—Pregnancy outcome in 140 patients.

Chromosome Studies

These studies will be presented in detail elsewhere. Chromosomal analyses of both peripheral leukocytes and skin fibroblasts obtained by biopsy were performed on the parents during pregnancy and at birth. The infant's chromosomes were examined at birth and at frequent intervals thereafter (eg, 2 weeks, 6 weeks, 3 months, 6 months, and 1 year of age). In brief, we found about 50% of the infants had normal findings in chromosome analyses. The other 50% with abnormal chromosomes (chiefly increased breakage) had repaired this damage by age 3 to 6 months.

Evaluation of Infants and Abortuses

Infants.—Whenever possible, the newborn infant was seen at birth by one of the authors of this communication. If the infant was born in another hospital, he was examined as soon as possible, usually by 2 weeks of age. Infants were examined at birth, at 2 weeks of age, 6 weeks, 3 months, 6 months, and thereafter at six-month intervals. Particular attention was paid to growth and development, head circumference, and eye examination. Complete blood cell counts and urinalysis were done. The longest follow-up to date is 2½ years.

Abortuses.—Fetal tissue was obtained, when possible, from both ther-

Table 1.—Parental LSD Use

	Maternal and Paternal	Maternal Only	Paternal Only	Total
Live births	61	15	7	83
Abortions	51	11	3	65
Total pregnancies	112	26	10	148

Table 2.—LSD Use in Pregnant Women

No. of Exposures	% Women Using LSD*	
	Before Pregnancy	After Pregnancy
Single use	20	0
2-5	17	17
6-10	14	8
11-20	25	22
20+	14	11

*The sum of both columns exceeds 100% because many patients took LSD both before and during pregnancy.

Table 3.—Other Drugs Ingested by LSD Users

Drug	% Study Group Using Drug
Marihuana	100
Amphetamines	82
Peyote (and mescaline)	41
Dimethyltryptamine	28
Narcotics	25
Dimethoxy methylamphetamine (STP)	17
Barbiturates	15

Table 4.—Percent Exposure to Possible Mutagens

Agent	Users	Nonusers
Coffee/tea	56	44
Cyclamates	8	92
Tobacco	81	19
X-rays (heavy abdominal exposure)	36	64

Table 5.—LSD Exposure in Parents of Abnormal Infants

Patient No.	Birthdate	Exposure	Parent Age, yr	PTC*	Trimesters 1	2	3	Timing Nearest to Conception
1	10/14/68	Paternal	21	25	...	...	...	Within 3 days
		Maternal	19	0	0	0	0	
2	11/23/68	Paternal	18	40	...	0	0	Within 3 days
		Maternal	18	25	0	2	6	Within 3 days
3	2/11/69	Paternal	22	200	0	0	0	1 mo PTC
		Maternal	19	25	0	0	0	1 mo PTC
4	3/15/69	Paternal	21	40	...	...	0	1 mo PTC
		Maternal	17	3	2	0	0	2 weeks PTC
5	1/23/70	Paternal	19	4	0	0	0	1 mo PTC
		Maternal	17	3	0	0	0	1 mo PTC
6	2/3/70	Paternal	25	300	0	0	0	2 yr PC
		Maternal	20	400	25	0	0	1 mo PTC
7	9/3/70	Paternal	20	4	...	...	...	2 weeks PTC
		Maternal	20	1	0	0	0	2 weeks PTC
8	11/13/70	Paternal	22(?)	50	...	...	...	1 week PTC
		Maternal	25	50	0	0	0	1 week PTC

*Values are the number of times drug was taken prior to conception (PTC).

apeutic (dilatation and curettage) and spontaneous abortions. Embryos intact enough for analysis were obtained in 14 therapeutic and four spontaneous abortions. The specimens were examined in saline solution under a dissecting microscope. They were then fixed for routine pathological study; coronal sections were made from crown to rump.

Drug Exposure

Exposure to LSD in this population varied from 1 to 400 doses. Table 2 shows the extent of exposure to LSD both before and during pregnancy. Distribution is quite even, with 50% of the patients taking between 2 and 20 doses of LSD. The "street" dose of LSD is reputed to be 250μg. The five samples in this study were analyzed to be between 50μg and 125μg. These figures are consistent with published figures of analysis of "street" drugs.[9]

Many of these patients gave a history of ingestion of other illicit drugs. The range of experience with other drugs is seen in Table 3. All patients admitted smoking marihuana. Of the 26 patients admitting heroin usage, only six were true addicts (ie, requiring daily doses intravenously). Nearly all of the other drugs were taken orally. A small number (about 20%) of patients admitted to the occasional intravenous use of amphetamines or barbiturates. All drugs were obtained "on the street." Lysergic acid diethylamide, psilocybin, phencyclidine hydrochloride, dimethyltryptamine, mescaline, dimethoxy methylamphetamine (STP), tetrahydrocannabinol, heroin, cocaine, and morphine were all sold with no external means of identification nor reasonable assurance that they were, in fact, the reputed drugs. Barbiturates and amphetamines were nearly always provided in tablets and capsules which were recognizable as identical to the medically prescribed drug.

Exposure to Other Possible Mutagens

A careful survey was taken of exposure to other *possible* mutagens. These are listed in Table 4. About 50% of the patients drank caffeine beverages. There was very little use of cyclamates (confined to soft drinks). Cigarette smoking was common. Significant x-ray exposure (to the abdomen) was experienced by 36% of drug users. None of the women producing abnormal fetuses or abnormal infants had large amounts of x-ray exposure. It is of interest that such a high proportion of young women underwent multiple diagnostic x-ray films: included are x-ray film series of the gastrointestinal tract, barium enema, and intravenous pyelogram. According to the patients, none of these examinations revealed organic pathological findings. With the exception of one fetograph and one x-ray film of the chest in the third trimester, all patients denied exposure to x-rays during pregnancy.

Outcome of Pregnancies

Live-Born Infants.—These 140

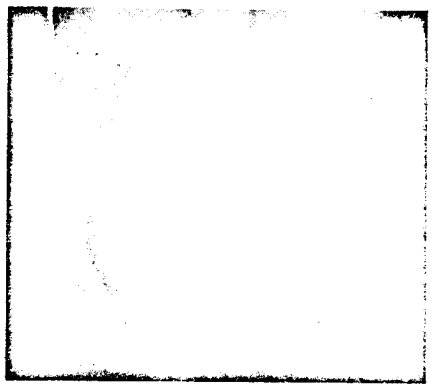

Fig 2.—Lower extremities; there are no rudimentary structures distal to the tibia (patient 5).

women had 148 pregnancies. Eighty-three pregnancies ended with live, newborn infants (Fig 1). Seventy-five infants were normal; one was premature and died in the newborn period of an intrapulmonary hemorrhage. Eight infants had major congenital anomalies; one of these was of 36 weeks gestational age and died of hyaline membrane disease. None of the 83 live-born infants were small for gestational age. The eight abnormal infants are presented in detail below.

Report of Cases

Abnormal Babies.—CASE 1.—This female infant was born on Oct 14, 1968, to a 19-year-old mother (gravida 1, para 1, abortions, 0). She was noted to have a sacral myelomeningocele (with hydrocephalus) at birth, which was repaired at the Children's Hospital, in the newborn period.

CASE 2.—This male infant was born Nov 23, 1968, to an 18-year-old mother (gravida 1, para 1, abortions, 0); the baby was noted to have a sacral swelling at birth. A sacral meningocele (with hydrocephalus) was found at operation and repaired. This child also has a clubfoot.

CASE 3.—This female infant was born Feb 11, 1969, to a 19-year-old mother (gravida 1, para 1, abortions, 0) whose first child is normal. The baby weighed 2.5 kg (5 lb 11 oz) at birth. Besides the LSD ingestion, both parents were heroin addicts. The mother was an addict at the time of birth, and had withdrawal symptoms in the postpartum period. Cardiac evaluation of the infant revealed tetralogy of Fallot. Toxoplasma titer was negative for both mother and infant. The mother had a rubella titer of 1:1,024 with no history of clinical rubella during pregnancy. The infant's cord titer was 1:2,048; at 3 months of age, 1:128; 6 months, 1:32; and 0 at 14 months of age.

CASE 4.—This male infant was born on March 15, 1969, to a 17-year-old mother (gravida 1, para 1, abortions, 0). Apgar scores were 4 and 8. Labor was difficult and the baby needed intubation. There were forceps marks and bruises on the face. Neonatal course was uneventful. The white blood cell count (WBC) remained elevated above 20,000/cu mm for the first month of life. Head circumference at birth was 34 cm; at four weeks it was 38.5 cm (same observer). Hydrocephalus was suspected because of this sudden increase in head circumference and the presence of a setting-sun sign. The infant was admitted to Children's Hospital at 4 weeks of age; pneumoencephalogram revealed considerable hydrocephalus.

CASE 5.—This infant girl was born Jan 23, 1970, (36 weeks gestation) to a 17-year-old mother (gravida 1, para 2, abortions, 0). Her first child was normal. At birth, this infant was noted to have bilateral amputation of both feet (Fig 2), symmetrical, racemose hemangioma of the abdomen and thighs (Fig 3), and a large hemangioma of the scalp. Hands had short, blunted fingers with one missing, and several hypoplastic terminal phalangeal bones seen by x-ray film. The child died at 16 hours of age due to hyaline membrane disease. Autopsy showed spina bifida occulta, as well as the described anomalies. Hyaline membrane disease was confirmed. The brain was grossly normal.

CASE 6.—This female infant was born Feb 3, 1970, to a 20-year-old mother (gravida 1, para 1, abortions, 0). Thoracic myelomeningocele with obvious hydrocephalus was noted at delivery.

CASE 7.—This infant boy was born at term on Sept 9, 1970, to a 20-year-old mother (gravida 2, para 2, abortions, 0). An abdominal mass was detected on the second day of life and two days later a neuroblastoma of the right kidney was removed. There was no evidence of metastases and recovery was uneventful.

CASE 8.—This infant boy was born at 37 weeks gestation to a 25-year-old mother (gravida 2, para 1, abortions 1). Her first pregnancy, ten years previously (prior to any drug exposure) ended in a first-trimester, induced abortion. At birth, the infant was noted to have an enlarged right side of the cranial vault and shortly thereafter had a congestive heart failure. Angiographic study showed a large arteriovenous (AV) malformation. The infant died before surgery could be done. Autopsy showed a large AV malformation involving the vein of Galen and bilateral hydrocephalus (right greater than left). There were dilated blood vessels over both hemispheres, brain stem, and cerebellum.

The LSD exposure of the parents of these patients, before and after conception, is shown in Table 5. The last

Fig 3.—Racemose hemangiomas of the abdomen and thigh; identical lesions present on opposite side (patient 5).

Fig 4.—Coronal section of an embryo with cerebral encephocele showing wide extent of defect.

column indicates timing of LSD dose nearest to conception. Table 6 indicates exposure, before and after conception, to other drugs and x-rays. Only one parent denied the use of LSD; all others had ingested LSD from 3 to 400 times. The ingestion of this illicit LSD was, in most cases, accompanied by hallucinations. Only two mothers took LSD during the first trimester, a third mother took it during the second and third trimester. However, all but one parent admitting to LSD use ingested the drug within one month of conception. Radiation exposure was minimal in these patients (Table 6). One mother had a chest roentgenogram in the first trimester; another had a pelvic roentgenogram at two days prior to delivery to determine pelvis outlet size and to rule out twins.

Abortions.—There were 65 abortions (Fig 1). Fifty-three were therapeutic abortions; 34 by dilatation and

Table 6.—Exposure to Drugs and X-rays in Parents of Abnormal Infants

Patient No.	Parent	Drugs*		X-rays	
		PTC†	During Gestation	PTC	During Gestation
1	Paternal	1,3,4,5,6	...	Chest, shoulder 1967	...
	Maternal	1	6 (Snuff, 1 time)	0	0
2	Paternal	1,2	...	0	...
	Maternal	1,5	0	Chest 1966(?)	0
3	Paternal	1,3,4,5,6 (addict)	...	0	...
	Maternal	1,3,4,5,6 (addict)	1,6	0	Chest, 9th week
4	Paternal	1, 2, 5,psilocybin	...	0	...
	Maternal	1, 2, 5,psilocybin	Quinine (1 dose, 200 mg)	Chest 1967	Pelvis (at term)
5	Paternal	1,3,5	...	0	...
	Maternal	1,3,5	1,3,5	0	0
6	Paternal	1,3,4,5,6 (addict)	...	Chest 1969	0
	Maternal	1,3,4,5,6 (addict)	1, 5, 6 (1st trimester)	Back (3 times) 1967	0
7	Paternal	1,5	...	?	...
	Maternal	1,5	0	0	0
8	Paternal	1,5	...	?	...
	Maternal	1,5,6 (opium twice)	0	Chest 1969	0

*Drugs include the following: (1) marihuana; (2) dimethyltryptamine; (3) barbiturates; (4) tranquilizers; (5) amphetamines; (6) narcotics (heroin, morphine).
†PTC, prior to conception.

Table 7.—Outcome of Repeat Pregnancies

First	Second	Third
Normal term	Therapeutic abortion—dilatation and curettage*	Normal term
Normal term	Therapeutic abortion—saline	Spontaneous abortion*
Normal term	Normal term	
Normal term	Neonatal death*	
Normal term	Therapeutic abortion—saline	
Normal term	Spontaneous abortion (twins)*	

*Indicates multiple anomalies.

curettage, and 19 by hypertonic saline solution. The therapeutic abortions were performed for psychiatric indications. We were not involved in the decision to terminate pregnancy. These patients denied to us the use of medically administered psychotropic drugs. In 14 instances the products of conception following the therapeutic abortion were intact enough for analysis. Four of these embryos were defective with midline fusion defects being most prominent. Figure 4 shows an embryo with a cerebral encephocele. The other three embryos had similar defects; one embryo also had facial and limb-bud dysgenesis. Of the seven spontaneous abortions, four including one set of twins were abnormal, with encephoceles and failure of skeletal development of the extremities. There were four missed abortions and one incomplete abortion.

Twenty-eight women were enrolled in the study prior to the 12th week of gestation. The initial contact with the other 105 women was established after 12 weeks of gestation. Of the 28 pregnancies thus presenting in early pregnancy, 12 (43%) ended in spontaneous abortion. There were no spontaneous abortions in those patients enrolled after they had passed the 12th week of gestation.

Infertility as a possible indication of genetic damage was examined by determining that there were 12 women expressing a desire and attempting to have repeat pregnancies; to date, eight of these women (attempting conception for at least 18 months) have been unable to conceive.

Repeat Pregnancies.—An examination of the repeat pregnancies in this study group shows that six women had more than one pregnancy. The first pregnancy resulted in a normal-term infant in all cases. However, in eight subsequent pregnancies in these six women, four terminated with abnormal offspring (Table 7); four abnormal fetuses (one twin pregnancy), and one abnormal newborn (case 5).

Comment

Recent work[10,11] has shown that the LSD molecule is capable of altering the structure of DNA in vitro. Animal studies cited in this communication have shown the teratogenic effect of LSD when given to pregnant animals. The present report raises the possibility that exposure to LSD prior to pregnancy, as well as during pregnancy, may also result in abnormal offspring. Both teratogenesis and mutagenesis may be explained on the basis of an altered DNA. Figure 5 illustrates the consequences of producing an altered DNA.

If DNA alteration occurs, and if the cell remains viable and shows persistent cellular abnormalities, two possible cell lines will be affected. If the somatic (body) cells are affected, cellular aging, induction of malignancy, and fetal abnormalities might result. If the gonadal (sex) cells are affected, sterility, abortion, and fetal abnormality (in offspring) might result. These predictions are based on work done in animals and exposure of humans to intense radiation.

There is no evidence of cellular aging in the infants. Follow-up to 2½ years of age has shown normal growth and development. There have

been no major medical or surgical illnesses in the normal infants. No newborn infants have been small for their gestational age. One infant (case 7) has had a malignancy in the newborn period. It is interesting to note that one abnormal infant (case 4) had a persistent WBC in excess of 20,000/cu mm for the first month of life. Results of an examination of the bone marrow in this child were within normal limits at 4 weeks of age; results of multiple chromosome analyses have been normal.

Eight of 83 live-born infants had serious congenital anomalies. A recent summary of reported incidence of congenital anomalies in the US population gives a range of 5.0 to 10.0 major structural anomalies per 1,000 live births.[12] It was not possible to assemble a strictly control group for the present study; ie, a similar group of young women who took psychedelic drugs excluding LSD. In the period of the study (1968 to 1970) LSD use was universal among young people taking various psychedelic drugs. We were unable to find any young adults, admitting to the use of psychedelic drugs, who denied taking LSD. The only group in the Washington, DC area that is available for comparison with our study group is the population of one of the homes for unwed mothers. This facility accepts unwed pregnant women from all socioeconomic classes and provides residential care prior to and after delivery. The outcome of these pregnancies has been monitored by one of the authors (C.B.J.) since 1962. Since then, the incidence of structural congenital defects has remained stable at six per 1,000 live births. Thus the incidence of major congenital anomalies in the offspring of a population of drug users was 96 per 1,000 live births, or 10 to 20 times that expected for the American population.

The defects described in these infants and embryos are chiefly of the CNS. Myelomeningocele is known to have a genetic component; eg, the incidence in Wales and parts of Ireland is two to three times that of the American population. It is also clear that environmental factors, especially infection, also play a role in the etiology of congenital defects. It is not unreasonable that both genetic and environmental factors may be operative through a common pathway, ie, altered DNA.

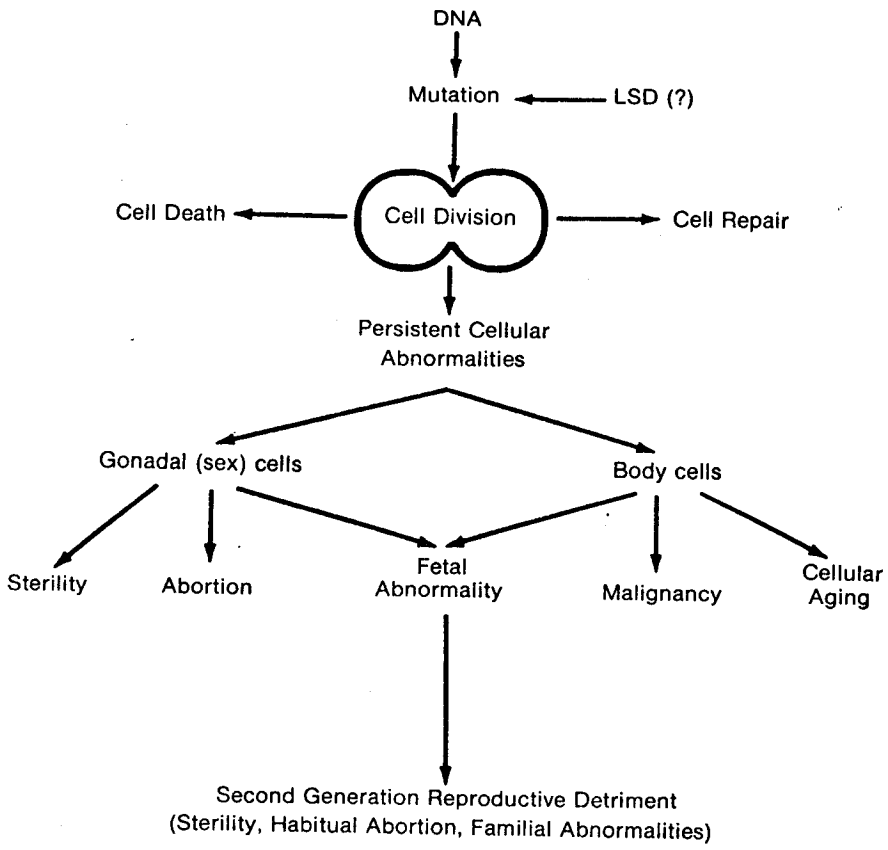

Fig 5.—Schematic representation of the consequences of altered DNA.

It is well known that many fetuses expelled in spontaneous abortions have structural defects. Miller and Poland[13] found 20% to 88% of the embryos abnormal, depending on gestation age; the overall incidence (all embryos less than 140 days old) was 43%. The same authors found 12% of the defective embryos to have spinal rachischisis.

The spontaneous abortions in our study showed four abnormal embryos of the seven available for study; all of these embryos had neural-tube fusion defects.

However, there is no reason to expect that embryos from pregnancies electively terminated in the first trimester would be abnormal. Nishimura et al, in a series of 1,213 intact embryos, found a peak frequency of 4%.[14] In the present study, four of 14 embryos available from therapeutic abortions had gross structural abnormalities. These defects (as well as those of the embryos from spontaneous abortions) involved failure of midline fusion of the CNS; defects similar to those reported in animal studies and also in our patients with myelomeningocele.

Twenty-eight women were enrolled in the study prior to the 12th week of their pregnancy. Twelve (43%) of these women subsequently had a first-trimester spontaneous abortion. This is a twofold increase in the commonly accepted figure of 15% to 20%.[15]

In the six patients who had more than one pregnancy, there was a 50% rate of defective offspring. These small numbers preclude a definite conclusion, but strongly suggest that serial reproduction may be at high risk.

A small number of women (12) expressed a desire for a repeat pregnancy. Four became pregnant, and to date (1½ to 2½ years of follow-up) eight have been unable to conceive. It is too soon to conclude definitely that fertility may be compromised.

Although it is true that LSD ingestion was a common denominator of all the pregnancies, its implication is difficult to prove. As used by the population, LSD is an illicit compound and the purity of "street" samples must be seriously questioned. Dosage is purely historical and, as Cheek et

al[15] have shown, seldom that advertised. Other chemicals might be added to or in place of LSD. There is a multiple-drug environment with especially heavy use of marihuana and amphetamines. Both of these drugs (especially amphetamines) have been implicated as possible mutagens or teratogens in animals[16] although not suspected in humans. Infectious diseases especially viral illnesses, were common during pregnancy; at least 10% of the women gave a history of febrile illness during gestation. Five percent had gonorrhea (by history) prior to pregnancy. There were no known positive results of serologic tests for syphilis during pregnancy. Five percent of the women gave a history of overt hepatitis (two during pregnancy) presumably due to contaminated hypodermic needles. Maternal nutrition is frequently inadequate prior to the mother's knowledge that she is pregnant. All pregnant women made a reasonable effort to provide good nutrition after pregnancy was known, but frequently the first trimester went by without pregnancy being determined.

All of the above factors may contribute to increased fetal defects in this group of young women. In this environment, conducive to high obstetrical risk, LSD is a common denominator. This observation has support in some animal studies and in studies of LSD binding to nucleic acids. All of these considerations support the suspicion that ingestion of this illicit compound may be hazardous to human reproduction.

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Milton Jaffe, MD, of the Bureau of Narcotics and Dangerous Drugs, performed the analyses of the LSD.

The rubella titers were performed by Charles A. Alford, Jr., MD, from the Department of Pediatrics, University of Alabama Medical Center.

Nonproprietary and Trade Names of Drug

Phencyclidine hydrochloride—*Sernylan.*

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JAMA 75 YEARS AGO

Dec 11, 1897

On the Nose

At last a change came in medicine as regards the nose, and its anatomy was more carefully studied. Advances were also made in the study of nasal physiology, and it was learned that the nasal fossae were something more than simply two "blow holes" for convenience in respiration. Different investigators have independently made a careful study of the nose and, as their several results have in the main agreed, we now know approximately the form and character of a perfect nose, which, if even seldom met with, we should always keep in our mind's eye as an ideal standard. Our ideas of nasal physiology are also crystallized into a rational form.

In an ideal nose the two fossae are identical in size. The septum is vertical and its walls nearly plane. It is not deformed by bony, cartilaginous or soft growths of exuberant tissue, rhinologically known as exostoses, enchondromata, etc. The turbinated bodies are of symmetrical shape, and in no case at any point should they touch the septum. Through the tortuous convolutions of these bodies the area of the nasal mucous membrane is materially increased. The inferior meatus should be clear and the inferior turbinal should never touch the floor of the nasal passage. The middle meatus should also be clear, meaning that at no point should the inferior and middle turbinals touch each other. The superior meatus should likewise be free and there should be enough free space for the so-called superior turbinal, and even for a fourth turbinal if such anomaly be present. This upper portion of the nose may be called the nasal attic and its proper shape and condition is of more importance in the consideration of nasal catarrh than has been generally appreciated. . . .

In a healthy adult nose the quantity of the nasal secretion approximates one pint each twenty-four hours, being watery in character and of a specific gravity of about 1015°. The quantity mentioned, one pint, is none too great to properly humidify the large quantity of air inspired. Taking for an average eighteen respirations per minute we have 1,080 per hour, 25,920 per day, 9,467,280 per year, and so on through life, and, as at each breath in the adult male there is taken into the lungs on an average one pint or twenty cubic inches of air, we have twelve and one-half cubic feet per hour, 300 cubic feet per day and 109,575 cubic feet per annum, or enough to fill a cistern sixty feet square and over thirty feet in depth. . . .

When the laity, as well as the rank and file of the profession, fully recognize the great import of nasal deformity, it will be quite as customary to have the rhinologist examine and correct the defects of the nose as it is now to make annual visits to the dentist in order that the teeth may be kept in perfect repair.