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# Amniocentesis For Chromosomal Evaluation Of The Fetus: An Analysis.

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# AMNIOCENTESIS FOR CHROMOSOMAL EVALUATION OF THE FETUS: AN ANALYSIS

by

CLYDE HENRY BARGANIER

A DISSERTATION

Submitted in partial fulfillment of the requirements for the degree of
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ABSTRACT OF DISSERTATION
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Since 1968 midtrimester amniocentesis has become an increasingly used medical procedure for *in utero* diagnosis or exclusion of fetal chromosomal disorders. This elective procedure is clinically indicated for pregnancies at known risk for fetal chromosomal abnormalities. Little information is available on the diffusion and impact of this technology which is currently being delivered in the United States by 125 service centers.

This study analyzes data for 1978-1980 to determine utilization patterns and user characteristics, scientific and socio-economic factors relative to the procedure's use, and projected need for amniocentesis during the ten-year period 1982-1991. The data base was synthesized from records in the amniocentesis program of the Laboratory of Medical Genetics, Alabama vital event registrations, and the United States Bureau of Census profile of Alabama females.

From a catchment area primarily in north Alabama, the Laboratory of Medical Genetics provided amniocentesis annually to an average of 456 predominantly white patients. An ever increasing proportion of amniocentesis users referred to the Laboratory of Medical Genetics was

younger than 35 years of age. There were no instances of false positives or false negatives observed in establishing karyotypes from cells obtained *in utero*. Amniocentesis patients experienced a 2.3 per cent abnormal karyotype detection rate and, when fetal abnormalities would produce adverse phenotypes, 91 per cent of families chose pregnancy termination. The minimum direct service cost for an amniocentesis procedure is estimated to be $308.76 when delivered in an established prenatal diagnosis center which serves 800-1,000 patients annually. Through 1982, at least 62 per cent of Alabama's projected need for amniocentesis because of maternal age will occur in the primary service area of the Laboratory of Medical Genetics.

**Abstract Approved by:** **Committee Chairman** C B Hale

**Program Director** Thomas A. Tillman

**Date** 12/3/82 **Dean of Graduate School** [signature]

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"Remove not the ancient landmark, which thy fathers have set." Proverbs 22:28.

The achievement of any major goal is usually the culmination of activities by numerous individuals. The completion of this work certainly verifies that hypothesis. Major contributions from scores of instructors, mentors, family, and friends have characterized a formal education which has spanned three decades and six educational institutions located in four states. This work is dedicated in honor of these influences.

With the first graduate of this doctoral program, tribute is due faculty and staff in both the Graduate School and School of Public Health. Special appreciation is extended to members of my Committee, chaired by Dr. Christiane B. Hale, for their guidance and support in this research project. The contributions of Drs. Wayne and Sara Finley and the entire staff in the Laboratory of Medical Genetics are praiseworthy.

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# CHAPTER I

## INTRODUCTION

Since the early part of this century there has been a significant shift in childhood mortality and morbidity patterns. At the beginning of the century the major obstacles to favorable childhood health were infectious diseases, nutritional deficiencies, and gastrointestinal disorders. Although these are still significant problems, their role in adversely affecting the overall health status of our nation's children has greatly diminished (Richmond, 1977). This is largely due to improved living standards and to effective control or eradication of unfavorable environmental factors (Knowles, 1977). In the second half of this century greater attention is being given to chronic conditions and their effect on our child population.

Congenital anomalies offer a dramatic example of this shifting pattern from acute to chronic causes for childhood mortality. Sixty years ago, congenital anomalies did not rank in the top ten causes of death for one-to-four year olds. Today congenital anomalies are the second-ranked cause of death for this age group (Richmond, 1977). In 1915, 6.4 per cent of all infant deaths were attributed to congenital anomalies (Leavell and Clark, 1965) compared to 17.3 per cent in 1976 (Vital Statistics, 1980). The nearly threefold increase in the proportion of infant deaths attributable to congenital anomalies during the past six decades signifies the growing relative importance of

hereditary disorders. This increase, however, does not reveal the full impact such disorders have on their victims, their families, society, and our health care resources.

From three to five per cent of all infants are born with a congenital malformation, chromosomal abnormality, or other clearly defined genetic disorder. Annually, this means over 250,000 infants are born with such disorders (March of Dimes, 1979). Many of these disorders do not claim the victims' lives at birth but result in severe physical or mental handicaps. Also, the disorders may not be manifested until later in life. One of the most prevalent genetic disorders, Down's syndrome, has an incidence of one in 600 births. The prevalence of this disorder in the United States in 1970 was approximately 50,000 victims (Swanson, 1970). Presently, the annual incidence of Down's syndrome is 5,000 (Omenn, 1978). Mental retardation, a usual condition in a Down's syndrome patient, is probably the most common handicapping condition of the genetic disorders. It is estimated that from 20 to 25 per cent of all residents in mental retardation facilities have a disorder with a genetic etiology, (Swanson, 1970) and that 40 per cent of individuals with an IQ less than 50 have a disease or disorder of a genetic origin (Antenatal Diagnosis, 1979).

Although efforts are being made to treat genetic disorders, the majority of efforts may best be described, in Lewis Thomas' terminology, as "halfway" technologies (Thomas, 1977). Therefore, the routine objective in delivering genetic services is to provide diagnostic evaluations to patients with suspected genetic disorders and to interpret these findings to the family in genetic counseling sessions

(W. Finley, 1978). To be effective, in addition to reciting recurrence risks and discussing treatment potential, genetic counselors should provide information about the severity of the disorder, the various alternatives in family planning, and reassurance as needed (S. Finley, 1978).

A major factor in delivering effective genetic counseling is reliable and early diagnostic capabilities. The pursuit of this objective has produced major technological achievements in medical genetics. Several recent technological developments enable in utero evaluation of the fetal chromosome pattern through midtrimester amniocentesis (Epstein and Golbus, 1978). The capabilities of this procedure, combined with knowledge of clinical effects of abnormal chromosome patterns, provide the medical geneticist with a powerful diagnostic tool which has major public health implications.

Since its introduction in 1968 the use of amniocentesis for in utero diagnosis or exclusion of chromosomal disorders has steadily increased with only fragmentary knowledge available on its long-range effects on individuals, families, or society. The transfer of this technology from research to service settings during the past decade has been sporadic with evidence suggesting underutilization by high risk populations and overutilization by low risk populations. Moreover, equal accessibility to amniocentesis by all segments of our society is questionable due to the high cost of the procedure.

Many issues essential to making policy decisions on amniocentesis remain unanswered. Costs and benefits of the procedure in many instances have not been properly delineated for either the family or

society. The absence of a monitoring/surveillance mechanism for amniocentesis prohibits a national assessment on outcomes of those pregnancies having chromosomal disorders diagnosed in utero. The lack of uniformity in laboratory standards or techniques and inadequate training guidelines for genetic service providers complicate regional comparisons of amniocentesis centers. Few efforts have been made by amniocentesis centers to project needs in their service areas in order to facilitate the development of long range plans.

There are numerous legal and ethical issues associated with amniocentesis. Obstetrical care providers have been declared legally liable for failure to inform patients at risk for fetal disorders about the procedure and its capabilities. However, serious debate continues on what constitutes adequate informed consent. Fetal diagnosis of a disorder requires a family decision on what alternative to choose; however, little knowledge is available on how to support a family facing that burden. The availability and appropriateness of therapeutic abortion is an issue of immense concern since pregnancy termination is one alternative after the diagnosis of an affected fetus (Antenatal Diagnosis, 1979).

## Classification of Patients with Genetic Disorders

The more than 3,000 known genetic disorders have been arranged into three different classes: (1) single gene or gene pair which follow Mendelian inheritance patterns, (2) multifactorial disorders which are familial in nature but have neither a definitive inheritance pattern nor chromosomal aberration, and (3) chromosomal aberration syndromes which

are multiple malformations associated with an abnormal chromosome pattern. Examples of single gene disorders include Tay-Sachs disease, sickle cell anemia, and cystic fibrosis. The best known multifactorial disorders include neural tube defects (spina bifida and anencephaly), cleft lip/palate, and club foot. Some of the more common chromosomal disorder syndromes are Down's, Turner's, and Klinefelter's (Schlesselman, 1979).

Diagnostic evaluations and subsequent assignment to a class are accomplished by family history, physical examination, cytogenetic or biochemical laboratory studies, and, as appropriate, clinical/pathological studies (W. Finley, 1978). Newborn screening studies have found that 0.5 per cent to one per cent of liveborn infants have a chromosomal abnormality (Human Genetics and Public Health, 1964; Lubs and Ruddle, 1970), one per cent are afflicted with a multifactorial disorder (Simpson, 1980), and another one per cent have a single gene disorder (Carter, 1977).

## Chromosome Aberrations and Their Incidence

Of the three classifications of genetic diseases, none has received more study than disorders associated with chromosomal aberrations. Chromosomal aberrations may be divided into three types: (1) variation in the number of chromosomes, (2) structural rearrangement of chromosomes, and (3) a combination of the two. The normal chromosome pattern in the human cell consists of 22 pairs of nonsex chromosomes (autosomes) and one pair of sex chromosomes (XX in the female, XY in the male). Variations in this number usually produce observable clinical

abnormalities in the physical appearance (phenotype). Variation in chromosome structure may take one of four forms. A deletion may be present in which one or more chromosome segments are missing. A duplication occurs when a specific segment of genetic information is repeated on a single chromosome. An inversion occurs when a chromosome segment breaks at two points and becomes reattached in reverse order. Finally, a translocation exists when a segment of a chromosome becomes dislodged from its normal position and subsequently attaches to another chromosome (Levine, 1978).

Several research programs conducted on chromosomal disorders have shown a relationship between chromosomal aberrations, advanced maternal age, and increased incidence of Down's syndrome--a chromosomal disorder associated with having an additional chromosome 21 (Screening to Provide Reproductive Information, 1975). Women who are 35 years and over are at increased risk for having infants with this syndrome. More recent analysis (1975) has shown that women 35 and older produced 4.6 per cent of all live births and 28.5 per cent of all Down's births in the United States (Milunsky, 1979). Subsequent investigations have also verified an increased incidence of other chromosomal abnormalities with advancing maternal age (Hook and Cross, 1979) (See Table I-1).

Studies have also shown that advanced maternal age is associated with an increased frequency of spontaneous abortions with chromosomal aberrations present in the zygote or fetus (Carr, 1970; Boue, Boue, and Lazar, 1975; Schlesselman, 1979). There is also an increased likelihood of repeated spontaneous abortions among women with histories of aborted fetuses with abnormal chromosome patterns (Hassold, 1980). Estimates of the percentage of first trimester spontaneous abortions attributable to

TABLE I-1

Incidence of Fetal Chromosomal Abnormalities
by Maternal Age

| Maternal Age | Chromosomal Disorders Excluding Down's* | Chromosomal Disorders Including Down's* |
|---|---|---|
| 20 | 1.3 | 1.9 |
| 25 | 1.3 | 2.1 |
| 30 | 1.4 | 2.5 |
| 35 | 2.2 | 4.9 |
| 40 | 4.5 | 13.7 |
| 45 | 12.6 | 43.4 |

*Rate per 1,000 live births

Source: E.B. Hook and P.K. Cross, 1979.

chromosomal aberrations vary from eight to over 60 per cent (Carr, 1972; Boue et al., 1975; Hassold, Matsuyama, Newlands, Matsuura, Jacobs, Mannel and Tsuei, 1978) with the great majority of such studies showing a rate of approximately 50 per cent (Hassold et al., 1978).

One explanation for variations in the reported rates is a lack of uniformity in the studies' materials and methods (Carr, 1972). An analysis of the studies reveals a lack of consistent knowledge about prior reproductive histories, whether the abortions were spontaneous or induced, where and how the aborted specimens were obtained, proportion of early versus late abortions, tissue culture techniques used in cell growth, and the number and quality of chromosome preparations analyzed. All of these factors are relevant in ascertaining the rate of chromosome abnormalities detected in a particular study group (Boue et al., 1975).

A second hypothesis, that geographic differences account in part for the varying rates of chromosome abnormalities (Carr, 1970 and 1972), is supported by a study which analyzed the incidence of congenital anomalies among over 400,000 pregnancies reported through major birth centers in 16 countries (Stephenson, Johnston, Stewart, and Golding, 1966). In some instances, there were major variations among countries in the incidence of Down's syndrome. The investigators acknowledged that these variations could be due to sampling biases, or differences among the centers in standards for diagnosing Down's syndrome. A variety of local environmental factors could produce geographic variations in the prevalence of chromosome anomalies in abortuses (Carr, 1970). When all spontaneous abortuses (including first, second, and third trimesters) with chromosomal aberrations are considered, the rate

appears to be from 25 to 33 per cent (Stephenson et al., 1966; Carr, 1972).

The impact of chromosomal aberrations on perinatal health status is not manifested only in spontaneous abortions. In the most frequently referenced study of newborn chromosomal aberrations found in the United States, 0.5 per cent of the live newborns were found to have a clinically significant chromosomal anomaly (Levine, Kaback, and Griffin, 1975). This study found that only one in four chromosomal abnormalities could have been identified by phenotype. A more recent survey established a chromosomal abnormality rate of 6.2 per 1,000 live births. This study, which analyzed the findings of several investigations conducted on the subject, found the reported rates varying from 3.9 to 9.2 per 1,000 (Schlesselman, 1979). An extensive survey of 4,000 seven- and eight-year olds showed a chromosome abnormality rate of 4.8 per 1,000 (Patil, Lubs, Kimberling, Brown, Cohen, Gerald, Hecht, Moorehead, Myrianthopoulos, and Summit, 1977).

## Impact of Genetic Disease

The morbidity associated with genetic disorders places great demands on available health care resources. Twenty-five to 30 per cent of acute care hospital admissions for children are for conditions of genetic origin or those which are greatly affected by genetic factors (e.g., malformation and developmental anomalies)(Childs, Miller, and Beam, 1972; Antenatal Diagnosis, 1979). The strain on this country's health resources, however, is not attributable strictly to the child population. In one study of adult admissions to an urban hospital, 13

per cent were for conditions associated with genetic disorders (Childs et al., 1972).

Financial expenditures to provide care for patients with genetic disorders are significant. Each year in the United States, approximately 1.2 million people are admitted to hospitals because of genetic disorders, with annual inpatient care costs of $800 million (Stickle, 1979). Also, one economic analysis on public institutional care in the United States for the mentally retarded during 1979 yielded an average annual cost of $20,850 per patient (Krantz, Bruininks, and Clumpner, 1979). The projected annual costs of custodial care for Down's syndrome patients alone amounted to approximately $600 million in 1980 (Swanson, 1970). Additional research on the costs of caring for patients with genetic disease would be useful.

There is also an important emotional cost for families with a child affected with genetic disease (Drator, Baskiewiz, Irvin, Kennell, and Klaus, 1975). Some studies have reported feelings of guilt complicated by fear and uncertainty regarding the future planning of their families (Johns, 1971; Kenen, 1980). Other studies have indicated that some families suffer from anxiety and marital discord as a result of their affected offspring (Hare, Laurence, Payne, and Rawnsley, 1966; Conley and Milunsky, 1975; Thain, Glendo, and Peterson, 1977).

## Amniocentesis as an Aid in Detecting Chromosome Disorders

Since 1968, a new technology has added a significant dimension to the diagnostic capabilities of genetic services. Transabdominal amniocentesis for the detection of hereditary disorders in utero is becoming a more frequently used procedure in the provision of maternity

care to selected prenatal patients in the United States. This diagnostic procedure is performed on an outpatient basis at 16-18 weeks gestation. In the obstetrical practice protocol, amniocentesis is considered an elective procedure, although patients at known risk for certain genetic disorders should routinely be counseled about its availability (Antenatal Diagnosis, 1979).

The amniocentesis procedure requires the aspiration of approximately 20ml-30ml of amniotic fluid from the uterus through a 22 or 30 gauge needle (Antenatal Diagnosis, 1979). The fluid is then assayed for biochemical and/or cytological parameters. These laboratory studies provide the basis for determining the presence or absence of all known chromosomal aberrations in the developing fetus and detecting approximately 107 single-gene or gene-pair diseases with biochemical etiologies (Golbus, 1982). Assaying the concentration of alpha-fetoprotein present in amniotic fluid, coupled with sonographic scans, provides the means for identifying the only multifactorial disorder currently detectable in utero--neural tube defects (Screening to Provide Reproduction Information, 1975). The detection of genetic disorders through amniocentesis followed by the option of abortion provides a method of reducing the incidence of birth defects.

By far the greatest use of amniocentesis is in the detection of chromosomal disorders in the fetus. From 80 to 90 per cent of all diagnostic amniocenteses at 16-20 weeks gestation in the United States are performed for chromosomal evaluation of the fetus (Antenatal Diagnosis, 1979). The increasing use and reliability of the amniocentesis have resulted in its becoming one of the most important

procedures in early detection and prevention of many chromosomal disorders (NICHD National Registry, 1976).

There are at least seven major reasons which help to explain the increasing and predominant use of amniocentesis for detection of chromosomal disorders. First, clinical studies have correlated numerous chromosomal aberrations with adverse clinical manifestations in humans. Second, significant technical progress has been achieved in cell culture and subsequent karyotyping of chromosome patterns from fetal cells obtained in utero. Third, epidemiological studies and clinical observations have facilitated identification of many prenatal patients who are at increased risk of having infants affected with disorders. Fourth, the increasing mean maternal age is accompanied by a greater number of pregnancies at increased risk for fetal chromosome disorders. Fifth, there has been an increase in both the acceptability and availability of abortion services. Sixth, technical development for in utero study of the fetus are presently not as fully developed in biochemical genetics as in cytogenetics, although a significant amount of clinical and basic research is currently being conducted in biochemical genetics. Seventh, extensive education of providers and the public has occurred on the procedure's use and safety.

Based on epidemiological studies which have indicated the risks to individuals and families for a number of chromosome disorders, the American College of Obstetricians and Gynecologists recommends routine counseling for the following patients regarding the use of amniocentesis for chromosomal evaluation of the fetus (Antenatal Diagnosis, 1976).

(1) The pregnant patient is 35 years or older. In the United States, advanced maternal age is the indication for 75 per cent of all

amniocentesis procedures performed each year. The positive correlation between increasing maternal age and rate of chromosomal abnormalities in the fetus is well established. This correlation is presented in Table I-1.

(2) A chromosome abnormality is present in either parent. Amniocentesis may be requested because of an existing chromosome aberration in one of the parents. Some individuals may have an abnormal genotype which is expressed as a normal phenotype. However, the offspring of individuals with this "unbalanced translocation" are at increased risk of having a handicapping condition from a chromosomal disorder.

(3) The patient previously gave birth to a child with a chromosome abnormality. Studies have shown that women giving birth to infants affected by chromosomal disorders are at increased risk for subsequent pregnancies producing chromosomally abnormal children. In the case of Down's syndrome, for example, the mother of a Down's syndrome child is at higher risk than the general prenatal population for producing another child afflicted with the disorder. The risk of having a second Down's syndrome child is approximately one per cent with maternal age held constant.

(4) The patient is a carrier of a detrimental gene linked to the X chromosome. The X-linked recessive disorders produce disease only in the male but are transmitted by the unaffected mother who is a carrier of the abnormal gene. Most of the diseases which are X-linked (such as hemophilia and Duchenne muscular dystrophy) cannot be detected in utero. However, since only males are affected, a chromosomal study can ascertain the fetus to be a female and, therefore, assure the birth of a

child without the disorder. Upon verification of the presence of a male fetus, a decision to terminate the pregnancy must be made on a 50 per cent probability figure that the child will be affected.

Although these four indications provide the major basis for providing amniocentesis for chromosomal evaluation of the fetus, there are other, less clear indications for its use. These include a family history of chromosome abnormalities (other than a previous child), previous child with multiple handicaps from an unknown cause, and a history of repeated spontaneous abortions (Mental Retardation, 1980).

## Safety and Efficacy of Amniocentesis

As amniocentesis progressed from an area of research to a routine clinical procedure, clinicians readily recognized the possibility that patients and/or the fetuses they carried might be at risk as a result of undergoing such an invasive procedure. Of specific concern were complications, e.g., infection, fetal injury or abortion, and hemorrhage. Early clinical evaluation of the procedure, however, did not substantiate these fears (Nadler, 1968). On the other hand, the small number of procedures performed did not permit a final judgment on this issue. The need for a carefully constructed and implemented prospective study which assured the safety and efficacy of amniocentesis was obvious.

Through the initiative of the National Institute of Child Health and Human Development (NICHD), a study was begun in 1971 to evaluate the use of amniocentesis for <u>in utero</u> detection of genetic disorders. A National Registry for Amniocentesis was established and provided the

focus for coordinating the results of amniocenteses being performed in nine centers which were geographically distributed throughout the United States. These centers were established medical genetics units with clinical and laboratory resources capable of performing amniocentesis, amniotic fluid cell culture, and assessing the fetal karyotype for chromosome abnormalities. A total of 992 control patients was matched with 1,040 women who underwent amniocentesis; controls were matched for maternal age, prior pregnancy history, socio-economic status, gestation period, race, education, obstetrical care, and estimated date of confinement. Detailed clinical information was maintained on the maternity patient for the remainder of the pregnancy and for the postpartum period. Information was obtained on the newborn at delivery and during the perinatal period. Infants were followed and evaluated for approximately one year after birth. After two years, the study concluded there were no statistically significant differences between the two groups in fetal loss rate, perinatal problems, neonatal complications, birth defects, or birth weights. Followup of the infants did not reveal any difference in terms of growth, development, behavior, or intellectual function.

The diagnostic results of amniocentesis in the study are depicted in Table I-2.

TABLE I-2
Results From United States Study on Diagnostic Capabilities of Amniocentesis

| | | Genetic Disorder Present + | - | T |
|---|---|---|---|---|
| Diagnostic Test Results | + | 37 | 1 | 38 |
| | - | 5 | 982 | 987 |
| | T | 42 | 983 | 1,025 |

Source: Antenatal Diagnosis, 1979.

In this study the sensitivity of the test was 88.1 per cent and the specificity was 99.9 per cent. Initially, 1,040 subjects were included in the study. Of these, seven patients testing positive for an affected fetus were lost to followup, and the test results could neither be verified nor denied. For an additional eight patients, no diagnosis was made (NICHD National Registry, 1976).

When needles of 18 gauge or larger were used in aspirating amniotic fluid from patients in the study group, higher rates of amniotic fluid leakage and blood spotting were observed. Higher rates of these complications also occurred where three or more transuterine needle injections were required before successful aspiration the amniotic fluid. For reasons unapparent to the investigators, the amniocentesis group experienced a higher rate of delivery by cesarean-sections. There was no statistically significant difference in the nonelective fetal loss between the two groups. In the study group, 36 pregnancies (3.5 per cent) resulted in either a spontaneous abortion or stillbirth

compared to 32 (3.2 per cent) in the control group (Antenatal Diagnosis, 1979).

The safety and efficacy results of the United States study were replicated by a study designed for the same purposes and carried out from 1973 through 1976 in several Canadian provinces. This study did not attempt to match cases for control purposes, but compared results from the amniocentesis study group with Canadian Vital Statistics data. The fetal loss rate (3.4 per cent) in the amniocentesis group was not significantly different from the rate found in the vital statistics data (Simpson, Dallaire, Miller, Siminovitch, and Hamerton, 1976).

The results of a study recently completed in the United Kingdom conflict (Antenatal Diagnosis, 1979) with the results of the two investigations previously cited. This study compared the experience of 2,428 prenatal patients who underwent amniocentesis with the same number of matched controls and found a fetal loss rate of 2.6 per cent in the amniocentesis group compared to 1.1 per cent in the control group. Similar differences were also observed in newborn abnormalities, with higher rates of complications such as respiratory problems and orthopedic postural deformities in the amniocentesis group. The investigators also concluded that the study group experienced higher rates of complications in late pregnancy including abruptio placenta, premature rupture of the membranes, and postpartum hemorrhage.

A careful examination of the design and conclusions of the United Kingdom study offered a plausible explanation for the differences found between the studies cited. For example, unlike the United States investigation, little effort was given to age matching for the control group in the United Kingdom study (Milunsky, 1975). In the

amniocentesis group, 12.2 per cent of the subjects were 40 years of age or older while only 3.8 per cent of those in the control group were in this advanced maternal age range. With a greater proportion of maternity patients 40 years of age and over in the experimental group, a higher rate of pregnancy and fetal complications should be expected from this subgroup and could bias the results. If adjustments are made for maternal age disparities there is no statistically significant difference ($p=0.05$) in complications experienced by the newborn in the two groups. If the same adjustment is applied in comparing the groups for fetal loss rate, the difference is only at the borderline of significance ($p=0.051$). Second, there was no control for gestational age at the time of recruitment for the non-amniocentesis subjects. This fact resulted in a selection process which increased the likelihood that subjects chosen for the control group would not be truly representative of the amniocentesis group (Antenatal Diagnosis, 1979).

Finally, there is a major difference in the reason for amniocentesis in the United States and United Kingdom. A large number (40.9 per cent) of the amniocentesis group in the United Kingdom study received the procedure because of a high risk for neural tube defect in the fetus. Furthermore, of the 1,282 subjects in this category, 110 received amniocenteses only to confirm or dispel suspicions of an affected fetus. These suspicions were raised after a screening program revealed these subjects to have elevated serum alpha-fetoprotein levels. Although elevated alpha-fetoprotein levels in maternal serum may be indicative of a fetus affected with a neural tube defect, recent studies have also implicated other adverse clinical conditions including

impending fetal loss (Antenatal Diagnosis, 1979). Therefore, this study may have been biased by including a significant portion of subjects who were at higher risks for fetal demise and abnormalities than the control group.

Analysis of more recent studies involving amniocentesis use provides the following conclusions on risks associated with the procedure. 1) Amniocentesis users have an estimated increased risk for fetal loss of .05 per cent to 0.9 per cent (Verp and Gerbie, 1981; Porreco, Young, Resnick, Cousins, Jones, Richards, Kernahan, and Matson, 1982). Results from one study suggest that using ultrasound to achieve posterior placentation during amniocentesis can significantly reduce the fetal loss rate (Porreco et al, 1982). 2) Risks to the prenatal patient are minimal. 3) The risk of a small needle mark on the fetus although present, is low (Verp and Gerbie, 1981).

Recently, a long-term followup study was reported on children whose mothers had undergone amniocentesis. The subjects, aged five to seven years, were indistinguishable from other children in terms of fetal development and health status as both infants and growing children (Gillberg, Rasmussen, and Wahlstrom, 1982).

## Impact of Amniocentesis

Both the number of amniocenteses and the number of facilities providing the procedures have increased since the early 1970's. Only 10 amniocentesis centers were operating in 1970. This number increased to 30 in 1972 and to 60 in 1975. Presently, approximately 125 centers in the United States provide prenatal diagnosis. It is estimated that

between 30,000 and 40,000 midtrimester diagnostic procedures have been performed since 1967, with 15,000 being performed in 1978 (Antenatal Diagnosis, 1979).

The literature is replete with descriptions of technical developments in conducting the laboratory analysis required for identifying fetal cells containing cytogenetic disorders. Little information is available either on the impact of this new technology on its recipients or on its utilization. Most data on utilization rates are primarily limited to large urban areas which are in close proximity to amniocentesis centers. However, a statewide study on amniocentesis usage in 1976 was conducted for California and found a utilization rate of 13 per cent for prenatal patients 35 years of age and over (Antenatal Diagnosis, 1979). A more recent study analyzed amniocentesis utilization rates among prenatal patients 35 years old or older in Alabama, Nebraska, and California for years 1977 and 1978. The rates reported for 1978 were, respectively, 10.9 per cent, 6.7 per cent, and 19.8 per cent. The major conclusions of this study were that attention should be given to increasing utilization rates of prenatal diagnosis among women who are $\geq$ 40 years of age, black, and reside in rural areas (Adams, Finley, Hansen, Jahiel, Oakley, Sanger, Wells, and Wertelecki, 1981). In the case of Alabama, data analyzed in this study were for years just prior to the implementation of a statewide education project (1979) to increase the use of genetic services. Therefore, the study results served as an invaluable aid in establishing a base rate of amniocentesis use just prior to the project's initiation.

It appears that amniocentesis centers in the aggregate are experiencing detection rates (positive) of 2.2 per cent for maternity

patients 35-39 years of age, and 3.4 per cent for those 40 years of age or older. The overall rate of chromosomal disorders detected through amniocentesis centers is ranging from 2.1 per cent to 2.7 per cent for those procedures performed for acceptable clinical indications (Milunsky and Atkins, 1977; Saul, Riley, Jorgenson, Rogers, Young, and Hixson, 1980; Daniel, Stewart, Saville, Brookwell, Poull, Purvis-Smith and Taug, 1982).

Surveys of the 125 centers providing amniocentesis have also revealed two other important facts with policy implications. First, in cases where amniocentesis resulted in diagnosing an affected fetus, in excess of 95 per cent of the families elected to terminate the pregnancy (Antenatal Diagnosis, 1979). Second, in providing the service, the centers tend to limit the number of procedures available once their annual case loads reach 200-300 (Levine et al., 1975; Association of Cytogenetic Technologists Laboratory Directory, 1981-1982, 1981). This is due presumably to the centers' operating in environments primarily research oriented rather than being heavily devoted to the delivery of services. It may also indicate a strategy of providing few services to help insure high quality results.

## Rationale

A continuing increase in the demand for amniocentesis seems certain. Demographic forecasts in our nation indicate a higher proportion of women in the advanced maternal age range (35-49) constituting our childbearing population. One study projects a 46 per cent increase in births nationally among this cohort during the 1980-1989 decade (Adams, Oakley, and Marks, 1982). Another analysis

projects a 61 per cent increase in births to women 35 years old or older between 1977 and 2000 (Selle, Holmes, and Ingbar, 1979).

With the distinct possibility that an enormous increase in demand for diagnostic amniocentesis will accompany this demographic shift in our childbearing population, it is essential that an analysis of amniocentesis take place to assist in policy determinations of the procedure's use. One purpose of this study was to evaluate more fully current utilization patterns of amniocentesis for prenatal diagnosis provided through the Laboratory of Medical Genetics, a comprehensive medical genetics unit at the University of Alabama in Birmingham (UAB) which has provided the majority of amniocenteses obtained by Alabama women during the years 1978-1980. This study also assessed certain technical aspects of amniocentesis, based on those procedures which have been performed through the Laboratory of Medical Genetics. A numerical analysis of karyotypes performed for prenatal diagnosis was compared with confirmatory efforts conducted postdelivery to establish a base upon which to conduct future evaluations of the procedure. Also, a followup was conducted on pregnancies previously identified with fetal chromosomal abnormalities to determine their outcomes.

As in the case of most high-level technologies, cost is an important variable in policy consideration on the use of amniocentesis. A 1976 study at a University of California genetics center in San Francisco, established a cost figure of $450 for each amniocentesis procedure (Antenatal Diagnosis, 1979). Cost estimates in a South Carolina laboratory, which provides annually fewer than 200 amniocenteses, total $620 for detection of an abnormal karyotype (Saul et al., 1980). Although specific figures are not provided, directors of

a laboratory in England contend that only one-third of amniocentesis costs is required for counseling, ultrasound, and aspiration of amniotic fluid, the remaining two-thirds is involved in karyotyping or laboratory activities (Babrow, Lindenbaum, Seabright, and Gregson, 1981). Reliable financial data are needed on the operational costs of a high volume prenatal diagnostic service center and were developed in this study.

Finally, a model was developed to project need for amniocenteses in Alabama for the current and subsequent years. Accurate projection of need is essential to anticipate the resources required to insure the availability of amniocentesis and to prevent over-investment in an expensive technology. Such a planning effort has been conducted for a portion of the New England states (Selle et al., 1979) but no comparable effort has been published for the southern states or Alabama in particular.

One potential limitation of the study is the premise that the technical capabilities of amniocentesis will remain constant--which is unlikely considering the ongoing achievements and research in this area. A second is the assumption of legal availability and accessibility of selective abortion for reasons of fetal disorders. For the purposes of this study both the legal availability and accessibility of abortion were considered constant.

## Statement of the Problem

This study did not propose to test a major hypothesis. Descriptive data on the use of amniocentesis was obtained and organized in a scientifically acceptable manner that, at the same time, facilitated

analysis for future research, policy determinations, and service planning procedures. The major goals of this study was as follows:

> To determine and analyze utilization patterns and user characteristics of amniocentesis for detection of fetal disorders in selected protions of Alabama for years 1978-1980; extrapolate scientific and socio-economic factors relative to the procedure's use; and project immediate and long-range indications for the service.

The specific aims of this study were:

1) To delineate the service area of the Laboratory of Medical Genetics in the provision of amniocentesis to Alabama residents during the years 1978-1980;

2) To analyze the extent to which amniocenteses provided through the Laboratory of Medical Genetics were used in detecting fetal disorders among Alabama prenatal patients for years 1978-1980;

3) To describe the diagnostic parameters of the amniocentesis procedure in the Laboratory of Medical Geneitcs during the years 1978-1980;

4) To determine the demographic composition of Alabama women receiving amniocentesis through the Laboratory of Medical Genetics during 1978-1980;

5) To determine the number and outcome of those abnormal fetuses detected by amniocentesis in the Laboratory of Medical Genetics during the years 1978-1980;

6) To determine the cost of a prenatal diagnostic procedure provided through amniocentesis in the Laboratory of Medical Genetics during 1982;

7) To predict the need for amniocentesis (based on maternal age) in each Alabama Public Health Area (PHA) for the years 1982-1991.

# CHAPTER II

# MATERIALS AND METHODS

## Operational Definitions

### Specific Aim # 1

The delineation of the area served by the Laboratory of Medical Genetics' amniocentesis program consists of an enumeration of patients receiving amniocenteses by Alabama county of residence. This assessment was made for each year of the period 1978-1980. A composite number of patients served from each county during the three-year period was also calculated.

### Specific Aim # 2

Two measures were obtained on the extent to which amniocentesis was used in detecting fetal disorders for each year, 1978-1980. First, a utilization rate among prenatal patients $\geq$ 35 years of age was obtained for each Alabama county served by the Laboratory of Medical Genetics. The denominator is the total number of women $\geq$ 35 years of age for each county of residence who had a live birth during each year. The numerator is the total number of amniocenteses provided to women referred because of maternal age ( $\geq$ 35 years) from each respective county of residence during each year. The second measure of amniocentesis use is the rate of utilization for any reason among all

prenatal patients. The denominator is the number of resident women having live births for each year in each county served through the Laboratory of Medical Genetics. The numerator is the number of women having amniocenteses from each respective county of residence.

Specific Aim # 3

The diagnostic parameters of amniocentesis were assessed by compiling the normal, abnormal, and unsuccessful karyotypes performed during 1978-1980. The rate of abnormal karyotype detection was calculated by year with the numerator being the number of abnormal karyotypes detected and the total successful karyotypes as denominator. Records were analyzed to determine those karyotype results confirmed by cell culture or supported through clinical observations.

Specific Aim # 4

The demographic description of women receiving amniocentesis consists of the total number of patients from each Alabama Public Health Area by age, race, referral source, and reason for referral. This information was obtained for each year, 1978-1980.

Specific Aim # 5

Fetal abnormalities identified *in utero* are numerically presented by specific karyotype. Pregnancy results of each abnormal karyotype were obtained and totaled for each of three outcome categories: delivery, termination, and spontaneous abortion. The proportion (rate) for each outcome category was calculated using the following formula:

$$\text{Delivery} = \frac{\text{Number of Pregnancies Carried to Delivery Among Abnormals Detected}}{\text{Number of Abnormals Detected}} \times 100$$

$$\text{Termination} = \frac{\text{Number of Terminations Among Abnormals Detected}}{\text{Number of Abnormals Detected}} \times 100$$

$$\text{Spontaneous Abortion} = \frac{\text{Number of Spontaneous Abortions Among Abnormals Detected}}{\text{Number of Abnormals Detected}} \times 100$$

Specific Aim # 6

The cost of providing an amniocentesis includes the personnel, supplies, equipment, and overhead resources expended in obtaining a fetal karyotype in the prenatal diagnosis program of the Laboratory of Medical Genetics during 1981-82. Overhead costs are based on the UAB negotiated rate for indirect cost for extramural grants.

Specific Aim # 7

The projected need for amniocenteses during the years 1982-1991 is based on a demographic projection of women aged 35-49 years in Alabama. A mean fertility rate was used to estimate the number of births occurring among women in this age range and also serves as the estimated need for amniocentesis based on maternal age. This estimated need was calculated for each year.

## Data Sources

Data for this study originated from two sources: The Bureau of Vital Statistics of the Alabama Department of Public Health and the Laboratory of Medical Genetics at the University of Alabama in Birmingham. The Bureau of Vital Statistics is responsible for routinely collecting and tabulating statistical data on vital events in Alabama.

The registrar for vital statistics in Alabama is charged with the responsibility to record, collect, and tabulate certain statistical data relating to birth, death, and marriage events occurring in Alabama. The governmental unit assigned this responsibility is the Bureau of Vital Statistics of the Alabama Department of Public Health. This unit, therefore, serves as a valuable resource in obtaining information related to the perinatal health status of Alabama citizens. Specific information available from this agency which was of value in this study includes the number of annual live births by county and selected demographic data on mothers by county of residence.

The Laboratory of Medical Genetics at the University of Alabama in Birmingham was established in 1962 and conducted its first prenatal diagnostic study through amniocentesis in 1970. Since that time over 3,500 amniocentesis procedures have been conducted through this unit's facilities. All aspects of the amniocentesis program in the Laboratory of Medical Genetics are performed within a single facility and are located in the Center for Developmental and Learning Disorders building. This amniocentesis program includes initial counseling with patients/families, withdrawal of amniotic fluid, fluid preparation and cell culture, karyotyping, reporting results to the referring agent, and

counseling with those parents who have fetuses diagnosed with chromosomal disorders.

The data sources for the specific information described in operational definitions were as follows:

- Denominator data on the number of prenatal patients in the state were obtained from birth certificates in the Bureau of Vital Statistics. Numerator data on the number of amniocenteses performed by age of patient were available from the Laboratory of Medical Genetics.

- A demographic description of women who obtained amniocenteses was obtained from data available in the Laboratory of Medical Genetics.

- The diagnostic parameters of amniocentesis were determined by compiling data on test results and followup studies from records in the Laboratory of Medical Genetics.

- The outcome for those pregnancies with fetal abnormalities diagnosed in utero was determined by data available in the Laboratory of Medical Genetics. These data were collected from the patients' primary care providers who deliver their obstetrical care.

- Costs associated with detecting an abnormal fetus in the Laboratory of Medical Genetics were calculated from a compilation of financial data available in that unit. This data were obtained from time sheets and supply/equipment invoices. The calculation of overhead costs was based on a uniform indirect cost rate used by the University of Alabama in Birmingham.

- A demographic model was constructed to estimate the number of Alabama women 35-49 years of age for each year, 1982-1991.

## Data Collection

Data obtained from the Bureau of Vital Statistics were tabulated from information routinely reported on birth certificates submitted on Alabama residents. A copy of the Alabama birth certificate, adopted in 1976, is included as Appendix 1. This document has not been altered during the time period of this study.

Three data instruments used in the Laboratory of Medical Genetics have played a vital role in this study. The Basic Patient Data form (Appendix 2) was specifically developed for a computer program designed to store service data on patients served by the Laboratory of Medical Genetics. This form is routinely completed for each patient receiving amniocentesis by a specially trained secretary in the Laboratory of Medical Genetics. The information recorded on this form is taken from each clinical record which also includes selected demographic data. The clinical record on each patient is completed by a nurse during the initial interview. A computer entry of the information contained on the Basic Patient data form is made through a Infoton 100 terminal which is located in the administrative facilities of the Laboratory of Medical Genetics. Specific information on the Basic Patient Data form of value to this study includes: service date, Alabama resident code (county and Public Health Area designated for Alabama residents), referral source, race, birthdate, and reason for referral.

The second data instrument used from the Laboratory of Medical Genetics is a form letter which is sent to each referral source after an amniocentesis patient has delivered. Selected clinical information is requested including clinical observations of neonatal birth defects. Since 1977 these raw data have been collected but not analyzed on a collective basis; they have been reviewed on an individual patient basis to aid confirmation of laboratory diagnoses.

The third data instrument is a service chronicle which contains karyotype information and outcome of each fetus who received a chromosomal evaluation in the unit's prenatal diagnostic center. Due to

the importance of this information, the chronicle is personally maintained by the director of the cytology laboratory which cultures the amniotic fluid. A data form was developed to enable the systematic recording by year of those fetuses with abnormal karyotypes and outcomes.

Data from Alabama's birth certificates are compiled, tabulated, and published, in part, for each calendar year by the Alabama Department of Public Health. Certain information needed for this study, therefore, is a matter of public record. Although selected raw data from birth certificates are available for public use, they were not organized in a format which met all the needs of this study. A special computer program was used to obtain live birth information for those pregnancies of women $\geq$ 35 years of age by Public Health Area of residence.

Data from the Basic Patient Data form was processed through batch modules which sorted demographic data on prenatal patients and provided numerical reports for the following information:

- Current residence including Public Health Area and county--out-of-state patients were designated,
- Patients seen by referral source,
- Patients seen by race (white, black, and other).
- Patients seen by reasons for referral.

In addition to these batch reports additional computer software was available to organize patient data for special reports needed in this study. For example, a report was generated on the number of patients receiving amniocenteses for each Public Health Area of residence by one-year maternal age intervals.

A review was made of the amniocentesis service chronicle to determine the number and types of fetal abnormalities detected through amniocentesis and their outcomes. A computer program was not needed to process this data since less than 50 abnormal karyotypes were detected for the years 1978-1980.

The cost of conducting an amniocentesis procedure was calculated through analysis of personnel, supply and equipment (depreciation), and overhead costs in the Laboratory of Medical Genetics. Expenditures associated with these items were used to estimate the cost of providing an amniocentesis procedure in a prenatal diagnostic center.

# CHAPTER III

## UTILIZATION OF AMNIOCENTESIS THROUGH THE LABORATORY OF MEDICAL GENETICS

### Introduction

To determine the geographical area served by the Laboratory of Medical Genetics' amniocentesis program, an analysis was made of data routinely collected on amniocentesis patients. These data (Appendix 2) will be computerized and maintained in the UAB Macy Computer Center. A batch module was developed to retrieve selected data on the number of patients obtaining amniocentesis by Alabama county of residence. The module also enumerated those patients served who were residents outside of Alabama.

Another computer program was designed to assist in determining the extent of amniocentesis utilization through the Laboratory of Medical Genetics among Alabama prenatal patients. This program retrieved the number of women referred because of maternal age ( $\geq$ 35 years) by Alabama county of residence. This information provided the numerator data for each county in calculating the extent of utilization.

The denominator data consisted of the total live births by year occurring in each county to women age 35 or older. The information was obtained by year through a computer program of Alabama birth

registration data stored on computer tapes and obtained from the Alabama Department of Public Health's Bureau of Vital Statistics.

A second measure of utilization was obtained for Alabama women for the years included in this study. This effort was designed to assess the extent of use for any reason among all women having a live birth. The denominator consisted of the number of live births by mother's county of residence. This information was obtained from data compiled and published by the Alabama Department of Public Health's Bureau of Vital Statistics. The numerator consists of the number of amniocentesis provided by patient's county of residence. This information was obtained by computer batch module as described above.

## Findings

During the three-year period 1978-1980, 1,512 patients received amniocentesis through the Laboratory of Medical Genetics for *in utero* diagnosis of fetal disorders. Of this number 60 amniocenteses (4.0 per cent) were performed on out-of-state residents and in 85 cases the patient's address was not obtained. (Obstetrical care physicians occasionally will obtain the amniotic fluid and forward it for cell culture and growth without giving demographic data on the patient).

Table III-1 provides amniocentesis data by Alabama county for each year of interest and the composite number of amniocentesis data for the three years for each Alabama county. During this three-year period the volume of amniocenteses provided to Alabama women increased 94.8 per cent (305 to 594). At least one amniocentesis was provided to residents in all but four Alabama counties during this time (Baldwin, Mobile,

TABLE III-1

Number of Amniocenteses Provided Through the Laboratory of Medical Genetics to Alabama Women by County of Residence, 1978-1980

| COUNTY | 1978[a] | | 1979[b] | | 1980[c] | | Total[d] | |
|---|---|---|---|---|---|---|---|---|
| | N | Col.% | N | Col.% | N | Col.% | N | Col.% |
| Autuauga | 4 | 1.2 | 3 | .6 | 6 | .9 | 13 | .9 |
| Baldwin | 0 | .0 | 0 | .0 | 0 | .0 | 0 | .0 |
| Barbour | 0 | .0 | 1 | .2 | 0 | .0 | 1 | .1 |
| Bibb | 0 | .0 | 0 | .0 | 3 | .5 | 3 | .2 |
| Blount | 6 | 1.8 | 2 | .4 | 11 | 1.7 | 19 | 1.3 |
| Bullock | 0 | .0 | 1 | .2 | 2 | .3 | 3 | .2 |
| Butler | 3 | .9 | 2 | .4 | 5 | .8 | 10 | .7 |
| Calhoun | 23 | 6.9 | 19 | 3.6 | 27 | 4.1 | 69 | 4.6 |
| Chambers | 0 | .0 | 5 | 1.0 | 4 | .6 | 9 | .6 |
| Cherokee | 0 | .0 | 0 | .0 | 3 | .5 | 3 | .2 |
| Chilton | 1 | .3 | 2 | .4 | 6 | .9 | 9 | .6 |
| Choctaw | 1 | .3 | 0 | .0 | 0 | .0 | 1 | .1 |
| Clarke | 2 | .6 | 1 | .2 | 1 | .2 | 4 | .3 |
| Clay | 0 | .0 | 2 | .4 | 1 | .2 | 3 | .2 |
| Cleburne | 5 | 1.5 | 0 | .0 | 1 | .2 | 6 | .4 |
| Coffee | 1 | .3 | 8 | 1.5 | 6 | .9 | 15 | 1.0 |
| Colbert | 10 | 3.0 | 5 | 1.0 | 4 | .6 | 19 | 1.3 |
| Conecuh | 1 | .3 | 0 | .0 | 0 | .0 | 1 | .1 |
| Coosa | 2 | .6 | 0 | .0 | 0 | .0 | 2 | .1 |
| Covington | 2 | .6 | 3 | .6 | 2 | .3 | 7 | .5 |
| Crenshaw | 0 | .0 | 1 | .2 | 0 | .0 | 1 | .1 |
| Cullman | 1 | .3 | 6 | 1.1 | 11 | 1.7 | 18 | 1.2 |
| Dale | 3 | .9 | 4 | .8 | 6 | .9 | 13 | .9 |
| Dallas | 1 | .3 | 4 | .8 | 14 | 2.1 | 19 | 1.3 |
| DeKalb | 2 | .6 | 4 | .8 | 10 | 1.5 | 16 | 1.1 |
| Elmore | 7 | 2.1 | 4 | .8 | 6 | .9 | 17 | 1.1 |
| Escambia | 2 | .6 | 3 | .6 | 3 | .5 | 8 | .5 |
| Etowah | 5 | 1.5 | 25 | 4.8 | 16 | 2.5 | 46 | 3.0 |
| Fayette | 1 | .3 | 1 | .2 | 1 | .2 | 3 | .2 |
| Franklin | 1 | .3 | 0 | .0 | 2 | .3 | 3 | .2 |
| Geneva | 1 | .3 | 2 | .4 | 1 | .2 | 4 | .3 |
| Greene | 0 | .0 | 0 | .0 | 3 | .5 | 3 | .2 |
| Hale | 0 | .0 | 0 | .0 | 1 | .2 | 1 | .1 |
| Henry | 1 | .3 | 0 | .0 | 1 | .2 | 2 | .1 |
| Houston | 2 | .6 | 4 | .8 | 14 | 2.1 | 20 | 1.3 |
| Jackson | 1 | .3 | 1 | .2 | 6 | .9 | 8 | .5 |
| Jefferson | 90 | 26.9 | 161 | 30.7 | 190 | 29.1 | 441 | 29.2 |
| Lamar | 0 | .0 | 1 | .2 | 2 | .3 | 3 | .2 |
| Lauderdale | 4 | 1.2 | 12 | 2.3 | 14 | 2.1 | 30 | 2.0 |
| Lawrence | 3 | .9 | 2 | .4 | 4 | .6 | 9 | .6 |
| Lee | 11 | 3.3 | 13 | 2.5 | 6 | .9 | 30 | 2.0 |
| Limestone | 8 | 2.4 | 3 | .6 | 3 | .5 | 14 | .9 |

TABLE III-1 Con't

| COUNTY | 1978[a] | | 1979[b] | | 1980[c] | | Total[d] | |
|---|---|---|---|---|---|---|---|---|
| | N | Col.% | N | Col.% | N | Col.% | N | Col.% |
| Lowndes | 0 | .0 | 1 | .2 | 4 | .6 | 5 | .3 |
| Macon | 2 | .6 | 6 | 1.1 | 0 | .0 | 8 | .5 |
| Madison | 25 | 7.5 | 29 | 5.5 | 42 | 6.4 | 96 | 6.3 |
| Marengo | 0 | .0 | 0 | .0 | 2 | .3 | 2 | .1 |
| Marion | 2 | .6 | 3 | .6 | 3 | .5 | 8 | .5 |
| Marshall | 5 | 1.5 | 8 | 1.5 | 7 | 1.1 | 20 | 1.3 |
| Mobile | 0 | .0 | 0 | .0 | 0 | .0 | 0 | .0 |
| Monroe | 0 | .0 | 1 | .2 | 0 | .0 | 1 | .1 |
| Montgomery | 21 | 6.3 | 44 | 8.4 | 43 | 6.6 | 108 | 7.1 |
| Morgan | 4 | 1.2 | 12 | 2.3 | 21 | 3.2 | 37 | 2.4 |
| Perry | 1 | .3 | 1 | .2 | 1 | .2 | 3 | .2 |
| Pickens | 0 | .0 | 0 | .0 | 2 | .3 | 2 | .1 |
| Pike | 1 | .3 | 3 | .6 | 3 | .5 | 7 | .5 |
| Randolph | 0 | .0 | 0 | .0 | 1 | .2 | 1 | .1 |
| Russell | 0 | .0 | 1 | .2 | 0 | .0 | 1 | .1 |
| St. Clair | 7 | 2.1 | 3 | .6 | 6 | .9 | 16 | 1.1 |
| Shelby | 7 | 2.1 | 12 | 2.3 | 22 | 3.4 | 41 | 2.7 |
| Sumter | 0 | .0 | 0 | .0 | 0 | .0 | 0 | .0 |
| Talladega | 3 | .9 | 3 | .6 | 8 | 1.2 | 14 | .9 |
| Tallapoosa | 4 | 1.2 | 5 | 1.0 | 3 | .5 | 12 | .8 |
| Tuscaloosa | 10 | 3.0 | 22 | 4.2 | 23 | 3.5 | 55 | 3.6 |
| Walker | 6 | 1.8 | 8 | 1.5 | 6 | .9 | 20 | 1.3 |
| Washington | 0 | .0 | 1 | .2 | 0 | .0 | 1 | .1 |
| Wilcox | 0 | .0 | 0 | .0 | 0 | .0 | 0 | .0 |
| Winston | 2 | .6 | 0 | .0 | 1 | .2 | 3 | .2 |
| TOTAL | 305 | 100.0 | 468 | 100.0 | 594 | 100.0 | 1367 | 100.0 |

a. 24(7.2%)Not selected; 6(0.6%)out of state - Gr. Total 335
b. 34(6.5%)Not selected; 22(4.2%)out of state - Gr. Total 524
c. 27(4.1%)Not selected; 32(4.9%)out of state - Gr. Total 653
d. 85(5.6%)Not selected; 60(4.0%)out of state - Gr. Total 1512

Sumter, and Wilcox). As expected the largest volume of service was provided to Jefferson County residents (29.2 per cent).

During the three-year period only minor variations occurred within the respective counties in the proportion of amniocenteses provided to residents of that county. Increases in the provision of amniocentesis occurred in Etowah, Houston, Lauderdale, and Morgan counties. There was also a decline in amniocenteses provided to residents of Lee County (from 3.3 per cent of amniocenteses provided in 1978 to 0.9 per cent in 1980). Of the 67 counties, 21 contributed 1.0 per cent or more of the total amniocenteses provided during the three-year period. One of these (Jefferson County) contributed 29.9 per cent of the total and the remaining counties varied from 1.0 per cent (Coffee County) to 7.1 per cent (Montgomery County). The remaining 42 counties which received service from the Laboratory of Medical Genetics each contributed to less than 1.0 per cent of the total amniocenteses.

Table III-2 contains measurements of amniocentesis utilization among Alabama women based on referrals because of maternal age (numerator) and live births by residents $\geq$ 35 years of age (denominator). Utilization assessments are constructed by county for each of the three years and a composite number for the entire period. Comparisons of utilization measurements among the three years are difficult due to the small number of both amniocenteses and live births which occurred to residents in most counties. During this period amniocenteses referrals because of maternal age $\geq$ 35 were received from all but nine Alabama counties.

TABLE III-2

Utilization of Amniocentesis by Alabama Women Referred to the Laboratory of Medical Genetics Because of Maternal Age, 1978-1980

| | 1978 | | | 1979 | | | 1980 | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Del. ≥ 35 | Age Ref | % Util Rate | Del. ≥ 35 | Age Ref | % Util Rate | Del. ≥ 35 | Age Ref | % Util Rate | Del. ≥ 35 | Age Ref | % Util Rate |
| Autauga | 23 | 2 | 8.7 | 18 | 3 | 16.7 | 30 | 3 | 10.0 | 71 | 8 | 11.3 |
| Baldwin | 57 | 0 | .0 | 51 | 0 | .0 | 55 | 0 | .0 | 163 | 0 | .0 |
| Barbour | 14 | 0 | .0 | 15 | 1 | 6.7 | 17 | 0 | .0 | 46 | 1 | 2.2 |
| Bibb | 15 | 0 | .0 | 10 | 0 | .0 | 11 | 3 | 27.3 | 36 | 3 | 8.3 |
| Blount | 22 | 6 | 27.3 | 13 | 2 | 15.4 | 11 | 6 | 54.5 | 46 | 14 | 30.4 |
| Bullock | 6 | 0 | .0 | 17 | 1 | 5.9 | 9 | 1 | 11.1 | 32 | 2 | 6.3 |
| Butler | 14 | 1 | 7.1 | 15 | 2 | 13.3 | 16 | 5 | 31.3 | 45 | 8 | 17.8 |
| Calhoun | 63 | 17 | 27.0 | 50 | 7 | 14.0 | 59 | 19 | 32.2 | 172 | 43 | 25.0 |
| Chambers | 18 | 0 | .0 | 19 | 3 | 15.8 | 14 | 4 | 28.6 | 51 | 7 | 13.7 |
| Cherokee | 24 | 0 | .0 | 18 | 0 | .0 | 29 | 2 | 6.9 | 71 | 2 | 2.8 |
| Chilton | 18 | 0 | .0 | 18 | 1 | 5.6 | 24 | 4 | 16.7 | 60 | 5 | 8.3 |
| Choctaw | 14 | 0 | .0 | 15 | 0 | .0 | 15 | 0 | .0 | 44 | 0 | .0 |
| Clarke | 32 | 2 | 6.3 | 33 | 1 | 3.0 | 36 | 1 | 2.8 | 101 | 4 | 4.0 |
| Clay | 12 | 0 | .0 | 12 | 2 | 16.7 | 8 | 1 | 12.5 | 32 | 3 | 9.4 |
| Cleburne | 8 | 5 | 62.5 | 7 | 0 | .0 | 4 | 1 | 25.0 | 19 | 6 | 31.6 |
| Coffee | 22 | 1 | 4.5 | 28 | 6 | 21.4 | 31 | 6 | 19.4 | 81 | 13 | 16.0 |
| Colbert | 19 | 8 | 42.1 | 18 | 3 | 16.7 | 18 | 3 | 16.7 | 55 | 14 | 25.5 |
| Conecuh | 11 | 0 | .0 | 16 | 0 | .0 | 10 | 0 | .0 | 37 | 0 | .0 |
| Coosa | 7 | 1 | 14.3 | 12 | 0 | .0 | 5 | 0 | .0 | 24 | 1 | 4.2 |
| Covington | 23 | 2 | 8.7 | 19 | 3 | 15.8 | 19 | 1 | 5.3 | 61 | 6 | 9.8 |
| Crenshaw | 3 | 0 | .0 | 11 | 1 | 9.1 | 9 | 0 | .0 | 23 | 1 | 4.3 |
| Cullman | 34 | 1 | 2.9 | 32 | 5 | 15.6 | 37 | 9 | 24.3 | 103 | 15 | 14.7 |
| Dale | 33 | 3 | 9.1 | 19 | 2 | 10.5 | 22 | 3 | 13.6 | 74 | 8 | 10.8 |
| Dallas | 34 | 1 | 2.9 | 56 | 4 | 7.1 | 50 | 12 | 24.0 | 140 | 17 | 12.1 |
| DeKalb | 46 | 2 | 4.3 | 36 | 2 | 5.6 | 58 | 9 | 15.5 | 140 | 13 | 9.3 |
| Elmore | 29 | 7 | 24.1 | 29 | 4 | 13.8 | 29 | 3 | 10.3 | 87 | 14 | 16.1 |
| Escambia | 24 | 2 | 8.3 | 22 | 3 | 13.6 | 20 | 2 | 10.0 | 66 | 7 | 10.6 |
| Etowah | 56 | 3 | 5.4 | 61 | 14 | 23.0 | 54 | 6 | 11.1 | 171 | 23 | 13.5 |
| Fayette | 6 | 1 | 16.7 | 9 | 1 | 11.1 | 6 | 1 | 16.7 | 21 | 3 | 14.3 |
| Franklin | 17 | 1 | 5.9 | 16 | 0 | .0 | 14 | 2 | 14.3 | 47 | 3 | 6.4 |
| Geneva | 15 | 1 | 6.7 | 11 | 2 | 18.2 | 15 | 1 | 6.7 | 41 | 4 | 9.8 |
| Greene | 11 | 0 | .0 | 12 | 0 | .0 | 19 | 3 | 15.8 | 42 | 3 | 9.4 |
| Hale | 14 | 0 | .0 | 12 | 0 | .0 | 14 | 0 | .0 | 40 | 0 | .0 |
| Henry | 13 | 0 | .0 | 11 | 0 | .0 | 14 | 0 | .0 | 38 | 0 | .0 |
| Houston | 39 | 1 | 2.6 | 58 | 2 | 3.4 | 61 | 8 | 13.1 | 158 | 11 | 7.0 |
| Jackson | 32 | 1 | 3.1 | 34 | 1 | 2.9 | 44 | 6 | 13.6 | 110 | 8 | 7.3 |
| Jefferson | 379 | 66 | 17.4 | 338 | 116 | 34.3 | 364 | 125 | 34.3 | 1081 | 307 | 28.4 |
| Lamar | 14 | 0 | .0 | 13 | 1 | 7.7 | 3 | 2 | 66.7 | 30 | 3 | 10.0 |
| Lauderdale | 42 | 3 | 7.1 | 36 | 10 | 27.8 | 40 | 11 | 27.5 | 118 | 24 | 20.3 |
| Lawrence | 10 | 1 | 10.0 | 13 | 1 | 7.7 | 23 | 3 | 13.0 | 46 | 5 | 10.9 |
| Lee | 35 | 10 | 28.6 | 32 | 10 | 31.3 | 37 | 4 | 10.8 | 104 | 24 | 23.1 |
| Limestone | 26 | 4 | 15.4 | 20 | 2 | 10.0 | 30 | 1 | 3.3 | 76 | 7 | 9.2 |

TABLE III-2 Con't

| | 1978 | | | 1979 | | | 1980 | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Del. ≥ 35 | Age Ref | % Util Rate | Del. ≥ 35 | Age Ref | % Util Rate | Del. ≥ 35 | Age Ref | % Util Rate | Del. ≥ 35 | Age Ref | % Util Rate |
| Lowndes | 36 | 0 | .0 | 31 | 0 | .0 | 44 | 4 | 9.1 | 111 | 4 | 3.6 |
| Macon | 17 | 2 | 11.8 | 17 | 4 | 23.5 | 18 | 0 | .0 | 52 | 6 | 11.5 |
| Madison | 94 | 20 | 21.3 | 119 | 20 | 16.8 | 113 | 35 | 31.0 | 326 | 75 | 23.0 |
| Marengo | 27 | 0 | .0 | 21 | 0 | .0 | 20 | 1 | 5.0 | 68 | 1 | 1.5 |
| Marion | 19 | 1 | 5.3 | 19 | 1 | 5.3 | 13 | 2 | 15.4 | 51 | 4 | 7.8 |
| Marshall | 43 | 5 | 11.6 | 30 | 5 | 16.7 | 38 | 4 | 10.5 | 111 | 14 | 12.6 |
| Mobile | 238 | 0 | .0 | 219 | 0 | .0 | 253 | 0 | .0 | 710 | 0 | .0 |
| Monroe | 20 | 0 | .0 | 24 | 0 | .0 | 24 | 0 | .0 | 68 | 0 | .0 |
| Montgomery | 143 | 18 | 12.6 | 169 | 42 | 24.9 | 137 | 34 | 24.8 | 449 | 94 | 20.9 |
| Morgan | 38 | 2 | 5.3 | 56 | 9 | 16.1 | 58 | 15 | 25.9 | 152 | 26 | 17.1 |
| Perry | 19 | 1 | 5.3 | 26 | 1 | 3.8 | 15 | 1 | 6.7 | 60 | 3 | 5.0 |
| Pickens | 18 | 0 | .0 | 14 | 0 | .0 | 19 | 1 | 5.3 | 51 | 1 | 2.0 |
| Pike | 17 | 1 | 5.9 | 25 | 3 | 12.0 | 15 | 3 | 20.0 | 57 | 7 | 12.3 |
| Randolph | 5 | 0 | .0 | 14 | 0 | .0 | 12 | 1 | 8.3 | 31 | 1 | 3.2 |
| Russell | 29 | 0 | .0 | 29 | 1 | 3.4 | 39 | 0 | .0 | 97 | 1 | 1.1 |
| St. Clair | 20 | 5 | 25.0 | 28 | 2 | 7.1 | 20 | 3 | 15.0 | 68 | 10 | 14.7 |
| Shelby | 28 | 2 | 7.1 | 32 | 6 | 18.8 | 48 | 14 | 29.2 | 108 | 22 | 20.4 |
| Sumter | 16 | 0 | .0 | 21 | 0 | .0 | 11 | 0 | .0 | 48 | 0 | .0 |
| Talladega | 55 | 3 | 5.5 | 51 | 2 | 3.9 | 41 | 5 | 12.2 | 147 | 10 | 6.8 |
| Tallapoosa | 16 | 2 | 12.5 | 17 | 2 | 11.8 | 10 | 3 | 30.0 | 43 | 7 | 16.3 |
| Tuscaloosa | 55 | 8 | 14.5 | 65 | 15 | 23.1 | 71 | 19 | 26.8 | 191 | 42 | 22.0 |
| Walker | 32 | 4 | 12.5 | 48 | 5 | 10.4 | 29 | 6 | 20.7 | 109 | 15 | 13.8 |
| Washington | 8 | 0 | .0 | 18 | 1 | 5.6 | 25 | 0 | .0 | 51 | 1 | 2.0 |
| Wilcox | 22 | 0 | .0 | 32 | 0 | .0 | 20 | 0 | .0 | 74 | 0 | .0 |
| Winston | 19 | 2 | 10.5 | 13 | 0 | .0 | 11 | 1 | 9.1 | 43 | 3 | 7.0 |
| TOTAL | 2368 | 229 | 9.7 | 2423 | 335 | 13.8 | 2488 | 423 | 17.0 | 7279 | 987 | 13.6 |

The three years of data suggest a trend of increasing use for residents in certain counties. These counties include Jefferson (17.4 per cent to 34.3 per cent), Lauderdale (7.1 per cent to 27.5 per cent), Montgomery (12.6 per cent to 24.8 per cent), Morgan (5.3 per cent to 25.9 per cent), and Shelby (7.1 per cent to 29.2 per cent). Trends are also indicated for certain counties at the other end of the spectrum. For example, Cleburne County experienced a utilization rate decrease from 62.5 per cent in 1978 to 25.0 per cent in 1980 (1979 had 0.0 per cent utilization). However, as in the case of Cleburne County, counties experiencing a reduced rate of utilization usually had less than five amniocenteses per year.

Analysis of data for all counties for 1978, 1979, and 1980 reveals the Laboratory of Medical Genetics provided amniocenteses statewide to, respectively, 9.7 per cent, 13.8 per cent and 17.0 per cent of Alabama women $\geq$ 35 years of age who had a live birth. The composite utilization rate for the three-year period was 13.6 per cent. During this time frame, the provision of amniocenteses to women referred because of maternal age $\geq$ 35 years of age had increased 84.7 per cent (229 to 423).

The second measure of amniocentesis use provided by the Laboratory of Medical Genetics to Alabama women during 1978-1980 is presented in Table III-3. These data assess the utilization of amniocentesis among Alabama's entire childbirth population during the years of study. As previously mentioned ascertaining trends during this period is difficult on a county- by-county basis due to the small number of amniocenteses provided. On a composite basis a slight increase in the level of annual use of amniocentesis is detectable since 1978. For the three-year

TABLE III-3

Utilization of Amniocentesis Through the Laboratory of Medical Genetics, by Alabama Women of All Ages, 1978-1980

| County | 1978 | | | 1979 | | | 1980 | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Births | Amnio | % Util. | Births | Amnio | % Util. | Births | Amnio | % Util. | Births | Amnio | % Util. |
| Autauga | 472 | 4 | .8 | 488 | 3 | .6 | 545 | 6 | 1.1 | 1505 | 13 | .9 |
| Baldwin | 1205 | 0 | .0 | 1259 | 0 | .0 | 1214 | 0 | .0 | 3678 | 0 | .0 |
| Barbour | 422 | 0 | .0 | 405 | 1 | .3 | 439 | 0 | .0 | 1266 | 1 | .08 |
| Bibb | 227 | 0 | .0 | 232 | 0 | .0 | 268 | 3 | 1.1 | 727 | 3 | .4 |
| Blount | 447 | 6 | 1.3 | 466 | 2 | .4 | 449 | 11 | 2.5 | 1362 | 19 | 1.4 |
| Bullock | 197 | 0 | .0 | 212 | 1 | .5 | 224 | 2 | .9 | 633 | 3 | .5 |
| Butler | 367 | 3 | .8 | 409 | 2 | .5 | 439 | 5 | 1.1 | 1215 | 10 | .8 |
| Calhoun | 1904 | 23 | 1.2 | 1747 | 19 | 1.0 | 1827 | 27 | 1.5 | 5478 | 69 | 1.3 |
| Chambers | 585 | 0 | .0 | 547 | 5 | .9 | 566 | 4 | .7 | 1698 | 9 | .5 |
| Cherokee | 231 | 0 | .0 | 242 | 0 | .0 | 271 | 3 | 1.1 | 744 | 3 | .4 |
| Chilton | 484 | 1 | .2 | 475 | 2 | .4 | 437 | 6 | 1.4 | 1396 | 9 | .7 |
| Choctaw | 263 | 1 | .4 | 292 | 0 | .0 | 248 | 0 | .0 | 803 | 1 | .1 |
| Clarke | 509 | 2 | .4 | 517 | 1 | .2 | 540 | 1 | .2 | 1566 | 4 | .3 |
| Clay | 230 | 0 | .0 | 219 | 2 | .9 | 212 | 1 | .5 | 661 | 3 | .5 |
| Cleburne | 166 | 5 | 3.0 | 176 | 0 | .0 | 178 | 1 | .6 | 520 | 6 | 1.2 |
| Coffee | 573 | 1 | .2 | 586 | 8 | 1.4 | 631 | 6 | 1.0 | 1790 | 15 | .8 |
| Colbert | 698 | 10 | 1.4 | 783 | 5 | .6 | 752 | 4 | .5 | 2233 | 19 | .9 |
| Conecuh | 295 | 1 | .3 | 258 | 0 | .0 | 273 | 0 | .0 | 826 | 1 | .1 |
| Coosa | 146 | 2 | 1.4 | 169 | 0 | .0 | 171 | 0 | .0 | 486 | 2 | .4 |
| Covington | 527 | 2 | .4 | 598 | 3 | .5 | 587 | 2 | .3 | 1712 | 7 | .4 |
| Crenshaw | 194 | 0 | .0 | 210 | 1 | .5 | 229 | 0 | .0 | 633 | 1 | .2 |
| Cullman | 809 | 1 | .1 | 865 | 6 | .7 | 876 | 11 | 1.3 | 2550 | 18 | .7 |
| Dale | 801 | 3 | .4 | 836 | 4 | .5 | 877 | 6 | .7 | 2514 | 13 | .5 |
| Dallas | 1053 | 1 | .1 | 1049 | 4 | .4 | 1057 | 14 | 1.3 | 3159 | 19 | .6 |
| DeKalb | 744 | 2 | .3 | 811 | 4 | .5 | 823 | 10 | 1.2 | 2378 | 16 | .7 |
| Elmore | 637 | 7 | 1.1 | 719 | 4 | .6 | 711 | 6 | .8 | 2067 | 17 | .8 |
| Escambia | 604 | 2 | .3 | 626 | 3 | .5 | 608 | 3 | .5 | 1838 | 8 | .4 |

TABLE III-3 Con't

| County | 1978 Births | 1978 Amnio | 1978 % Util. | 1979 Births | 1979 Amnio | 1979 % Util. | 1980 Births | 1980 Amnio | 1980 % Util. | Total Births | Total Amnio | Total % Util. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Etowah | 1473 | 5 | .3 | 1535 | 25 | 1.6 | 1494 | 6 | 1.1 | 4502 | 46 | 1.0 |
| Fayette | 229 | 1 | .4 | 242 | 1 | .4 | 265 | 1 | .4 | 736 | 3 | .4 |
| Franklin | 431 | 1 | .2 | 409 | 0 | .0 | 468 | 2 | .4 | 1308 | 3 | .2 |
| Geneva | 326 | 1 | .3 | 351 | 2 | .6 | 344 | 1 | .3 | 1021 | 4 | .4 |
| Greene | 209 | 0 | .0 | 216 | 0 | .0 | 227 | 3 | 1.3 | 652 | 3 | .5 |
| Hale | 316 | 0 | .0 | 331 | 0 | .0 | 322 | 1 | .3 | 969 | 1 | .1 |
| Henry | 251 | 1 | .4 | 262 | 0 | .0 | 242 | 1 | .4 | 755 | 2 | .3 |
| Houston | 1223 | 2 | .2 | 1280 | 4 | .3 | 1344 | 14 | 1.0 | 3847 | 20 | .5 |
| Jackson | 780 | 1 | .1 | 780 | 1 | .1 | 839 | 6 | .7 | 2399 | 8 | .3 |
| Jefferson | 10353 | 90 | .9 | 10812 | 161 | 1.5 | 10923 | 190 | 1.7 | 32088 | 441 | 1.4 |
| Lamar | 234 | 0 | .0 | 218 | 1 | .5 | 247 | 2 | .8 | 699 | 3 | .4 |
| Lauderdale | 1024 | 4 | .4 | 1107 | 12 | 1.0 | 1123 | 14 | 1.3 | 3254 | 30 | .9 |
| Lawrence | 475 | 3 | .6 | 442 | 2 | .5 | 502 | 4 | .8 | 1419 | 9 | .6 |
| Lee | 1060 | 11 | 1.0 | 1047 | 12 | 1.2 | 1094 | 6 | .6 | 3201 | 30 | .9 |
| Limestone | 657 | 8 | 1.2 | 667 | 3 | .5 | 650 | 3 | .5 | 1974 | 14 | .7 |
| Lowndes | 283 | 0 | .0 | 290 | 1 | .3 | 319 | 4 | 1.3 | 892 | 5 | .6 |
| Macon | 418 | 2 | .5 | 405 | 6 | 1.5 | 394 | 0 | .0 | 1217 | 8 | .7 |
| Madison | 2731 | 25 | .9 | 2938 | 29 | 1.0 | 2921 | 42 | 1.4 | 8590 | 96 | 1.1 |
| Marengo | 439 | 0 | .0 | 448 | 0 | .0 | 504 | 2 | .4 | 1391 | 2 | .1 |
| Marion | 382 | 2 | .5 | 358 | 3 | .8 | 403 | 3 | .7 | 1143 | 8 | .7 |
| Marshall | 864 | 5 | .6 | 896 | 8 | .9 | 929 | 7 | .8 | 2689 | 20 | .7 |
| Mobile | 6555 | 0 | .0 | 6733 | 0 | .0 | 6938 | 0 | .0 | 20226 | 0 | .0 |
| Monroe | 407 | 0 | .0 | 461 | 1 | .2 | 449 | 0 | .0 | 1317 | 1 | .08 |
| Montgomery | 3072 | 21 | .7 | 3373 | 44 | 1.3 | 3532 | 43 | 1.2 | 9977 | 108 | 1.1 |
| Morgan | 1317 | 4 | .3 | 1398 | 12 | .9 | 1328 | 21 | 1.6 | 4043 | 37 | .9 |
| Perry | 228 | 1 | .4 | 264 | 1 | .4 | 233 | 1 | .4 | 725 | 3 | .4 |
| Pickens | 360 | 0 | .0 | 407 | 0 | .0 | 367 | 2 | .6 | 1134 | 2 | .2 |
| Pike | 391 | 1 | .3 | 463 | 3 | .7 | 451 | 3 | .7 | 1305 | 7 | .5 |
| Randolph | 327 | 0 | .0 | 298 | 0 | .0 | 321 | 1 | .3 | 946 | 1 | .1 |
| Russell | 821 | 0 | .0 | 782 | 1 | .1 | 804 | 0 | .0 | 2407 | 1 | .04 |

TABLE III-3 Con't

| | 1978 | | | 1979 | | | 1980 | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| County | Births | Amnio | % Util. | Births | Amnio | % Util. | Births | Amnio | % Util. | Births | Amnio | % Util. |
| St. Clair | 597 | 7 | 1.2 | 627 | 3 | .5 | 617 | 6 | 1.0 | 1841 | 16 | .9 |
| Shelby | 976 | 7 | .7 | 1063 | 12 | 1.1 | 1111 | 22 | 2.0 | 3150 | 41 | 1.3 |
| Sumter | 305 | 0 | .0 | 338 | 0 | .0 | 348 | 0 | .0 | 991 | 0 | .0 |
| Talladega | 1279 | 3 | .2 | 1220 | 3 | .3 | 1146 | 8 | .7 | 3645 | 14 | .4 |
| Tallapoosa | 582 | 4 | .7 | 574 | 5 | .9 | 559 | 3 | .5 | 1715 | 12 | .7 |
| Tuscaloosa | 1959 | 10 | .5 | 2070 | 22 | 1.0 | 2089 | 23 | 1.1 | 6118 | 55 | .9 |
| Walker | 1017 | 6 | .6 | 1101 | 8 | .7 | 1038 | 6 | .6 | 3156 | 20 | .6 |
| Washington | 253 | 0 | .0 | 342 | 1 | .3 | 345 | 0 | .0 | 940 | 1 | .1 |
| Wilcox | 364 | 0 | .0 | 400 | 0 | .0 | 354 | 0 | .0 | 1118 | 0 | .0 |
| Winston | 350 | 2 | .6 | 350 | 0 | .0 | 369 | 1 | .3 | 1069 | 3 | .3 |
| TOTAL | 60108 | 305 | .5 | 62494 | 468 | .8 | 63405 | 594 | .9 | 186007 | 1367 | .7 |

composite only eight counties had utilization rates of 1.0 per cent or greater. However, during 1980 a total of 23 counties had utilization rates of 1.0 per cent or higher. On a statewide basis, less than 1.0 per cent of Alabama's prenatal patients received amniocenteses through the Laboratory of Medical Genetics during the three-year period.

## Summary

Using amniocentesis service data from the Laboratory of Medical Genetics and data from Alabama's official birth registrations, two distinct but complementary objectives were attained. First, the Alabama service area of the Laboratory of Medical Genetics was delineated. Second, the extent amniocentesis was provided by the Laboratory of Medical Genetics among Alabama women having live births was estimated for (a) women of advanced maternal age ( $\geq$ 35 years old) and (b) all women having a live birth. This information is essential in establishing base line data for future comparison and evaluation purposes.

During the three years included in this study the Laboratory of Medical Genetics provided amniocenteses to residents in every Alabama county except four. The proportion of amniocentesis users in Alabama's advanced maternal age group increased each year. In 1980, 17.0 per cent of women $\geq$ 35 years of age obtained amniocentesis through the Laboratory of Medical Genetics (compared to 9.7 per cent and 13.8 per cent in 1978 and 1979, respectively). A minor increase in utilization among all women having live births was observed during each of the three years. This utilization rate was 0.5 per cent in 1978, 0.8 per cent in 1979, and 0.9 per cent in 1980.

# CHAPTER IV

# DEMOGRAPHIC PROFILE OF AMNIOCENTESIS REFERRALS

## Introduction

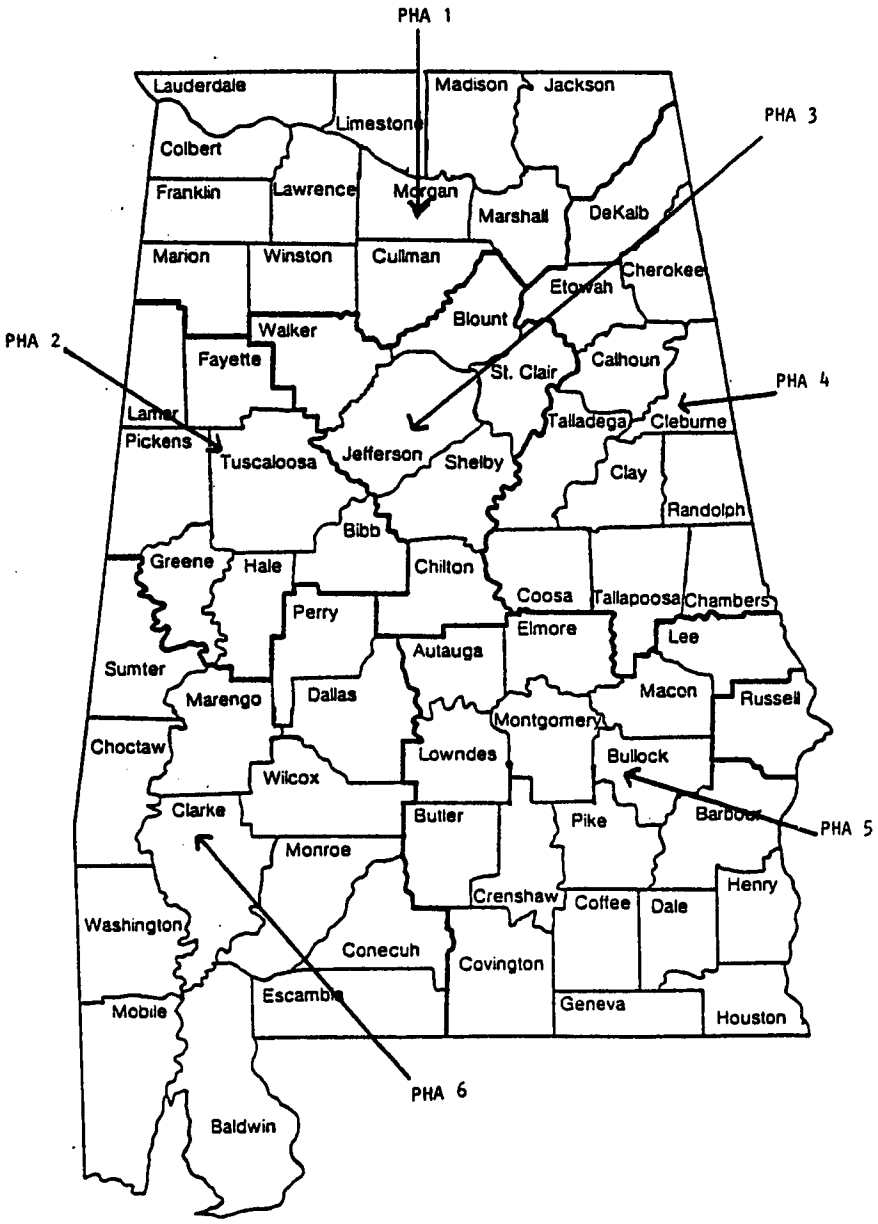
Data recorded on the Basic Patient Data form (Appendix 2) were tabulated by computer program and analyzed to obtain a demographic description of those women who obtained amniocenteses through the Laboratory of Medical Genetics. The specific items included in this analysis are number of patients by age, race, referral source, and reason for referral. This information was calculated for each year 1978-1980, and a composite number of patients was obtained for the entire three-year period.

A computer program was designed to retrieve age of patients by Public Health Area (PHA) of residence. (See Figure IV-A for the six PHA designations in Alabama.) The other variables listed above were retrieved by Alabama county of residence through computer programing. Through hand tabulations these data were categorized according to PHA of residence.

Ages of patients were tabulated by single year interval for age $\geq$ 30. Patients $\geq$ 29 years of age were combined into one group. Race is reported as white, black or other. Referral sources include private physician, hospital, community agency, public health department, and other. Reasons for referral include maternal age (Age), previous child

FIGURE IV-A

Geographical Designations for Alabama's Six
Public Health Areas (PHA)



with chromosomal aberration (Aberration), history of X-linked recessive disorder (X-Linked), patient carrier of translocation chromosome (Translocation), family history of biochemical disorder (Biochemical), family history of neural tube defect (NTD), anxiety, and other.

## Findings

Tables IV-2 through IV-5 provide data on the number of patients by age who obtained amniocentesis for years 1978-1980 by Alabama PHA of residence. After grouping patients by selected maternal age intervals, the age distribution of users was calculated and is presented below in Table IV-1.

TABLE IV-1
Proportion of Amniocentesis Patients by Maternal Age Interval Served in the Laboratory of Medical Genetics During 1978-1980

| Maternal Age | 1978 | 1979 | 1980 | Combined Years |
|---|---|---|---|---|
| ≤ 29 | 15.0% | 15.3% | 14.5% | 14.9% |
| 30-34 | 10.5% | 13.6% | 16.9% | 14.3% |
| 35-39 | 50.4% | 51.1% | 55.9% | 53.1% |
| 40-44 | 12.0% | 13.2% | 8.4% | 11.0% |
| ≥ 45 | .3% | .2% | 1.1% | .6% |
| Not Selected | 11.6% | 6.8% | 3.2% | 6.4% |
| Total* | 100% | 100% | 100% | 100% |

*May not be exact due to rounding factor

One notable change in data during the three years is the increasing proportion of patients in the 30-34 age group (10.5 per cent in 1978 to 16.9 per cent in 1980). Increases were also observed annually for the 35-39 age group (50.4 per cent in 1978 to 55.9 per cent in 1980). Of particular interest in 1980 is the decrease in the proportion of

TABLE IV-2

Age of Amniocentesis Patients by Alabama Public Health Area,
Laboratory of Medical Genetics, 1978

| Maternal Age | PHA 1 N | PHA 2 N | PHA 3 N | PHA 4 N | PHA 5 N | PHA 6 N | Not Selected N | Total N | Total % |
|---|---|---|---|---|---|---|---|---|---|
| ≤ 29 | 8 | 2 | 24 | 6 | 3 | 1 | 6 | 50 | 15.0 |
| 30 | 1 | 0 | 5 | 1 | 2 | 0 | 1 | 10 | 3.0 |
| 31 | 4 | 0 | 2 | 2 | 1 | 1 | 0 | 10 | 3.0 |
| 32 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 2 | .6 |
| 33 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 5 | 1.5 |
| 34 | 2 | 0 | 3 | 1 | 2 | 0 | 0 | 8 | 2.4 |
| 35 | 10 | 3 | 17 | 2 | 14 | 1 | 2 | 49 | 14.7 |
| 36 | 4 | 2 | 9 | 9 | 7 | 3 | 1 | 35 | 10.5 |
| 37 | 10 | 0 | 13 | 3 | 9 | 0 | 2 | 37 | 11.1 |
| 38 | 8 | 2 | 10 | 1 | 6 | 2 | 1 | 30 | 9.0 |
| 39 | 3 | 1 | 6 | 3 | 2 | 0 | 2 | 17 | 5.1 |
| 40 | 6 | 0 | 5 | 2 | 2 | 0 | 0 | 15 | 4.5 |
| 41 | 1 | 0 | 3 | 5 | 2 | 0 | 1 | 12 | 3.6 |
| 42 | 2 | 0 | 2 | 0 | 2 | 0 | 0 | 6 | 1.8 |
| 43 | 4 | 1 | 0 | 1 | 0 | 0 | 0 | 6 | 1.8 |
| 44 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | .3 |
| 45 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .0 |
| ≥ 46 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | .3 |
| Not Selected | 0 | 0 | 17 | 11 | 1 | 2 | 8 | 38 | 11.7 |
| TOTAL | 65 | 12 | 119 | 47 | 54 | 12 | 24 | 333 | 100.0 |

TABLE IV-3

Age of Amniocentesis Patients by Alabama Public Health Area,
Laboratory of Medical Genetics, 1979

| Maternal Age | PHA 1 N | PHA 2 N | PHA 3 N | PHA 4 N | PHA 5 N | PHA 6 N | Not Selected N | Total N | % |
|---|---|---|---|---|---|---|---|---|---|
| ≤ 29 | 10 | 5 | 36 | 18 | 7 | 0 | 1 | 77 | 15.3 |
| 30 | 2 | 0 | 5 | 2 | 1 | 0 | 0 | 10 | 2.0 |
| 31 | 3 | 0 | 1 | 2 | 1 | 0 | 1 | 8 | 1.6 |
| 32 | 1 | 1 | 4 | 2 | 4 | 1 | 0 | 13 | 2.6 |
| 33 | 4 | 0 | 4 | 5 | 1 | 1 | 1 | 16 | 3.2 |
| 34 | 3 | 1 | 5 | 2 | 9 | 0 | 1 | 21 | 4.2 |
| 35 | 10 | 1 | 30 | 3 | 18 | 1 | 6 | 69 | 13.8 |
| 36 | 10 | 7 | 29 | 8 | 17 | 0 | 7 | 78 | 15.5 |
| 37 | 10 | 3 | 19 | 3 | 11 | 0 | 3 | 49 | 9.8 |
| 38 | 4 | 1 | 12 | 7 | 7 | 2 | 5 | 38 | 7.6 |
| 39 | 8 | 0 | 8 | 3 | 3 | 0 | 0 | 22 | 4.4 |
| 40 | 4 | 3 | 9 | 2 | 11 | 0 | 1 | 30 | 6.0 |
| 41 | 5 | 0 | 9 | 3 | 2 | 1 | 1 | 21 | 4.2 |
| 42 | 4 | 0 | 1 | 2 | 3 | 0 | 0 | 10 | 2.0 |
| 43 | 0 | 0 | 4 | 0 | 1 | 0 | 0 | 5 | 1.0 |
| 44 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .0 |
| 45 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | .2 |
| ≥ 46 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .0 |
| Not Selected | 4 | 2 | 11 | 1 | 2 | 8 | 6 | 34 | 6.8 |
| TOTAL | 82 | 24 | 187 | 63 | 98 | 14 | 34 | 502 | 100.0 |

TABLE IV-4

Age of Amniocentesis Patients by Alabama Public Health Area,
Laboratory of Medical Genetics, 1980

| Maternal Age | PHA 1 N | PHA 2 N | PHA 3 N | PHA 4 N | PHA 5 N | PHA 6 N | Not Selected N | Total N | % |
|---|---|---|---|---|---|---|---|---|---|
| ≤ 29 | 18 | 3 | 39 | 12 | 10 | 4 | 4 | 90 | 14.5 |
| 30 | 0 | 0 | 4 | 1 | 2 | 0 | 0 | 7 | 1.1 |
| 31 | 0 | 0 | 3 | 3 | 4 | 0 | 0 | 10 | 1.6 |
| 32 | 3 | 1 | 7 | 1 | 1 | 0 | 1 | 14 | 2.3 |
| 33 | 0 | 0 | 10 | 5 | 1 | 1 | 1 | 18 | 2.9 |
| 34 | 7 | 4 | 27 | 4 | 10 | 4 | 0 | 56 | 9.0 |
| 35 | 20 | 10 | 42 | 10 | 19 | 2 | 4 | 107 | 17.2 |
| 36 | 16 | 6 | 30 | 7 | 17 | 4 | 6 | 86 | 13.9 |
| 37 | 16 | 6 | 29 | 6 | 8 | 2 | 4 | 71 | 11.4 |
| 38 | 11 | 1 | 12 | 11 | 11 | 1 | 3 | 50 | 8.1 |
| 39 | 12 | 1 | 8 | 5 | 5 | 0 | 2 | 33 | 5.3 |
| 40 | 5 | 1 | 14 | 1 | 4 | 0 | 2 | 27 | 4.4 |
| 41 | 3 | 0 | 3 | 2 | 2 | 0 | 0 | 10 | 1.6 |
| 42 | 2 | 1 | 2 | 1 | 2 | 0 | 0 | 8 | 1.3 |
| 43 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 3 | .5 |
| 44 | 0 | 0 | 2 | 1 | 1 | 0 | 0 | 4 | .6 |
| 45 | 2 | 0 | 1 | 0 | 0 | 1 | 0 | 4 | .6 |
| ≥ 46 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 3 | .5 |
| Not Selected | 2 | 0 | 7 | 3 | 2 | 6 | 0 | 20 | 3.2 |
| TOTAL | 118 | 35 | 241 | 74 | 99 | 27 | 27 | 621 | 100.0 |

TABLE IV-5

Age of Amniocentesis Patients by Alabama Public Health Area,
Laboratory of Medical Genetics, 1978-1980

| Maternal Age | PHA 1 N | PHA 2 N | PHA 3 N | PHA 4 N | PHA 5 N | PHA 6 N | Not Selected N | Total N | % |
|---|---|---|---|---|---|---|---|---|---|
| ≤ 29 | 36 | 10 | 99 | 36 | 20 | 5 | 11 | 217 | 14.9 |
| 30 | 3 | 0 | 14 | 4 | 5 | 0 | 1 | 27 | 1.9 |
| 31 | 7 | 0 | 6 | 7 | 6 | 1 | 1 | 28 | 1.9 |
| 32 | 4 | 2 | 12 | 3 | 5 | 2 | 1 | 29 | 2.0 |
| 33 | 5 | 1 | 15 | 10 | 3 | 3 | 2 | 39 | 2.7 |
| 34 | 12 | 5 | 35 | 7 | 21 | 4 | 1 | 85 | 5.8 |
| 35 | 40 | 14 | 89 | 15 | 51 | 4 | 12 | 225 | 15.5 |
| 36 | 30 | 15 | 68 | 24 | 41 | 7 | 14 | 199 | 13.7 |
| 37 | 36 | 9 | 61 | 12 | 28 | 2 | 9 | 157 | 10.8 |
| 38 | 23 | 4 | 34 | 19 | 24 | 5 | 9 | 118 | 8.1 |
| 39 | 23 | 2 | 22 | 11 | 10 | 0 | 4 | 72 | 5.0 |
| 40 | 15 | 4 | 28 | 5 | 17 | 0 | 3 | 72 | 15.0 |
| 41 | 9 | 0 | 15 | 10 | 6 | 1 | 2 | 43 | 3.0 |
| 42 | 8 | 1 | 5 | 3 | 7 | 0 | 0 | 24 | 1.7 |
| 43 | 5 | 1 | 5 | 1 | 1 | 1 | 0 | 14 | 1.0 |
| 44 | 1 | 0 | 2 | 1 | 1 | 0 | 0 | 5 | .3 |
| 45 | 2 | 0 | 1 | 0 | 0 | 1 | 1 | 5 | .3 |
| ≥ 46 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 4 | .3 |
| Not Selected | 6 | 2 | 35 | 15 | 5 | 16 | 14 | 93 | 6.4 |
| TOTAL | 265 | 71 | 547 | 184 | 251 | 53 | 85 | 1,456 | 100.0 |

patients who were 40 years of age or older (13.4 per cent in 1979 to 9.5 per cent). The percentage of patients in which age was not selected decreased from 11.7 per cent in 1978 to 3.2 per cent in 1980.

Tables IV-6 through IV-9 provide data on racial composition of patients receiving amniocenteses for years 1978-1980. Data collection techniques and subsequent computer storage of race designations of patients were not refined until well into the 1980 year. Therefore, a significant portion of racial data on patients is classified as "not selected."

A review of patient racial data for the combined three year period is provided in Table IV-9. Of those patients in which race was recorded, 89.8 per cent were white, 9.4 per cent were black, and .08 per cent were other. Table IV-8, containing racial analysis for 1980, provides the most complete data on race of any of the respective years. During the year 74.9 per cent of patients were white, 9.2 per cent were black, and 1.0 per cent were other (15.0 per cent of patients did not have race designated).

Tables IV-10 through IV-13 contain data on types of referral sources to the Laboratory of Medical Genetics. Each year the overwhelming majority (over 90 per cent) of patients were referred from physicians in private practice.

Tables IV-14 through IV-17 provide data on the specific reasons enumerated by providers in referring patients for amniocenteses. Maternal age is the predominant reason for referral during each of the years of study and accounted for 72.4 per cent of total referrals for the three- year period. Family history of neural tube defect (NTD) with

TABLE IV-6

Racial Analysis of Patients Receiving Amniocenteses by Alabama Public Health Area, Laboratory of Medical Genetics, 1978

| PHA | WHITE | BLACK | OTHER | NOT SELECTED | TOTAL |
|---|---|---|---|---|---|
| 1 | 38 | 2 | | 2 | 22 |
| 2 | 8 | - | | 3 | 11 |
| 3 | 61 | 8 | | 48 | 117 |
| 4 | 31 | 1 | | 12 | 44 |
| 5 | 39 | 1 | | 19 | 59 |
| 6 | 3 | - | | 5 | 8 |
| Not Selected | 15 | 1 | | 8 | 24 |
| Total | 195(59.3%) | 13(4.0%) | | 121(36.7%) | 329(100%) |

TABLE IV-7

Racial Analysis of Patients Receiving Amniocenteses by Alabama Public Health Area, Laboratory of Medical Genetics, 1979

| PHA | WHITE | BLACK | OTHER | NOT SELECTED | TOTAL |
|---|---|---|---|---|---|
| 1 | 7 | - | | 74 | 81 |
| 2 | 2 | - | | 22 | 24 |
| 3 | 21 | 3 | | 164 | 188 |
| 4 | 8 | - | | 55 | 63 |
| 5 | 8 | 1 | | 92 | 101 |
| 6 | 3 | - | | 8 | 11 |
| Not Selected | 7 | 1 | | 26 | 34 |
| Total | 56(11.2%) | 5(1.0%) | | 441(87.8%) | 502(100%) |

TABLE IV-8

Racial Analysis of Patients Receiving Amniocenteses by Alabama Public Health Area, Laboratory of Medical Genetics, 1980

| PHA | WHITE | BLACK | OTHER | NOT SELECTED | TOTAL |
|---|---|---|---|---|---|
| 1 | 98 | 1 | | 19 | 118 |
| 2 | 24 | 5 | | 6 | 35 |
| 3 | 165 | 34 | 5 | 37 | 241 |
| 4 | 59 | 5 | | 10 | 74 |
| 5 | 88 | 5 | 1 | 11 | 105 |
| 6 | 11 | 2 | | 8 | 21 |
| Not Selected | 20 | 5 | | 2 | 27 |
| Total | 465(74.9%) | 57(9.2%) | 6(1.0%) | 93(15.0%) | 621(100%) |

TABLE IV-9

Racial Analysis of Patients Receiving Amniocenteses by Alabama Public Health Area, Laboratory of Medical Genetics, 1978-80

| PHA | WHITE | | BLACK | | OTHER | | NOT SELECTED | | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | N | % | N | % |
| 1 | 143 | 54.0 | 3 | 1.1 | - | | 119 | 44.9 | 265 | 100 |
| 2 | 34 | 48.5 | 5 | 7.1 | - | | 31 | 44.3 | 70 | 100 |
| 3 | 247 | 45.2 | 45 | 8.2 | 5 | .9 | 249 | 45.6 | 546 | 100 |
| 4 | 98 | 54.1 | 6 | .03 | - | | 77 | 42.5 | 181 | 100 |
| 5 | 135 | 50.9 | 7 | 2.6 | 1 | .4 | 122 | 46.0 | 265 | 100 |
| 6 | 17 | 42.5 | 2 | 5.0 | - | | 21 | 52.5 | 40 | 100 |
| Not Selected | 42 | 49.4 | 7 | 8.2 | - | | 36 | 42.4 | 85 | 100 |
| Total | 716 | 49.3 | 75 | 5.2 | 6 | .4 | 655 | 45.1 | 1452 | 100 |

TABLE IV-10

Patients Receiving Amniocenteses by Referral Source and Alabama Public Health Area, Laboratory of Medical Genetics, 1978

| PHA | Private Physician | Hospital | Community Agency | Public Health | Other | Not Selected | TOTAL |
|---|---|---|---|---|---|---|---|
| 1 | 63 | 1 | | | | 2 | 66 |
| 2 | 9 | | | | 1 | 1 | 11 |
| 3 | 105 | 7 | | | 1 | 4 | 117 |
| 4 | 44 | | | | | - | 44 |
| 5 | 52 | | | | 5 | 2 | 59 |
| 6 | 7 | | | | | 1 | 8 |
| Not Selected | 17 | 3 | | | 2 | 2 | 24 |
| Total | 297(90.%) | 11(3.3%) | - | - | 9(2.7%) | 12(3.6%) | 329 |

TABLE IV-11

Patients Receiving Amniocenteses by Referral Source and Alabama Public Health Area, Laboratory of Medical Genetics, 1979

| PHA | Private Physician | Hospital | Community Agency | Public Health | Other | Not Selected | TOTAL |
|---|---|---|---|---|---|---|---|
| 1 | 79 | | | 1 | | 1 | 81 |
| 2 | 22 | | 1 | | 1 | | 24 |
| 3 | 181 | | | 1 | 4 | 2 | 188 |
| 4 | 63 | | | | | | 63 |
| 5 | 100 | | | | | 1 | 101 |
| 6 | 11 | | | | | | 11 |
| Not Selected | 33 | | | | 1 | | 34 |
| Total | 489(97.4%) | | 1(.2%) | 2(.4%) | 6(1.2%) | 4(.8%) | 502 |

TABLE IV-12

Patients Receiving Amniocenteses by Referral Source and Alabama Public Health Area, Laboratory of Medical Genetics, 1980

| PHA | Private Physician | Hospital | Community Agency | Public Health | Other | Not Selected | TOTAL |
|---|---|---|---|---|---|---|---|
| 1 | 111 | 1 | | 2 | | 4 | 118 |
| 2 | 34 | | 1 | | | | 35 |
| 3 | 220 | 5 | | 10 | 1 | 5 | 241 |
| 4 | 70 | 1 | | | | 3 | 74 |
| 5 | 100 | | | 1 | | 4 | 105 |
| 6 | 19 | | | 1 | | 1 | 21 |
| Not Selected | 24 | | | | | 3 | 27 |
| Total | 578(93.1%) | 7(1.1%) | 1(.2%) | 14(2.3%) | 1(.2%) | 20(3.27%) | 621 |

TABLE IV-13

Patients Receiving Amniocenteses by Referral Source and Alabama Public Health Area, Laboratory of Medical Genetics, 1978-1980

| PHA | Private Physician N | % | Hospital N | % | Community Agency N | % | Public Health N | % | Other N | % | Not Selected N | % | Total N | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 253 | 95.5 | 2 | .8 | - | | 3 | 1.1 | - | | 7 | 2.6 | 265 | 100 |
| 2 | 65 | 92.9 | - | | 2 | 2.9 | - | | 2 | 2.9 | 1 | 1.4 | 70 | 100 |
| 3 | 506 | 92.7 | 12 | 2.2 | 0 | | 11 | 2.0 | 6 | 1.1 | 11 | 2.0 | 546 | 100 |
| 4 | 177 | 97.8 | 1 | .6 | - | | - | | - | | 3 | 1.7 | 181 | 100 |
| 5 | 252 | 95.1 | - | | - | | 1 | .4 | 5 | 1.9 | 7 | 2.6 | 265 | 100 |
| 6 | 37 | 92.5 | - | | - | | 1 | 2.5 | - | | 2 | 5.0 | 40 | 100 |
| Not Selected | 74 | 87.1 | 3 | 3.5 | - | | - | | 3 | 3.5 | 5 | .59 | 85 | 100 |
| TOTAL | 1364 | 93.9 | 18 | 1.2 | 2 | .1 | 16 | 1.1 | 16 | 1.1 | 36 | 2.5 | 1452 | 100 |

TABLE IV-14

Patients Receiving Amniocenteses by Reasons for Referral and Alabama Public Health Area, Laboratory of Medical Genetics, 1978

| PHA | Age | Aberration | X-Link | Translocation | Biochemical | NTD | Anxiety | Other | Not Selected | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 49 | 3 | 1 | | | 8 | 2 | 2 | 1 | 66 |
| 2 | 9 | 1 | | | | 1 | | | | 11 |
| 3 | 83 | 5 | | | | 21 | 3 | 5 | | 117 |
| 4 | 33 | 1 | | | | 6 | 1 | 3 | | 44 |
| 5 | 49 | 1 | | | | 5 | 1 | 3 | | 59 |
| 6 | 6 | | | | | 1 | | 1 | | 8 |
| Not Selected | 16 | 3 | | | | 1 | | 3 | 1 | 24 |
| TOTAL | 245 (74.5%) | 14 (4.3%) | 1 (.3%) | | | 43 (13.1%) | 7 (2.1%) | 17 (5.2%) | 2 (.6%) | 329 |

TABLE IV-15

Patients Receiving Amniocenteses by Reasons for Referral and Alabama Public Health Area, Laboratory of Medical Genetics, 1979

| | Age | Aberration | X-Link | Translocation | Biochemical | NTD | Anxiety | Other | Not Selected | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 57 | 7 | | | | 9 | 5 | 2 | 1 | 81 |
| 2 | 17 | 1 | | | | 2 | 3 | 1 | | 24 |
| 3 | 132 | 3 | 1 | 1 | | 25 | 12 | 12 | 2 | 188 |
| 4 | 32 | 1 | | | | 16 | 7 | 6 | 1 | 63 |
| 5 | 87 | 1 | | | | 7 | 2 | 4 | | 101 |
| 6 | 10 | | | | | 1 | | | | 11 |
| Not Selected | 27 | | | | | 3 | 1 | 3 | | 34 |
| TOTAL | 362 (72.1%) | 13 (2.6%) | 1 (.2%) | 1 (.2%) | | 63 (12.5%) | 30 (6.0%) | 28 (5.6%) | 4 (.8%) | 502 |

TABLE IV-16

Patients Receiving Amniocenteses by Reasons for Referral and Alabama Public Health Area, Laboratory of Medical Genetics, 1980

| | Age | Aberration | X-Link | Translocation | Biochemical | NTD | Anxiety | Other | Not Selected | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 92 | 7 | | | | 11 | 2 | 4 | 2 | 118 |
| 2 | 29 | | | | | 1 | | 4 | 1 | 35 |
| 3 | 158 | 10 | | 1 | 1 | 33 | 10 | 19 | 9 | 241 |
| 4 | 51 | 3 | | | | 11 | 4 | 5 | | 74 |
| 5 | 76 | 8 | | | | 6 | 2 | 8 | 5 | 105 |
| 6 | 17 | | | | | 1 | 2 | | 1 | 21 |
| Not Selected | 21 | 1 | | | | 3 | 1 | | 1 | 27 |
| TOTAL | 444 (71.5%) | 29 (4.7%) | | 1 (.2%) | 1 (.2%) | 66 (10.6%) | 21 (3.4%) | 40 (6.4%) | 19 (3.1%) | 621 |

TABLE IV-17

Patients Receiving Amniocenteses by Reasons for Referral and Alabama Public Health Area, Laboratory of Medical Genetics, 1978-1980

| PHA | Age | Aberration | X-Link | Translocation | Biochemical | NTD | Anxiety | Other | Not Selected | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 198 | 17 | 1 | - | - | 28 | 9 | 8 | 4 | 265 |
| 2 | 55 | 2 | - | - | | 4 | 3 | 5 | 1 | 70 |
| 3 | 373 | 18 | 1 | 2 | 1 | 79 | 25 | 36 | 11 | 546 |
| 4 | 116 | 5 | - | - | - | 33 | 12 | 14 | 1 | 181 |
| 5 | 212 | 10 | - | - | - | 3 | 2 | 1 | 1 | 40 |
| 6 | 64 | 4 | - | - | - | 7 | 2 | 6 | 2 | 85 |
| Not Selected | 64 | 4 | - | - | - | 7 | 2 | 6 | 2 | 85 |
| TOTAL | 1,051 (72.4%) | 56 (3.9%) | 2 (.1%) | 2 (.1%) | 1 (.01%) | 172 (11.9%) | 58 (4.0%) | 85 (5.9%) | 25 (1.7%) | 1,452 (100%) |

11.8 per cent of patients accounted for the second most frequent reason for referral. Having a child with a previous chromosomal aberration (Aberration) accounted for 3.9 per cent of referrals. Referrals for other clinically indicated reasons were negligible. Of interest is the slight increase annually of referrals categorized as other.

## Summary

Using demographic data collected on amniocentesis referrals, a profile of patients was developed. Specific demographic variables of interest included age, race, referral source, and reason for referral. Unfortunately, these data had not been uniformly collected for computer storage thus complicating efforts to describe the demographic profile of patients.

Comparison of patients by age during the three-year period indicates an increase occurring in the proportion of patients comprising the 30-34 age group (10.5 per cent to 16.9 per cent). The five-year age group 35-39 contained the largest proportion of users each year as follows: 1978, 50.4 per cent; 1979, 51.1 per cent; 1980, 53.1 per cent. A sharp reduction in 1980 was observed in the proportion of users 40 years of age and older.

The most recent available data (1980) collected in this study on racial composition of the patient population indicates that 74.9 per cent are white, 9.2 per cent are black, and 1.0 per cent are other. Race was not designated for 15.0 per cent of patients. Prior to 1980, racial data on patients were not computerized sufficiently to enable extrapolation of racial composition.

The primary referral source of patients to the Laboratory of Medical Genetics is predominantly (over 90 per cent) private physicians. Other agents or services may play secondary and influential roles to these physician referrals but are not discernible from available data.

Maternal age is the single largest (71.5 per cent) reason for referral of patients followed by family history of neural tube defect (10.6 per cent). Slight increases were observed annually (5.2 per cent, 5.6 per cent, and 6.4 per cent) in the proportion of referrals categorized as other, thus indicating an increasing tendency among practitioners to refer for reasons other than usual clinical indications.

# CHAPTER V

# DIAGNOSTIC PARAMETERS OF AMNIOCENTESIS

## Introduction

Ideally, assessing the accuracy of amniocentesis by karyotyping should include two chromosome studies: (1) a study on fetal cells obtained *in utero* and (2) a comparative study on the neonate's cells after delivery. Many chromosomal abnormalities are phenotypically expressed at birth and may be detected through clinical observation; however, some are not readily discernible in this manner. Obviously, the cost of conducting two chromosome studies on all amniocentesis referrals would be exorbitant.

The present followup method in the Laboratory of Medical Genetics to confirm normal karyotypes consists of written inquiries to physicians who delivered those neonates having chromosomal studies *in utero*. This evaluation is based totally on the physician's clinical observation of the neonate at birth unless physical or neurological abnormalities were apparent and indicated the need for diagnostic tests. Upon being returned to the Laboratory of Medical Genetics, the physician evaluations of the respective neonates are recorded in the patient service chronicle which also contains the results of the neonates' chromosome studies from cells obtained *in utero*. The patient service

chronicle also includes a record of the final outcome of each pregnancy, i.e., delivery, termination, spontaneous abortion.

When possible, efforts are made to confirm *in utero* diagnoses of chromosomal abnormalities through studies of the neonate or, in the event of spontaneous abortion and pregnancy termination, the fetus. This is frequently difficult, especially if the pregnancy is terminated out-of-town; efforts are made, however, to culture a biopsy for karyotype analysis for confirmation of the prenatal karyotype.

Followup data on abnormal karyotypes in this study are presented as cytogenetically confirmed, clinically confirmed, or unconfirmed. Abnormal karyotypes confirmed both cytogenetically and clinically are categorized under cytogenetic confirmation. Among unconfirmed abnormals, growth failures in cell cultures resulting from efforts to confirm karyotypes are delineated.

In this study the patient service chronicle was analyzed by year to determine the number of chromosomal abnormalities detected, number of normal karyotypes registered, and number of normal karyotypes confirmed by clinical observation. Results of efforts to confirm abnormal karyotypes through either (1) cytogenetic studies of the neonate or abortus material or (2) clinical observation were obtained through a review of existing records in the Laboratory of Medical Genetics.

The patient service chronicle was analyzed by year to determine the final outcome of pregnancy in those instances in which fetal chromosomal abnormalities were diagnosed *in utero*. These pregnancy outcomes have been categorized as delivery, pregnancy termination, or spontaneous abortion. After a chromosomal abnormality is diagnosed *in utero*, the

referring physician is given the results and counsels the family to aid and support their decision on whether to continue the pregnancy. The staff of the Laboratory of Medical of Genetics is also available to counsel with the couple.

## *Findings*

Table V-1 contains pertinent data on the results of amniocenteses for fetal chromosomal evaluation during the years 1978-1980. The total number of amniocenteses attempted was calculated, which includes those repeat procedures necessary to achieve cell culture growth, plus the diagnostic results for each patient: normal karyotype, abnormal karyotype, or unsuccessful karyotype. The "unsuccessful karyotype" category consists of those patients whose cell cultures could not be analyzed due to contamination or other reasons.

As presented in Table V-1, 344 amniocenteses were provided through the Laboratory of Medical Genetics in 1978. Cell cultures were successfully grown on 332 patients; repeat amniocentesis procedures were necessary for 12 patients to obtain amniotic fluid to culture fetal cells. Of the 332 fetal karyotypes, 326 were diagnosed as normal and six as abnormal. There were no patients in the "unsuccessful karyotype" category, i.e., patients from whom a fetal karyotype was never obtained because of culture contamination or other reasons. The rate of abnormal fetal karyotype detection was 6/332 or 1.8 per cent.

The results of efforts to confirm karyotypes through followup are presented in Table V-2 by year. In 1978, two (33.3 per cent) of the six abnormal karyotypes were cytogenetically confirmed through cell culture

TABLE V-1

Analysis of Total Amniocenteses Attempted for Fetal Chromosomal Evaluations in the Laboratory of Medical Genetics for Years 1978-1980

| Year | (1) Successful Patient Karyotpyes | (2) Normal Karyotypes | (3) Abnormal Karyotypes | (4) Unsuccessful Karyotypes* | (5) Repeat Amniocenteses | (6) Total Amniocentesis | (7) Rate of Abnormal Karyotype Detection |
|---|---|---|---|---|---|---|---|
| | (2)+(3) | | | | | (1)+(4)+(5) | (3)-(1)x100 |
| 1978 | 332 | 326 | 6 | 0 | 12 | 344 | 1.8% |
| 1979 | 519 | 510 | 9 | 5 | 59 | 583 | 1.7% |
| 1980 | 680 | 660 | 20 | 5 | 33 | 718 | 2.9% |
| TOTAL | 1,523 | 1,496 | 35 | 10 | 104 | 1,645 | 2.3% |

* Prenatal patients requesting fetal diagnosis without a successful karyotype being obtained.

TABLE V-2

Results of Successful Fetal Karyotypes Performed in the Laboratory of Medical Genetics for Years 1978-1980

1978
Karyotype

| Followup | Abnormal | | Normal | | Total | |
|---|---|---|---|---|---|---|
| Cytogenetically confirmed | 2 | (33.3%) | 0 | | 2 | ( .6%) |
| Clinically Confirmed | 3 | (50.0%) | 262 | (80%) | 265 | (79.8%) |
| Unconfirmed | 1* | (16.7%) | 64 | (20%) | 65 | (19.6%) |
| Total | 6 | (100%) | 326 | (100%) | 332 | (100%) |

*Cell culture attempt to confirm was unsuccessful.

1979
Karyotype

| Followup | Abnormal | | Normal | | Total | |
|---|---|---|---|---|---|---|
| Cytogenetically Confirmed | 3 | (33.3%) | 0 | | 3 | ( .6%) |
| Clinically Confirmed | 2 | (22.2%) | 405 | (79.4%) | 407 | (78.4%) |
| Unconfirmed | 4* | (44.4%) | 105 | (20.6%) | 119 | (21.0%) |
| Total | 9 | (100%) | 510 | (100%) | 519 | (100%) |

*Includes 2 unsuccessful cell cultures to confirm.

1980
Karyotype

| Followup | Abnormal | | Normal | | Total | |
|---|---|---|---|---|---|---|
| Cytogenetically Confirmed | 6 | (30%) | 0 | | 6 | ( .9%) |
| Clinically Confirmed | 10 | (50%) | 550 | (83.3%) | 560 | (82.4%) |
| Unconfirmed | 4* | (20%) | 110 | (16.7%) | 114 | (16.7%) |
| Total | 20 | (100%) | 660 | (100%) | 680 | (100%) |

*Includes 2 unsuccessful cell cultures to confirm.

of abortus material, three (50 per cent) were clinically confirmed. One case (16.7 per cent) was unconfirmed and an effort to confirm by cytogenetic study the diagnosis proved unsuccessful due to failure in cell culture growth. A total of 262 (80 per cent) of the normal karyotypes were confirmed by clinical observations of attending physicians at birth and evaluations were not returned or not reported for 64 (20 per cent). Of the 332 successful karyotypes performed in 1978, 267 (80.4 per cent) were confirmed either cytogenetically or clinically and 65 (19.6 per cent) were unconfirmed. There were no instances of false positives or false negatives noted.

The specific abnormal fetal karyotypes identified and their respective pregnancy outcomes for 1978 are contained in Table V-3. Five of the six abnormal karyotypes were either male or female with an extra chromosome 21 (Down's syndrome). The other karyotype was a mosaic Down's syndrome, i.e., some fetal cells showed a normal karyotype while others had an extra chromosome 21. In all six instances, (100 per cent) the families chose to terminate the pregnancies.

In 1979, 583 amniocenteses were provided to 524 patients; 59 repeat amniocenteses were performed. Efforts to obtain fetal karyotypes for five of these 524 patients were unsuccessful. Of the five unsuccessful fetal karyotypes, four patients refused repeat amniocenteses after an initial failure in cell culture growth and one patient aborted before a repeat amniocentesis was provided. Of the 519 remaining patients with successful karyotypes, 510 were classified as normal and nine as abnormal. The rate of abnormal fetal karyotype detection was 9/519 or 1.7 per cent.

Table V-2 presents data on followup efforts to confirm karyotype results in 1979. Of nine abnormal karyotypes, three (33.3 per cent) were cytogenetically confirmed through cell culture of abortus material, two (11.1 per cent) were clinically confirmed, and four (44.4 per cent) were unconfirmed. In two of the four unconfirmed cases, efforts to confirm abnormal karyotype diagnoses resulted in unsuccessful cell culture growth. A total of 405 (79.4 per cent) normal karyotypes was confirmed through reports of clinical observations by physicians attendant at birth, and evaluations were not returned or reported for 105 (20.6 per cent). Of the 519 successful karyotypes performed in 1979, 407 (78.4 per cent) were confirmed either cytogenetically or clinically and 109 (21.0 per cent) were unconfirmed. There were no instances of false positives or false negatives noted.

Table V-3 presents analytical data on the nine abnormal karyotypes identified in 1979. Five of these were karyotypes for Down's syndrome: two with 47,XY,+21; two with 47,XX,+21; and one with the unbalanced translocation 46XX,t(21;21). In each instance the family chose to terminate the pregnancy. One balanced translocation with a 45,XX,t(14;21) karyotype was carried to delivery since the fetus was expected to be phenotypically normal. Three sex chromosome disorders were identified: two 47,XXY (Klinefelter's syndrome) and a 45,XO/46,XX (Turner's syndrome mosaic). All three pregnancies were terminated by choice of the parents. Outcome analysis of the nine pregnancies with abnormal fetal karyotypes provides the following results: eight were terminated (88.9 per cent) and one was carried to delivery (11.1 per cent).

Table V-3

Abnormal Karyotypes Detected *in utero* Through the Laboratory of Medical Genetics by Outcome of Pregnancy for Years 1978-1980

| Year | Abnormal Karyotypes | Pregnancy Outcome | | |
|---|---|---|---|---|
| | | Delivery | Spontaneous Abortion | Termination |
| 1978 | 47,XX,+21 | | | 3 |
| | 47,XX,+21 | | | 2 |
| | 46,XX/47XX,+21 | | | 1 |
| | Subtotal | | | 6 |
| 1979 | 47,XY,+21 | | | 2 |
| | 47,XX,+21 | | | 2 |
| | 46,XX,t (21;21) | | | 1 |
| | 45,XX,t (14;21)* | 1 | | |
| | 47,XXY | | | 2 |
| | 45,XO/46,XX | | | 1 |
| | Subtotal | 1 | | 8 |
| 1980 | 46,XY,+fragment | | | 1 |
| | 47,XY,+21 | 2 | | 2 |
| | 47,XX,+21 | | | 1 |
| | 47,XX,+18 | | 1 | 1 |
| | 47,XY,+18 | | | 1 |
| | 46,XX,t (2;15)* | 1 | | |
| | 46,XY,t (4;11)* | 1 | | |
| | 45,XY,t (14;22)* | 1 | | |
| | 45,XX,t (13;14)* | 1 | | |
| | 45,XY,t (13;14)* | 1 | | |
| | 45,XX,t (13;21)* | 1 | | |
| | 47,XXX | 1 | | |
| | 46,XXp- | 1 | | |
| | 46,XX,5p- | | | 1 |
| | 45,XO/47,XXX | | | 1 |
| | 46,XX/47,XX,+21 | 1 | | |
| | Sub Total | 11 | 1 | 8 |
| | Grand Total | 12 | 1 | 22 |

*Balanced translocation which indicates the fetus will be phenotypically normal.

In 1980, 718 amniocenteses were provided to 685 patients; 33 repeat amniocenteses were performed. Efforts to obtain fetal karyotypes for five patients were unsuccessful. Of the five unsuccessful karyotypes, three patients refused repeat amniocenteses after previous failures in cell culture growth, one aborted after an unsuccessful cell culture growth and before a repeat amniocentesis, and one patient was too late in pregnancy for another amniocentesis after two unsuccessful cell cultures. Of the 680 patients with successful karyotypes, 660 were evaluated normal and 20 abnormal. The rate of abnormal fetal karyotype detection was 20/680 or 2.9 per cent.

Table V-2 presents data for 1980 on efforts to confirm karyotype results. A total of 20 abnormal karyotypes was diagnosed prenatally and six (30 per cent) were cytogenetically confirmed through cell culture after pregnancy termination or delivery; ten (50 per cent) abnormal karyotypes were clinically confirmed. Four (20 per cent) abnormal karyotypes were unconfirmed and included two unsuccessful efforts to confirm cytogenetically abnormal karyotype results. A total of 550 (83.3 per cent) normal karyotypes was confirmed through reports of clinical observations by physicians attendant at birth, and evaluations were not returned or reported for 110 (16.7 per cent). Of 680 successful karyotypes performed in 1980, 566 (83.3 per cent) were confirmed either cytogenetically or clinically and 114 (16.8 per cent) were unconfirmed. There were no instances of false positives or false negatives noted.

Data on pregnancy outcomes and specific abnormal karyotypes identified in 1980 can be observed in Table V-3. One fetal karyotype, 46,XY,+fragment, was identified with additional non-specific chromosomal

material. The family chose to terminate this pregnancy. Five Down's syndrome karyotypes were identified: two of these families chose to carry their pregnancies to delivery and three families chose pregnancy termination. Three karyotypes were identified with an extra chromosome 18: one of these resulted in spontaneous abortion and the other two families chose pregnancy termination. Six karyotypes with balanced translocations were identified in 1980 and are noted in Table V-3 by an asterisk; each of these families chose to continue their pregnancy to delivery since the fetuses were expected to be phenotypically normal. Two sex chromosome abnormalities were diagnosed: a 47,XXX and a 46,XXp-. In each instance the family chose to continue the pregnancy to delivery. Pregnancy termination was the family choice in the case of a chromosomal disorder known as the cat cry syndrome; a 46,XX,5p- karyotype. Two mosaics were identified which resulted in different pregnancy outcomes: the families of the 45,XO/47,XXX (Turner's syndrome mosaic) and 46,XX/47,XX,+21 (Down's syndrome mosaic) chose, respectively, pregnancy termination and to carry the pregnancy to delivery. Outcome analysis of the 20 pregnancies with abnormal karyotypes diagnosed in utero provides the following results: 11 deliveries (55.0 per cent), eight pregnancy terminations (40.0 per cent), and one spontaneous abortion (5.0 per cent).

## Summary

The patient service chronicle and medical records in the prenatal diagnosis unit of the Laboratory of Medical Genetics were analyzed by selected years to determine the following: results of karyotype

efforts, confirmation of in utero diagnosis, and outcome of pregnancies with abnormal karyotypes. First, data were assembled and analyzed by year to evaluate the diagnostic results of amniocentesis including the rate of abnormal karyotype detection. Next, the rates of confirmation of karyotype results were calculated. Finally, specific abnormal karyotype results were grouped for analysis by year according to pregnancy outcome.

In 1978, 326 normal karyotypes and six abnormal karyotypes were reported for a 1.8 per cent abnormal karyotype detection rate. Eighty per cent (262) of normal karyotypes were confirmed and 20 per cent (64) were unconfirmed. Of abnormal karyotypes, 83.3 per cent (5) were confirmed and 16.7 per cent (1) were unconfirmed. All six pregnancies with abnormal fetal karyotypes had pregnancy termination outcomes.

In 1979, 510 normal karyotypes and nine abnormal karyotypes were reported for a 1.7 per cent abnormal karyotype detection rate. Of the normal karyotypes, 79.4 per cent (405) were confirmed and 20.6 per cent (105) were unconfirmed. Of abnormal karyotypes, 55.6 per cent (5) were confirmed and 44.4 per cent (4) were unconfirmed. Eight of the abnormal karyotypes resulted in pregnancy termination and one, a phenotypically normal balanced translocation, was carried to delivery.

In 1980, 660 normal karyotypes and 20 abnormal karyotypes were reported for an abnormal karyotype detection rate of 2.9 per cent. Of normal karyotypes, 83.3 per cent (550) were confirmed and 16.7 per cent (110) were unconfirmed. Of abnormal karyotypes, 80 per cent (16) were confirmed and 20 per cent (4) were unconfirmed. Of the pregnancies with abnormal karyotypes, 11 (including six phenotypically normal balanced

translocations) were carried to delivery, eight were terminated and one resulted in spontaneous abortion.

During the three-year period 1978-1980, 35 pregnancies were diagnosed *in utero* with abnormal fetal karyotypes. Seven of these abnormal karyotypes were balanced translocations which produce phenotypically normal offspring. Twenty-two (66.9 per cent) of these pregnancies were terminated, twelve (34.3 per cent) delivered, and one (2.9 per cent) resulted in spontaneous abortion.

# CHAPTER VI

# SERVICE COSTS OF DETECTING CHROMOSOMAL ABNORMALITIES *IN UTERO*

## Introduction

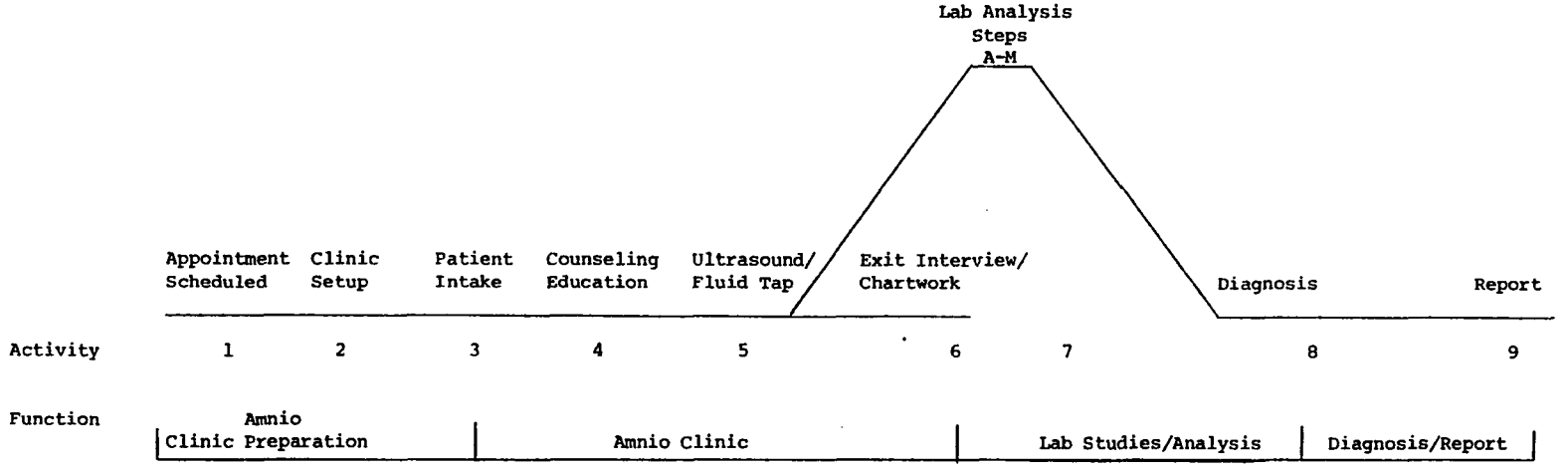
Costs associated with an ongoing prenatal diagnosis program for *in utero* detection of chromosomal abnormalities may be assessed using four categories: personnel, expendable supplies, equipment, and overhead. To assist in assessing costs assignable to each respective category, a flow chart (Figure VI-A) was devised to facilitate identification of specific activities comprising the prenatal diagnosis program in the Laboratory of Medical Genetics.

Initial development of the flow chart consisted of ascertaining the major functions of an operational prenatal diagnosis program. Next, each function was analyzed to determine those specific activities essential to its achievement. Each activity consists of clinical, laboratory, or administrative work elements routinely provided to accomplish the respective function.

Figure VI-A depicts the sequence of activities currently required in the Laboratory of Medical Genetics to obtain prenatal diagnosis. This sequence of events originates with an appointment for the patient being scheduled by the obstetrical care provider. The clinic function concludes with administrative preparations being finalized for clinic

FIGURE VI-A

Sequence of Activities Identified with the Four Functions
Comprising Prenatal Diagnosis in the Laboratory of Medical Genetics



service. The clinic function requires a half day and includes the following four activities: patient intake, counseling and education, ultrasound and amniocentesis, and patient exit interview. When an amniotic fluid specimen is collected through amniocentesis, it is immediately processed for laboratory studies and subsequent fetal karyotyping. Several laboratory procedures are required to obtain a karyotype. After the fetal karyotype is obtained the cytogeneticist and clinical geneticist collaborate to establish a diagnosis. A report of this diagnosis is sent to the prenatal patient's obstetrical care provider.

Many of the costs in prenatal diagnosis are allocated for personnel who provide essential clinical, laboratory, and administrative activities. To measure such costs, those personnel services involved with each activity were identified. During the period July 12-23, 1982, personnel time studies were conducted for these activities. Time studies were conducted by those individuals performing the activities. Measurement of time necessary to perform each activity consisted of written notation of when the task began and ended. Time required to perform activities was expressed in hour units.

From UAB wage scales, the median hourly salary rate was obtained for amniocentesis service staff; using these rates the total personnel costs were calculated for each defined activity. An hourly service rate was used to estimate cost of the clinical geneticist, obstetrician, and cytogeneticist since they are also involved in UAB programs other than service. Fringe benefits for service staff were included by calculating

23 per cent of base salaries, the approximate mandatory fringe benefit rate for UAB employees.

The flow chart depicted in Figure VI-A was also used to assess administrative and clinical supplies needed for the prenatal diagnosis program. Laboratory supply needs were documented by a cytotechnologist who performs the laboratory procedures. The cost of supply items was obtained from current price listings of vendors used by the Laboratory of Medical Genetics.

The estimated cost of equipment in the prenatal diagnosis program was based on annual depreciation. An inventory was conducted of existing equipment in the prenatal diagnosis program and the original price of each item was obtained from records in the Laboratory of Medical Genetics. An estimation of annual equipment cost was derived by amortizing each item using the ten-year straight line depreciation method. The annual cost (depreciation) of laboratory equipment was divided by the number of amniocenteses provided in 1981 to obtain the cost per patient.

Calculation of overhead costs associated with the prenatal diagnosis program was based on total personnel and supply costs. The amount was derived using the UAB indirect cost rate which is routinely used for extramural grants. The rate during 1981-82 is 32.6 per cent Total Modified Direct Costs which, for purposes of this analysis, includes all costs excluding equipment.

## Findings

In the provision of prenatal diagnosis the following personnel were identified as being directly involved in those activities outlined in Figure VI-A:

| Function | | Personnel Involved |
|---|---|---|
| Clinic Preparation | Activity 1 | secretary |
| | Activity 2 | secretary, nurse, social worker, administrative assistant |
| Clinic | Activity 3 | secretary, social worker, nurse |
| | Activity 4 | social worker, clinical geneticist, M.D. fellow, cytogeneticist |
| | Activity 5 | 2 student aids, nurse, ultrasound technician, obstetrician |
| | Activity 6 | administrative assistant, nurse |
| Laboratory analysis | Activity 7 | cytogenetic technologist, clinical geneticist, cytogeneticist, laboratory aid |
| | Activity 8 | cytogeneticist, clinical geneticist |
| Diagnosis/ Report | Activity 9 | secretary, clinical geneticist, cytogeneticist |

Table VI-1 presents by function the cost of staff in providing prenatal diagnosis to one patient. The total direct personnel cost in serving one patient is $189.79. Fulfilling those activities enumerated for the laboratory analysis function requires the greatest personnel costs--$111.80. The personnel costs of other functions in descending order are clinic ($40.16), diagnosis/report ($31.79), and clinic preparation ($6.04).

The major personnel cost of laboratory studies is the cytogenetic technologist who performs those procedures essential to obtaining a fetal karyotype. The time study for the cytogenetic technologist provided the following information:

| | Procedure | Hour Units |
|---|---|---|
| Step A | Fluid centrifuged | .17 |
| Step B | Culture initiated | .08 |
| Step C | Flasks changed with new media | .25 |
| Step D | Subculturing | .50 |
| Step E | Harvesting | 1.00 |
| Step F | Slide making | .50 |
| Step G | Staining slides | .17 |
| Step H | Slide reading | 2.00 |
| Step I | Film developing | .50 |
| Step J | Film processing | .17 |
| Step K | Karyotyping | 1.00 |
| Step L | Fluorescence | .25 |
| Step M | Chart summarization | .17 |
| | Total | 6.76 hours |

The 6.76 hours represent the minimum time needed to perform directly those 12 procedures identified and does not include preparation and clean-up tasks which are routinely required in such settings. With allowance made for these tasks, eight hours of cytogenetic technologist's time are required to perform one fetal karyotype.

Table VI-2 contains a list of supplies needed to provide prenatal diagnosis. Supply purchases were analyzed to arrive at an estimate of current cost for each supply item needed to obtain one fetal karyotype. The greatest cost is in laboratory supplies with the most expensive ($9.73) item being culture medium. The total supply cost for one patient is estimated to be $36.71.

Each item of equipment needed for prenatal diagnosis is listed in Table VI-3 and includes its original purchase price. All equipment was purchased in the last five years. The largest cost item, sonar with attachments, is used in the clinic function. With the exception of the

TABLE VI-1

Minimum Personnel Costs by Function to Serve One Patient in the Prenatal Diagnosis Service Program of the Laboratory of Medical Genetics During 1981-82

| Function | Staff | Hourly Rate | Hour Units | Total Cost | Cost per pt. |
|---|---|---|---|---|---|
| Clinic Preparation | Secretary | $ 6.19 | .25 | (per pt) | $1.55 |
| | Nurse | 11.83 | .17 | | 2.01 |
| | Social Worker | 10.59 | .17 | | 1.80 |
| | Administrative Assistant | 8.46 | .08 | | .68 |
| | | | Sub Total | | 6.04 |
| Clinic | Administrative Assistant | 8.46 | 4.00 | 33.84 | 2.42 |
| | Secretary | 6.19 | 5.50 | 21.67 | 1.55 |
| | Social Worker | 10.59 | 5.50 | 58.25 | 4.16 |
| | Nurse | 11.83 | 5.50 | 65.07 | 4.65 |
| | Clinical Geneticist | 45.00 | 3.00 | 135.00 | 9.64 |
| | Cytogeneticist | 27.68 | 2.42 | 66.99 | 4.79 |
| | M.D. Fellow | 11.69 | .97 | 11.34 | .81 |
| | Student Aides (2) | 3.46 | 2.30 | 7.96 | .57 |
| | Ultrasound Tech | 10.66 | 2.67 | 28.46 | 2.03 |
| | Obstetrician | 50.00 | 2.67 | 133.50 | 9.54 |
| | | | Sub Total | $562.08 | $40.16 |
| Laboratory/ Studies | Clinical Geneticist | 45.00 | .40 | (per pt) | 18.00 |
| | Cytogeneticist | 27.68 | .88 | | 24.36 |
| | Cytogenetic Technologist | 8.13 | 8.00 | | 65.04 |
| | Laboratory Aid | 3.14 | 1.40 | | 4.40 |
| | | | Sub Total | | $111.80 |
| Diagnosis/ Report | Clinical Geneticist | 45.00 | .33 | (per pt) | 14.85 |
| | Cytogeneticist | 27.68 | .50 | | 13.84 |
| | Secretary | 6.19 | .50 | | 3.10 |
| | | | Sub Total | | 31.79 |
| | | | GRAND TOTAL | | $189.79 |

TABLE VI-2

Estimated Cost of Supplies Needed to Provide Prenatal Diagnosis For One Patient in the Laboratory of Medical Genetics During 1981-82

| Quantity | Item | Estimated Cost |
|---|---|---|
| | Amniocentesis/ultrasound clinical supplies | 5.00 |
| 12 | Centrifuge tubes | 1.26 |
| 8 | Tissue culture flasks (25 $cm^3$) | 2.28 |
| 16 | Pasteur pipettes | .64 |
| 4 | Pasteur pipettes | .16 |
| 12 | 10 ml. pipettes | 1.32 |
| 60 ml. | Chang's medium | 9.00 |
| 30 ml. | McCoy's medium | .73 |
| 16 ml. | Trypsin (subculturing) | 1.00 |
| 25 ml. | Hypotonic soln. | .05 |
| 28 ml. | Fix | .49 |
| 6 | Glass slides | 1.76 |
| 4 | cover slips | .42 |
| 10 ml. | Giemsa stain | .90 |
| 120 ml. | Disoduim phosphate buffer | .05 |
| 120 ml. | Hank's buffer | 1.70 |
| 3 ml. | Trypsin (banding) | .05 |
| 3 ml. | EDTA | .50 |
| 1.6 ml. | Colcemid | .35 |
| 50 ml. | 70% Ethanol | .40 |
| 30 | Sheets of sketch pad | .20 |
| 12 | Frames (2 ft.) film | .32 |
| | $CO_2$ - gas flasks 5% $CO_2$ | .05 |
| | $CO_2$ - Incubators | .95 |
| 1 | Combistix | .13 |
| 3 | Karyotype cards | .25 |
| 3 ft. | Scotch tape | .30 |
| | D-19 Film Developer | .50 |
| | Stop bath | .10 |
| | Fix | .05 |
| 6 | Sheets photographic paper | 1.80 |
| | Activator | 1.00 |
| | Stabilizer | .20 |
| | Light bulb | .20 |
| | Slide box | .50 |
| 10 | Kimwipes | .10 |
| 20 | Drops immersion oil | .10 |
| 1 ft. | Yellow tape | .15 |
| | Postage | .60 |
| | Clinic Administrative supplies (folder, forms, etc) | .75 |
| | Xeroxing | .40 |
| | TOTAL | $36.71 |

TABLE VI-3

Basic Equipment Available in the Prenatal Diagnosis Program of the Laboratory of Medical Genetics, 1981-82

| Item | Cost |
|---|---|
| (2) Table Top Clean | $ 1,614 |
| (2) Optional Work Tables | 342 |
| Fluorescent | 66 |
| Freezer | 913 |
| Exam Room Equipment | 1,389 |
| (2) Inverted Microscope | 4,030 |
| (2) Gas Pressure Regulators | 141 |
| Autoclave | 1,266 |
| Mettler Balancer | 1,682 |
| Water Still | 927 |
| PH Meter | 476 |
| Hot Plate/Stirrer | 104 |
| Mixer, Vortex Genie | 93 |
| Oven, Utility Equipment | 110 |
| Centrifuge Clinical Equipment | 3,622 |
| (2) Incubator, Water-Jacketed Equipment | 3,622 |
| (2) Utility Tables | 288 |
| (3) Photomicroscopes | 19,362 |
| Photomicroscop/Fluorescent Attachment | 12,392 |
| Sonar/Attachments | 28,500 |
| Refrigerator | 539 |
| (2) Pipette Aide | 240 |
| Exam Room Equipment | 1,389 |
| Projector/Recorder with Attachments | 760 |
| Film Enlarger | 269 |
| Film Processor | 500 |
| Film Dryer | 100 |
| Timer | 70 |
| Typewriter | 1,379 |
| TOTAL | $83,582 |

typewriter and projector-recorder, all remaining times are used in completing the laboratory studies. The total equipment cost is $83,582.

Table VI-4 contains a summary of cost by major category attributed to serving one prenatal diagnosis patient. Of the total cost, 61.5 per cent goes for personnel ($189.79), 23.3 per cent for overhead ($71.83), 11.9 per cent for supplies ($36.71), and 3.4 per cent for equipment ($10.43). Annual depreciation of equipment amounts to a total of $8358 which equals $10.43 per patient when prorated among the 801 prenatal diagnosis patients served in 1981. Overhead cost calculation is based on 32.6 per cent of the combined total for personnel and supplies and amounts to $71.83 per patient.

## Summary

The major functions and their activities comprising the prenatal diagnosis program in the Laboratory of Medical Genetics were identified. These four functions were clinic preparation, clinic, laboratory studies, and diagnosis/report. Each function was analyzed to determine the personnel, supplies, and equipment needed to provide prenatal diagnosis to one patient. Overhead costs were calculated for each patient using the UAB rate of 32.6 per cent Total Modified Direct Cost.

The personnel cost per patient was $189.79. The laboratory studies function produces the greatest personnel cost ($111.80). The estimated supply cost per karyotype was $36.71 with the overwhelming majority associated with laboratory studies. Prorated equipment cost amounts to $10.43 per patient. The overhead cost per patient was calculated at $71.83. The total cost of all four functions per patient is $308.76.

TABLE VI-4

Summary of Estimated Cost by Major Category to Provide Prenatal Diagnosis for One Patient in the Laboratory of Medical Genetics During 1981-82

| | |
|---|---|
| Personnel | $189.79 |
| Supplies | $ 36.71 |
| Equipment | $ 10.43 |
| Annual equipment depreciation prorated among 801 prenatal patients served in 1981 - $8,358 ÷ 801 = $10.43 | |
| Overhead (32.6% Total Modified Direct Cost or 32.6% of Personnel and Supplies | $71.83 |
| Cost Per Patient | $308.76 |

# CHAPTER VII

## PROJECTED NEED FOR AMNIOCENTESIS BASED ON MATERNAL AGE

### Introduction

Anticipating the need through 1991 for amniocenteses among Alabama women for reason of maternal age requires two steps. First, a projection of female residents aged 35-49 is needed for each year 1982-1991. Second, an estimation of fertility among this cohort must be derived to assess expected births and, subsequently, the estimated need for amniocentesis among this age group.

Two demographic models were used to project the number of women by age group for each of the years of interest. A previously developed model (Irwin, 1977) was adapted to obtain a population projection of the study group by Alabama county for 1982-1985. This model, a modification of the cohort component method used by the U.S. Bureau of the Census, considers fertility, mortality, and migration and is controlled to 1980 census totals by county and race.

The second model, developed specifically for this study, provides a population estimate by county for the female population in three age groups: 35-39, 40-44, and 45-49. Data from the 1980 Census were not available by Alabama county when this study was performed. Therefore, a model was developed through a computerized program with the 1970 age

specific census data, adjusted to 1980, serving as the base for estimating the population of interest for years 1986-1991. The 1970 census cohort of females aged 14-33 was "brought forward" and reduced by single year age- and race-specific mortality probabilities to provide an estimate of females by Alabama county for each age group for the years 1986-1991. This model assumed no migratory effect on the population under study.

Once population estimates by county and race were established for the study group, they were sorted and summed by Alabama Public Health Area (PHA) through a computer program. This procedure created race-specific estimates of the number of females for each year 1981-1991 for each of Alabama's six Public Health Areas.

The final step in estimating the need for amniocentesis for reason of maternal age required applying Alabama age-specific fertility rates to the estimated population to derive the number of live births likely to occur. Since Alabama's age- and race-specific fertility rates for the study cohort did not vary significantly during the three-year period 1978-1980, a mean fertility rate for each race was calculated for each of the three age groups. This mean fertility rate was used in calculating the estimated live births which will occur among the three age cohorts for each year 1982-1991.

## Findings

Tables VII-1 through VII-7 present, by PHA and year, the combined results of these procedures described above including: total projected females, mean age-specific birth rate, and the expected births. These

TABLE VII-1
Projected Births Among Total Females Residing in Alabama Public Health
Area 1 By Selected Age Cohorts for Years 1982-1991

| YEAR | 35-39 Cohort Total Projected Females | 35-39 Cohort Birth Rate Per 1000 | 35-39 Cohort Expected Births | 40-44 Cohort Total Projected Females | 40-44 Cohort Birth Rate Per 1000 | 40-44 Cohort Expected Births | 45-49 Cohort Total Projected Females | 45-49 Cohort Birth Rate Per 1000 | 45-49 Cohort Expected Births | Total Expected Births |
|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 27,989 | 16.5 | 461.8 | 23,515 | 4.1 | 96.4 | 20,989 | .2 | 4.2 | 562.4 |
| 1983 | 29,058 | 16.5 | 479.5 | 24,167 | 4.1 | 99.1 | 21,351 | .2 | 4.3 | 582.9 |
| 1984 | 30,133 | 16.5 | 497.2 | 24,801 | 4.1 | 101.7 | 21,712 | .2 | 4.3 | 603.2 |
| 1985 | 31,212 | 16.5 | 515.0 | 25,451 | 4.1 | 104.4 | 22,082 | .2 | 4.4 | 623.8 |
| 1986 | 31,345 | 16.5 | 517.2 | 27,120 | 4.1 | 111.2 | 22,651 | .2 | 4.5 | 632.9 |
| 1987 | 31,611 | 16.5 | 521.6 | 28,000 | 4.1 | 114.8 | 23,793 | .2 | 4.8 | 641.2 |
| 1988 | 32,726 | 16.5 | 540.0 | 28,809 | 4.1 | 118.1 | 24,513 | .2 | 4.9 | 663.0 |
| 1989 | 33,698 | 16.5 | 556.0 | 30,181 | 4.1 | 123.7 | 24,902 | .2 | 5.0 | 684.7 |
| 1990 | 35,363 | 16.5 | 583.5 | 31,102 | 4.1 | 127.5 | 25,307 | .2 | 5.1 | 716.1 |
| 1991 | 36,396 | 16.5 | 600.5 | 31,210 | 4.1 | 128.0 | 26,932 | .2 | 5.4 | 733.9 |
| TOTAL | | | 5,272.3 | | | 1,124.9 | | | 46.9 | 6,444.1 |

TABLE VII-2
Projected Births Among Total Females Residing in Alabama Public Health
Area 2 By Selected Age Cohorts for Years 1982-1991

| YEAR | 35-39 Cohort Total Projected Females | 35-39 Cohort Birth Rate Per 1000 | 35-39 Cohort Expected Births | 40-44 Cohort Total Projected Females | 40-44 Cohort Birth Rate Per 1000 | 40-44 Cohort Expected Births | 45-49 Cohort Total Projected Females | 45-49 Cohort Birth Rate Per 1000 | 45-49 Cohort Expected Births | Total Expected Births |
|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 7,468 | 16.5 | 123.2 | 6,438 | 4.1 | 26.4 | 6,053 | .2 | 1.2 | 150.8 |
| 1983 | 7,792 | 16.5 | 128.6 | 6,613 | 4.1 | 27.1 | 6,064 | .2 | 1.2 | 156.9 |
| 1984 | 8,135 | 16.5 | 134.2 | 6,801 | 4.1 | 27.9 | 6,099 | .2 | 1.2 | 163.3 |
| 1985 | 8,496 | 16.5 | 140.2 | 7,007 | 4.1 | 28.7 | 6,139 | .2 | 1.2 | 170.1 |
| 1986 | 9,447 | 16.5 | 155.9 | 7,004 | 4.1 | 28.7 | 6,252 | .2 | 1.3 | 185.9 |
| 1987 | 9,691 | 16.5 | 159.9 | 7,026 | 4.1 | 28.8 | 6,600 | .2 | 1.3 | 190.0 |
| 1988 | 9,794 | 16.5 | 161.6 | 7,424 | 4.1 | 30.4 | 6,804 | .2 | 1.4 | 193.4 |
| 1989 | 9,881 | 16.5 | 163.0 | 7,896 | 4.1 | 32.4 | 6,815 | .2 | 1.4 | 196.8 |
| 1990 | 9,991 | 16.5 | 164.9 | 8,463 | 4.1 | 34.7 | 6,967 | .2 | 1.4 | 201.0 |
| 1991 | 9,563 | 16.5 | 157.8 | 9,405 | 4.1 | 38.6 | 6,954 | .2 | 1.4 | 197.8 |
| TOTAL | | | 1,489.3 | | | 303.7 | | | 13.0 | 1,806.0 |

TABLE VII-3
Projected Births Among Total Females Residing in Alabama Public Health
Area 3 By Selected Age Cohorts for Years 1982-1991

| YEAR | 35-39 Cohort Total Projected Females | 35-39 Cohort Birth Rate Per 1000 | 35-39 Cohort Expected Births | 40-44 Cohort Total Projected Females | 40-44 Cohort Birth Rate Per 1000 | 40-44 Cohort Expected Births | 45-49 Cohort Total Projected Females | 45-49 Cohort Birth Rate Per 1000 | 45-49 Cohort Expected Births | Total Expected Births |
|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 32,013 | 16.5 | 528.2 | 26,702 | 4.1 | 109.5 | 24,640 | .2 | 4.9 | 642.6 |
| 1983 | 33,678 | 16.5 | 555.7 | 27,573 | 4.1 | 113.1 | 24,797 | .2 | 5.0 | 673.8 |
| 1984 | 35,459 | 16.5 | 585.1 | 28,536 | 4.1 | 117.0 | 25,023 | .2 | 5.0 | 707.1 |
| 1985 | 37,228 | 16.5 | 614.3 | 29,487 | 4.1 | 120.1 | 25,248 | .2 | 5.1 | 739.5 |
| 1986 | 38,004 | 16.5 | 627.1 | 30,952 | 4.1 | 126.9 | 25,993 | .2 | 5.2 | 759.2 |
| 1987 | 38,688 | 16.5 | 638.4 | 32,075 | 4.1 | 131.5 | 27,328 | .2 | 5.5 | 775.4 |
| 1988 | 39,638 | 16.5 | 654.0 | 33,477 | 4.1 | 137.3 | 28,224 | .2 | 5.6 | 796.9 |
| 1989 | 40,615 | 16.5 | 670.2 | 35,239 | 4.1 | 144.5 | 28,776 | .2 | 5.8 | 820.5 |
| 1990 | 41,589 | 16.5 | 686.2 | 37,093 | 4.1 | 152.1 | 29,312 | .2 | 5.9 | 844.2 |
| 1991 | 42,173 | 16.5 | 695.9 | 37,833 | 4.1 | 155.1 | 30,731 | .2 | 6.1 | 857.2 |
| TOTAL | | | 6,255.1 | | | 1,307.1 | | | 54.1 | 7,616.4 |

TABLE VII-4
Projected Births Among Total Females Residing in Alabama Public Health
Area 4 By Selected Age Cohorts for Years 1982-1991

| YEAR | 35-39 Cohort Total Projected Females | 35-39 Cohort Birth Rate Per 1000 | 35-39 Cohort Expected Births | 40-44 Cohort Total Projected Females | 40-44 Cohort Birth Rate Per 1000 | 40-44 Cohort Expected Births | 45-49 Cohort Total Projected Females | 45-49 Cohort Birth Rate Per 1000 | 45-49 Cohort Expected Births | Total Expected Births |
|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 17,346 | 16.5 | 286.2 | 14,112 | 4.1 | 57.9 | 12,674 | .2 | 2.5 | 346.6 |
| 1983 | 18,193 | 16.5 | 300.2 | 14,662 | 4.1 | 60.1 | 12,712 | .2 | 2.5 | 362.8 |
| 1984 | 19,081 | 16.5 | 314.8 | 15,243 | 4.1 | 62.5 | 12,503 | .2 | 2.5 | 379.8 |
| 1985 | 20,027 | 16.5 | 330.5 | 15,866 | 4.1 | 65.1 | 12,862 | .2 | 2.6 | 398.2 |
| 1986 | 20,837 | 16.5 | 343.8 | 16,781 | 4.1 | 68.8 | 13,168 | .2 | 2.6 | 415.2 |
| 1987 | 21,134 | 16.5 | 348.7 | 17,402 | 4.1 | 71.4 | 13,883 | .2 | 2.8 | 422.9 |
| 1988 | 21,719 | 16.5 | 358.4 | 17,916 | 4.1 | 73.5 | 14,720 | .2 | 2.9 | 434.8 |
| 1989 | 21,953 | 16.5 | 362.2 | 18,979 | 4.1 | 77.8 | 15,213 | .2 | 3.0 | 443.0 |
| 1990 | 22,343 | 16.5 | 368.7 | 19,951 | 4.1 | 81.8 | 15,771 | .2 | 3.2 | 453.7 |
| 1991 | 22,224 | 16.5 | 366.6 | 20,74- | 4.1 | 85.0 | 16,663 | .2 | 3.3 | 455.0 |
| TOTAL | | | 3380.2 | | | 703.9 | | | 27.9 | 4112.0 |

TABLE VII-5
Projected Births Among Total Females Residing in Alabama Public Health
Area 5 By Selected Age Cohorts for Years 1982-1991

| YEAR | 35-39 Cohort Total Projected Females | 35-39 Cohort Birth Rate Per 1000 | 35-39 Cohort Expected Births | 40-44 Cohort Total Projected Females | 40-44 Cohort Birth Rate Per 1000 | 40-44 Cohort Expected Births | 45-49 Cohort Total Projected Females | 45-49 Cohort Birth Rate Per 1000 | 45-49 Cohort Expected Births | Total Expected Births |
|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 26,995 | 16.5 | 445.4 | 21,941 | 4.1 | 90.0 | 19,086 | .2 | 3.8 | 539.2 |
| 1983 | 28,422 | 16.5 | 469.0 | 22,874 | 4.1 | 93.8 | 19,301 | .2 | 3.9 | 566.7 |
| 1984 | 29,860 | 16.5 | 492.7 | 23,806 | 4.1 | 97.6 | 19,544 | .2 | 3.9 | 594.2 |
| 1985 | 31,319 | 16.5 | 516.8 | 24,766 | 4.1 | 101.5 | 19,781 | .2 | 4.0 | 622.3 |
| 1986 | 33,117 | 16.5 | 546.4 | 26,239 | 4.1 | 107.6 | 20,327 | .2 | 4.1 | 658.1 |
| 1987 | 34,027 | 16.5 | 561.5 | 27,331 | 4.1 | 112.1 | 21,465 | .2 | 4.3 | 677.9 |
| 1988 | 35,065 | 16.5 | 578.6 | 28,392 | 4.1 | 116.4 | 22,727 | .2 | 4.5 | 699.5 |
| 1989 | 35,663 | 16.5 | 588.4 | 29,741 | 4.1 | 121.9 | 23,729 | .2 | 4.7 | 715.0 |
| 1990 | 36,580 | 16.5 | 603.6 | 31,189 | 4.1 | 127.9 | 24,624 | .2 | 4.9 | 736.4 |
| 1991 | 36,285 | 16.5 | 598.7 | 32,954 | 4.1 | 135.1 | 26,060 | .2 | 5.2 | 739.0 |
| TOTAL | | | 5,401.1 | | | 1,103.9 | | | 43.3 | 6,548.3 |

TABLE VII-6
Projected Births Among Total Females Residing in Alabama Public Health Area 6 By Selected Age Cohorts for Years 1982-1991

| YEAR | 35-39 Cohort Total Projected Females | 35-39 Cohort Birth Rate Per 1000 | 35-39 Cohort Expected Births | 40-44 Cohort Total Projected Females | 40-44 Cohort Birth Rate Per 1000 | 40-44 Cohort Expected Births | 45-49 Cohort Total Projected Females | 45-49 Cohort Birth Rate Per 1000 | 45-49 Cohort Expected Births | Total Expected Births |
|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 22,777 | 16.5 | 375.8 | 18,217 | 4.1 | 74.7 | 16,343 | .2 | 3.3 | 453.8 |
| 1983 | 24,065 | 16.5 | 397.1 | 18,907 | 4.1 | 77.5 | 16.496 | .2 | 3.3 | 477.9 |
| 1984 | 25,370 | 16.5 | 418.6 | 19,619 | 4.1 | 80.4 | 16,670 | .2 | 3.3 | 502.3 |
| 1985 | 26,733 | 16.5 | 441.1 | 20,356 | 4.1 | 83.5 | 16,856 | .2 | 3.4 | 528.0 |
| 1986 | 27,461 | 16.5 | 453.1 | 21,830 | 4.1 | 89.5 | 17,443 | .2 | 3.5 | 546.1 |
| 1987 | 28,877 | 16.5 | 476.5 | 22,870 | 4.1 | 93.8 | 18,365 | .2 | 3.7 | 574.0 |
| 1988 | 30,448 | 16.5 | 502.4 | 23,796 | 4.1 | 97.6 | 19,259 | .2 | 3.9 | 603.9 |
| 1989 | 32,079 | 16.5 | 529.3 | 25,193 | 4.1 | 103.3 | 19,718 | .2 | 3.9 | 636.5 |
| 1990 | 33,861 | 16.5 | 558.7 | 26,637 | 4.1 | 109.2 | 20,233 | .2 | 4.0 | 671.9 |
| 1991 | 35,086 | 16.5 | 578.9 | 27,340 | 4.1 | 112.1 | 21,674 | .2 | 4.3 | 695.3 |
| TOTAL | | | 4,731.5 | | | 921.6 | | | 36.6 | 5,689.7 |

TABLE VII-7
Projected Births Among Total Females Residing in Alabama by
Selected Age Cohorts for Years 1982-1991

| YEAR | 35-39 Cohort Total Projected Females | 35-39 Cohort Birth Rate Per 1000 | 35-39 Cohort Expected Births | 40-44 Cohort Total Projected Females | 40-44 Cohort Birth Rate Per 1000 | 40-44 Cohort Expected Births | 45-49 Cohort Total Projected Females | 45-49 Cohort Birth Rate Per 1000 | 45-49 Cohort Expected Births | Total Expected Births |
|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 134,588 | 16.5 | 2220.9 | 110,925 | 4.1 | 454.8 | 99,785 | .2 | 20.0 | 2695.5 |
| 1983 | 141,208 | 16.5 | 2329.9 | 114,796 | 4.1 | 470.7 | 100,721 | .2 | 20.1 | 2820.7 |
| 1984 | 148,038 | 16.5 | 2442.6 | 118,806 | 4.1 | 487.1 | 101,551 | .2 | 20.3 | 2950.0 |
| 1985 | 155,015 | 16.5 | 2557.8 | 122,933 | 4.1 | 504.0 | 102,968 | .2 | 20.6 | 3082.4 |
| 1986 | 160,211 | 16.5 | 2643.5 | 129,926 | 4.1 | 532.7 | 105,834 | .2 | 21.2 | 3197.4 |
| 1987 | 164,028 | 16.5 | 2706.5 | 134,704 | 4.1 | 552.3 | 111,434 | .2 | 22.3 | 3281.1 |
| 1988 | 169,390 | 16.5 | 2794.9 | 139,814 | 4.1 | 573.2 | 116,247 | .2 | 23.3 | 3391.4 |
| 1989 | 173,889 | 16.5 | 2869.2 | 147,229 | 4.1 | 603.6 | 119,153 | .2 | 23.8 | 3496.6 |
| 1990 | 179,727 | 16.5 | 2965.5 | 154,435 | 4.1 | 633.2 | 122,214 | .2 | 24.4 | 3623.1 |
| 1991 | 181,727 | 16.5 | 2998.5 | 159,482 | 4.1 | 653.9 | 129,014 | .2 | 25.8 | 3678.2 |
| TOTAL | | | 26,529.1 | | | 5,465.5 | | | 221.8 | 32,216.4 |

data are presented separately for each age cohort; a total expected birth column by year represents the estimated need for amniocentesis for reason of maternal age for each PHA in Alabama. This information was also calculated by race and is included in Appendix 3.

For the ten-year period in PHA 1, Table VII-1 indicates a 30.0 per cent population growth for the age group 35-39, 32.7 per cent increase in the age group 40-44, and 28.3 per cent increase in the age group 45-49. Annual increases in births, or need for amniocenteses, range from 2.0 per cent to 3.6 per cent with a total increased need of 30.5 per cent (171.5 amniocenteses) during the projected period (562.4 to 733.9)

The projected need for amniocenteses in PHA 2 is presented in Table VII-2. A population increase of 28.1 per cent is anticipated for the 35-39 age cohort, 46.1 per cent increase for the 40-44 age cohort, and 14.9 per cent increase in the 45-49 age cohort. Annual increases in the need for amniocenteses should experience variations from 2.0 per cent to 8.5 per cent. In 1991, a decrease (1.6 per cent) in need from the previous year is predicted and is due to a decrease in the size of the 35-39 age cohort. A 31.2 per cent increase in need is anticipated for PHA 2 during the ten years (150.8 to 197.8).

The presentation of projections for PHA 3 is found in Table VII-3. A population increase of 31.7 per cent is predicted for the 35-39 age cohort, 41.7 per cent increase for the 40-44 age cohort, and 24.7 per cent increase in the 45-49 age cohort. Increases of less than five per cent are expected annually in amniocenteses need; however, a 33.4 per

cent combined increase in need is predicted during the ten-year period (642.6 to 857.2).

Table VII-4 contains projection data for PHA 4. During the ten year period a 28.1 per cent increase is expected in the 35-39 age cohort, 47.0 per cent increase in the 40-44 age cohort, and 31.5 per cent increase in the 45-49 age cohort. Annual increases in need for amniocenteses of less than five per cent are predicted. The predicted increase in need for amniocenteses in PHA 4 will be 31.3 per cent (346.6 to 455.0) during the projection period.

Table VII-5 presents projection data for PHA 5. During the ten-year period the 35-39 cohort is expected to increase 34.4 per cent, the 40-44 age cohort 50.2 per cent, and the 45-49 age cohort 36.5 per cent. Annual increases will range from less than three per cent to over five per cent. The total predicted increase in need for amniocenteses during the period is 37.1 per cent (539.2 to 739.0).

Table VII-6 contains projections for PHA 6. Population increases in the three advanced maternal age cohorts are the following: 35-39 age group 54.0 per cent, 40-44 age group 50.1 per cent, and 45-49 age group 32.6 per cent. Annual increases in the need for amniocenteses are expected to exceed five per cent slightly. The total increase in amniocenteses need for the ten-year period is 53.2 per cent (453.8 to 695.3).

During 1982-1991, a total of 32,216.4 amniocenteses will be needed for reason of advanced maternal age (Table VII-7). The estimated need in 1982 (2695.5) and the estimated need in 1991 (3678.2) represents a statewide increase of 36.5 per cent. An analysis by PHA, however,

indicates different growth rates will be experienced among the respective regions. The northern part of Alabama, represented by PHA's 1-4, should experience comparable growth rates. PHA's 1 and 2 will experience growth rates of 30.5 per cent and 31.2 per cent, respectively; PHA's 3 and 4 will experience increases of 33.4 per cent and 31.3 per cent, respectively. The highest rates of growth in need will be in the southern portion of the state consisting of PHA's 5 and 6. An increase of 37.1 per cent is predicted for PHA 5 and 53.2 per cent increase is predicted for PHA 6.

Despite higher rates of increased need being predicted for PHA's 5 and 6, the greatest number in need is clearly in PHA's 1-4. Of the total need during the ten-year projection (32,216.4), 62.0 per cent (19,978.5) will be found in PHA's 1-4. An analysis of projected proportionate need among the respective PHA's during the period reveals the following: PHA 1, 20.0 per cent; PHA 2, 5.6 per cent; PHA 3, 23.6 per cent; PHA 4, 12.8 per cent; PHA 5, 20.3 per cent; and PHA 6, 17.7 per cent.

## Summary

Two demographic models were used to project the number of women by Alabama Public Health Area (PHA) that would comprise the advanced maternal age cohorts (35-39, 40-44, 45-49) for each year 1982-1991. Unlike the first model which yielded projections for 1982-85, the second model (1986-91) did not account for migration. A constant age-race-specific fertility rate was applied to each year's population projection to derive the estimated annual live births occurring among

these advanced maternal age cohorts during the period of interest. The resulting estimate was used as the predicted need for amniocenteses in Alabama for reason of maternal age.

The analysis of this data results in a predicted increase in need of 36.5 per cent during the ten-year period. Although the highest rate of increased need will be experienced in PHA's 5 and 6, the largest need (62.0 per cent) during this interval exists in PHA's 1-4.

# CHAPTER VIII

# DISCUSSION

This study was designed to describe the use of amniocentesis for *in utero* detection of chromosomal disorders. Results of this study provide baseline data for comparison with future measures of use and facilitate policy discussions. Data from the prenatal diagnostic services delivered through the UAB Laboratory of Medical Genetics during the period 1978-1980 were used to characterize services provided and outcomes, the catchment areas, and users; to estimate costs of the procedure; and to project future need.

## Services Provided and Outcomes

During the three-year period of this study, the Laboratory of Medical Genetics compiled an admirable record in performing fetal karyotypes with no known false positives or negatives. Although 18.6 per cent of normal karyotypes diagnosed were categorized as unconfirmed, in each instance the referring provider failed to return an outcome report for the pregnancy. It is postulated that had an unanticipated abnormality been detected at birth, the Laboratory of Medical Genetics would have been notified.

With an abnormal karyotype detection rate of 2.3 per cent, the benefit of amniocentesis to the great majority of users was exclusion of

chromosomal disorders rather than their detection. However, upon learning a fetus was affected with a chromosomal disorder with an adverse phenotype, 91 per cent of families chose the option of pregnancy termination. This suggests that prevention of birth defects through selective pregnancy termination may be a motivating factor for seeking amniocentesis. These rates are comparable to national figures. As previously stated, detection of abnormal fetal karyotypes in amniocentesis centers range from 2.1 per cent to 2.7 per cent. Also, approximately 95 per cent of families choose pregnancy termination upon learning the fetus is affected with a genetic disorder.

This analysis indicated that a high quality, reliable service is being delivered. Data are not available to assess the impact of this service on families before, during, or after the procedure. Information is needed on the immediate psychological impact and long-term familial effects among users. Special consideration should be given to those families in which abnormalities were detected in utero.

## Service Area and Users

These data substantiate a statewide service pattern, although the vast majority of users reside in north Alabama. From this study it is impossible to assess amniocentesis use among all Alabamians, especially residents of south Alabama. These residents rely primarily on the Department of Medical Genetics at the University of South Alabama in Mobile for amniocenteses, but the scope of this study did not encompass service data from that center. Many south Alabamians reside in rural environments where specialized services such as amniocentesis may be

less accessible. The continued development of the medical genetics outreach program at the University of South Alabama may partially alleviate this complex problem.

Amniocentesis may be underutilized by the entire state. That only 17.0 per cent of the state's childbearing women 35 years of age or older obtained amniocentesis in 1980 reflects significant underutilization by women for whom the procedure is indicated because of maternal age. However, increased annual utilization was observed for each of the three years. Comparisons with a 1978 study on amniocentesis use in Alabama (Adams et al., 1981) indicate that at least 6.1 per cent more women in the advanced maternal age cohort obtained the procedure in 1980.

A disproportionate share of whites comprise the amniocentesis patient load; the identification of a primary service area concentrated in north Alabama partially accounts for this pattern. The largest proportion of blacks in Alabama reside in the southern portion of the state. During the period studied, nonwhite women delivered 36 per cent of all live births in Alabama. For the same period 41 per cent of live births among Alabama women 35 years of age or older were nonwhite deliveries (Baby Yearbook, 1978, 1979, 1980). Based on the most reliable data, approximately 10 per cent of total amniocenteses are delivered to nonwhite women. This is considerably less than the proportion of nonwhites in either the childbearing population or the older childbearing women. Available data do not indicate reasons for this discrepancy. It may be due to failure of obstetrical care providers to counsel and refer nonwhite patients for amniocentesis, transportation difficulties, or other reasons. One explanation can be

ruled out, lack of money. The Laboratory of Medical Genetics accepts patients regardless of ability to pay. The possible existence of cultural proscriptions against amniocentesis or pregnancy termination among nonwhites should be explored, although one study found a 61 per cent acceptance rate by low income blacks in Atlanta, Georgia (Marion, Kassam, Fernhoff, Brantly, Carroll, Zacharias, Klein, Priest, and Elsas, 1982).

There appears to be substantial underutilization by patients known to originate from public health clinics. This may be related to the racial composition of amniocentesis users. Annually, public health clinics in Alabama serve at least 25 per cent of the state's prenatal population; over half of public health clinic patients are nonwhite. The finding that only 1.1 per cent of referrals originated in public health clinics may be partially explained by the referral patterns. Many public health clinics have arrangements with private physicians to provide obstetrical care for prenatal patients at high risk for clinical complications. Based on individual patient needs, these physicians make referrals for specialized services including amniocentesis. This system may result in under-reporting of referrals actually originating in public health clinics.

In reality, the term "underutilization" is arbitrary and fails to reflect the complex decision making involved in seeking amniocentesis. As previously discussed, while amniocentesis is clinically indicated for certain prenatal patients based on risk status, it is also a choice of the patient. This choice is influenced by the individual and family values concerning legal and ethical issues. These values may be clarified during the process of informing patients at risk.

## Costs

The methodology used to derive the cost of conducting one prenatal diagnostic procedure has several limitations. The $308.76 total calculated amount should be viewed as the estimated minimum direct service cost for activities routinely provided to all patients. The methodology fails to include certain indirect costs essential to the prenatal diagnosis program such as personnel administration, inservice training, equipment maintenance, and supply purchases/distribution. Nor does the methodology account for additional personnel time required in some instances for telephone conversations with providers or patients and counseling of families with diagnosed abnormal fetal karyotypes. Finally, the cost of replacing equipment will be considerably higher than original purchase prices since major cost increases have occurred for most of these items in recent years.

The total cost figure should be interpreted entirely in the context of an established prenatal diagnosis program with an annual service volume of 800-1,000 patients. This high volume reduces supply and equipment cost per patient and enhances more efficient production from personnel.

With an estimated direct service cost slightly in excess of $300 for each amniocentesis procedure, the minimum cost of a prenatal diagnosis center with an annual volume of 800 is approximately $250,000. This amount is less than the cost of 13 years of institutional care required for one mentally retarded patient (estimated at $20,800 annually) (Krantz, et al., 1979). This $300 cost per procedure is also considerably less than the $620 amount previously cited for a South

Carolina prenatal diagnosis center. Of the $300 cost figure, 60 per cent ($184.91) is devoted to laboratory activities essential to obtaining a karyotype. This percentage, although smaller, is similar to the two-thirds proportion of costs reported and previously cited for laboratory activities in an English amniocentesis program.

This cost analysis of amniocentesis delivery has demonstrated the procedure to be a relatively expensive technology even in a high volume center as represented by the Laboratory of Medical Genetics. Similar cost studies in other high volume service centers would provide a useful comparison.

## Projected Need

Results from the demographic model constructed to project future amniocenteses need based on maternal age must be interpreted cautiously. Because a constant fertility rate is assumed for the respective age groups during the ten-year projection period, the cohort size determines the annual estimated need for amniocenteses for each age group. Also, because fertility declines successively in each of the advance maternal age groups of interest, those geographical areas with higher proportions of females now in the lower age groups may anticipate higher rates of amniocenteses need. Thus, the projected rate of increased need in now-underserved south Alabama, where many females are relatively young, is greater than that in north Alabama.

Reliance on this demographic projection will be influenced primarily by two factors. One is actual net migration and the other is

the variation in age-race specific fertility rates from recent historic trends.

During the ten-year period of 1982-1991, 62.0 per cent of projected amniocenteses need based on maternal age will exist among residents of north Alabama. However, the Laboratory of Medical Genetics should prepare to accommodate a service demand based on approximately 75 per cent of the state's total maternal age need since it also serves residents from counties outside north Alabama. This prediction is founded on the assumption that current service centers and/or referral patterns will remain constant.

## Shifting Age Composition of Users

A serendipitous finding from this study is that the proportion of users under 35 years of age increased annually. During the three years there was no substantive change in birth rates among the respective maternal age cohorts to explain this shifting age composition of users (Baby Yearbook, 1978, 1979, 1980). The decrease in the proportion of users $\geq$ 40 years of age in 1980 is especially noteworthy since this age group has the highest risk for fetal abnormalities among the maternal age cohorts. A corollary finding is that 72.4 per cent of patients were referred because of maternal age but only 64.7 per cent were actually 35 years old or older.

This pattern has at least two implications. First, it limits the validity of the utilization assessment constructed in Chapter III. This assessment was based on the assumption that age composition of patients ( $\geq$ 35 years) would coincide with maternal age referrals ( $\geq$ 35 years),

an assumption refuted by the data. If the trend of referring younger patients for amniocentesis continues, the use of demographic models to predict future demand for the procedure will become increasingly less reliable. Additional user characteristics should be identified to aid forecasting need among the prenatal population. Since not all women for whom the procedure is indicated will choose to obtain amniocentesis service, models are needed to translate need into demand.

Second, this trend suggests that obstetrical care providers are making amniocenteses referrals based on maternal ages younger than 35. The reasons for these referrals are not readily apparent. Obstetrical care providers may have lowered the maternal age at which counseling on amniocentesis is routinely provided. There may be an increasing demand among all pregnant women for amniocentesis, regardless of their actual risk status.

The implications of this trend are serious. The rate of complications associated with amniocentesis is low. However, at ages younger than 35, the incidence of fetal abnormality is even lower. Routine amniocentesis at younger ages thus carries the risk inherent in an invasive medical procedure without corresponding benefits. Continued use by women under 35 could result in an unfavorable benefit/cost ratio for amniocentesis. For example, in a recent benefit cost study among British Columbian women with maternal ages 30 and above at delivery, the benefits of amniocentesis exceeded costs only for those patients aged 35 or greater (Sadovnick and Baird, 1981). Amniocentesis could also become standard practice in obstetrical care for all prenatal patients and represent a major factor in increased health care expenditures.

# CHAPTER IX

## RECOMMENDATIONS AND CONCLUSIONS

Based on findings in this three-year study (1978-1980) period, the following conclusions are made:

- From a catchment area primarily in north Alabama the Laboratory of Medical Genetics provided amniocentesis annually to an average of 456 predominantly white patients.
- There were no instances of false positives or false negatives observed in establishing karyotypes from cells obtained in utero.
- Amniocentesis patients experienced a 2.3 per cent abnormal karyotype detection rate and, when fetal abnormalities would produce adverse phenotypes, 91 per cent of families chose pregnancy termination.
- The minimum direct service cost for an amniocentesis procedure is estimated to be $308.76 when delivered in an established prenatal diagnosis center which serves 800-1,000 patients annually.
- Through 1992, at least 62 per cent of Alabama's projected need for amniocentesis because of maternal age will occur in the primary service area of the Laboratory of Medical Genetics.
- An ever increasing proportion of amniocentesis users referred to the Laboratory of Medical Genetics were younger than 35 years of age.

From this research, the following recommendations are made for future research:

- The immediate and long-term effects of both positive and negative amniocentesis results for users and their families should be investigated.
- Additional studies should be directed at assessing the status of amniocentesis use in Alabama populations and should include service data of the University of South Alabama, Department of Medical Genetics.
- The apparent underutilization by nonwhite and public health clinic patients should be explored further.
- Additional techniques should be developed to determine total cost of the amniocentesis procedure including indirect cost.
- Cost studies should be designed to identify economies of scale among facilities which deliver prenatal diagnosis.
- Identification of amniocentesis user characteristics and projections of potential users should be revised annually to assess changing patterns of demand.
- Studies should be initiated to ascertain reasons for the shift in age composition of users.

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# APPENDICES

APPENDIX 1

Alabama Certificate of Birth

STATE OF ALABAMA

# CERTIFICATE OF LIVE BIRTH

BIRTH NO. 101-

TYPE OR PRINT IN PERMANENT INK. DO NOT USE GREEN OR RED INK.

THIS IS A LEGAL RECORD AND MUST BE FILED WITH LOCAL REGISTRAR WITHIN FIVE (5) DAYS AFTER BIRTH.

SEE OTHER SIDE.

ALL ITEMS MUST BE COMPLETE AND ACCURATE.

| | | | | |
|---|---|---|---|---|
| 1. NAME — First / Middle / Last | | | 2. DATE OF BIRTH (Month, Day, Year) | 3. TIME OF BIRTH M. |
| 4. SEX | 5a. THIS BIRTH – Single, Twin, Triplet, etc. (Specify) | 5b. IF NOT SINGLE BIRTH – This child born first, second, etc. (Specify) | 6a. COUNTY OF BIRTH | |
| 6b. CITY OR TOWN OF BIRTH | | 6c. INSIDE CITY LIMITS? YES [ ] NO [ ] | 7. HOSPITAL – NAME (If not in hospital, give street and number) | |
| 8. MOTHER – MAIDEN NAME — First / Middle / Last | | | 9. MOTHER – STATE OF BIRTH (If not in U.S.A., name country) | 10. AGE YEARS / 11. COLOR OR RACE |
| 12a. USUAL RESIDENCE – State | 12b. COUNTY | | 12c. CITY OR TOWN | |
| 12d. STREET ADDRESS (If rural, give location) | | | | 12e. INSIDE CITY LIMITS YES [ ] NO [ ] |
| 13. FATHER – FULL NAME — First / Middle / Last | | | 14. FATHER – STATE OF BIRTH (If not in U.S.A., name country) | 15. AGE YEARS / 16. COLOR OR RACE |
| 17a. SIGNATURE OF EITHER PARENT I certify that the personal information provided is correct. ▶ | | | | 17b. DATE SIGNED (Month, Day, Year) |
| I hereby certify this child was born alive on the date and place stated above. | 18a. SIGNATURE OF ATTENDANT ▶ | | 18b. ATTENDANT AT BIRTH M.D. [ ] Midwife [ ] Other (Specify) | |
| | 18c. TYPED NAME AND ADDRESS | | | 18d. DATE SIGNED (Month, Day, Year) |
| 19a. DATE RECEIVED BY LOCAL REGISTRAR (Month, Day, Year) | | 19b. REGISTRAR'S SIGNATURE ▶ | | |

Following items will not be shown on certified copies.

CONFIDENTIAL INFORMATION FOR MEDICAL AND HEALTH USE ONLY

GIVE MOTHER'S MAILING ADDRESS

| | | | | |
|---|---|---|---|---|
| 20. APGAR SCORE — At 1 minute / At 5 minutes | | 21. WEIGHT AT BIRTH — LBS. / OZS. | 22. IS MOTHER MARRIED? YES [ ] NO [ ] | 23. DATE LAST NORMAL MENSES BEGAN (Month, Day, Year) |
| 24. MONTH OF PREGNANCY PRENATAL CARE BEGAN – First, Second, etc. (Specify) | | 25. PRENATAL VISITS – TOTAL NUMBER (If none, so state) | 26. COMPLICATIONS OF PREGNANCY (Describe or write "none") | |
| 27. PREVIOUS PREGNANCIES (Complete each section) | | | 28. CONCURRENT ILLNESSES OR CONDITIONS AFFECTING PREGNANCY (Describe or write "none") | |
| LIVE BIRTHS – EXCLUDE THIS CHILD | | OTHER PREGNANCIES | | |
| a. BORN ALIVE – NOW LIVING: Number ___ None [ ] | b. BORN ALIVE – NOW DEAD: Number ___ None [ ] | c. TERMINATING BEFORE 20 WEEKS: Number ___ None [ ] | d. TERMINATING AT 20 WEEKS OR MORE: Number ___ None [ ] | 29. COMPLICATIONS OF LABOR AND/OR DELIVERY (Describe or write "none") |
| | | | | 30. CONGENITAL MALFORMATIONS OR ANOMALIES OF CHILD (Describe or write "none") |
| 31. DATE OF LAST LIVE BIRTH (Month, Day, Year) | | 32. DATE LAST OTHER PREGNANCY ENDED (Month, Day, Year) | 33. MOTHER'S MAILING ADDRESS FOR REGISTRATION NOTICE: NAME ___ | |
| 34. MOTHER'S EDUCATION (Specify ONLY highest grade completed BELOW) | | 35. FATHER'S EDUCATION (Specify ONLY highest grade completed BELOW) | | |
| a. ELEMENTARY OR HIGH SCHOOL (Specify 0-12) | b. COLLEGE (1, 2, 3, 4 or 6+) | a. ELEMENTARY OR HIGH SCHOOL (Specify 0-12) | b. COLLEGE (1, 2, 3, 4 or 6+) | |

VS-1 Revised 1-78

# APPENDIX 2

## Basic Patient Data Form

LABORATORY OF MEDICAL GENETICS
THE UNIVERSITY OF ALABAMA IN BIRMINGHAM

Basic Patient Data

Index Case # _ _ _ _ _ - _ _ _ Service Date _ _ - _ _ - _ _

Hospital #_ _ _ _ _ _ _ _ _ AL Res. Code _ _._ _

Patient Type: _ Couple _ Individual _ Prenatal _ Counseling Only _ Stillborn _ Abortus

Referral Source: ( ) Private Physician ( ) Hospital ( ) Crippled Children
( ) Community Agency ( ) Public Health ( ) Other

Patient's Name: _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

Address: _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ City _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

State: _ _ Zip: _ _ _ _ _ Phone: (_ _ _) _ _ _ - _ _ _ _ Sex: _ Race: _

Birthdate: _ _ - _ _ - _ _ Geo. Code: _ _ _ _ Birth City: _ _ _ _ _ _ _ _ _ _ _ State: _ _

Birth Weight: _ _ lb. _ _oz. Birth Length: _ _ _ Gestation: _ _ Head Circumference: _ _ . _

Stood: _ _ Walked: _ _ Talked: _ _ Prenatal Medication: _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

Diagnosis Specimen: _

( ) Tissue ( ) Skin Biopsy ( ) Urine
( ) Bone Marrow ( ) Amniotic Fluid ( ) Sex Chromatin with + Barr bodies
( ) Leukocytes ( ) Serum ( ) Sex Chromatin with - Barr bodies
( ) Solid Tumor

Diagnostic Classification:

( ) Down Syndrome ( ) Multifactorial Disorder ( ) Neoplasm
( ) Autosomal Aberration ( ) Reproductive Wastage ( ) Unsuccessful
( ) Sex Chromosomal Aberration ( ) Single Gene Disorder ( ) Other _____
( ) Multiple Malformation Syndrome ( ) Fetal Diagnosis

Diagnosis: Karyotype _ _ _

( ) Normal Male (46,XY) ( ) Normal Female (46,XX) _ _ _ _ Abnormal Chromosome No.

Down _

( ) Trisomy 21 ( ) Trans. (G/D) ( ) Trans. (G/G) ( ) Mosaic

Autosomal Aberration _

( ) Trisomy 18 ( ) Trisomy 13 ( ) Trisomy 8 ( ) Other Trisomy ( ) 9p-

( ) 18p- ( ) 18r ( ) 5p- ( ) Other Deletion ( ) Translocation ( ) Mosaic

( ) Other Autosomal ( ) Balanced Translocation

Sex Chromosomal Aberration _

( ) XO Turner's ( ) XXY Klinefelter's ( ) Other Sex Chromosomal

( ) XO Turner's Mosaic ( ) XYY Male

Multifactorial Disorders _

( ) Neural Tube ( ) Cleft Lip/Cleft Palate ( ) Other

Neoplasm _

( ) Ph Chromosome Positive ( ) Ph Chromosome Negative ( ) Other Chr. Aberration

EXTENDED PATIENT DATA

FAMILY

Father: _____ Birthdate: __-__-__

Mother: _____ Birthdate: __-__-__

Family History of Genetic Disorder: _____

Siblings: _ Yes _ No _ #Stillbirths _ #Miscarriages

| Affected (A) or Unaffected (U) | Sex (M or F) | Birthdate |
|---|---|---|
| _ | _ | __-__-__ |
| _ | _ | __-__-__ |
| _ | _ | __-__-__ |
| _ | _ | __-__-__ |
| _ | _ | __-__-__ |
| _ | _ | __-__-__ |
| _ | _ | __-__-__ |
| _ | _ | __-__-__ |
| _ | _ | __-__-__ |
| _ | _ | __-__-__ |

PRENATAL EXAM: Husband's Blood Type: ___ Wife's Blood Type: ___

Alpha-Fetoprotein _.__ %

Reason for Referral:

( ) Maternal Age 35-39
( ) Maternal Age 40+
( ) Previous Child with Chromosomal Aberration
( ) History of X-Linked Recessive Disorder
( ) Patient Carrier of Translocation Chromosome
( ) Family History of Biochemical Disorder
( ) Family History of Neural Tube Defect
( ) Anxiety
( ) Other

APPENDIX 3

Projected Births Among Selected Age Cohorts
by Race and Alabama Public Health Area,
1982-1991

Projected Births Among White Females Residing in PHA 1
by Selected Age Cohorts for Years 1982-1991

| YEAR | 35-39 Cohort Total Projected Females | 35-39 Cohort Birth Rate Per 1000 | 35-39 Cohort Expected Births | 40-44 Cohort Total Projected Females | 40-44 Cohort Birth Rate Per 1000 | 40-44 Cohort Expected Births | 45-49 Cohort Total Projected Females | 45-49 Cohort Birth Rate Per 1000 | 45-49 Cohort Expected Births | Total Expected Births |
|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 25,029 | 12.8 | 320.4 | 21,210 | 2.5 | 53.0 | 18,905 | 0.1 | 2.0 | 375.4 |
| 1983 | 25,940 | 12.8 | 332.0 | 21,762 | 2.5 | 54.4 | 19,263 | 0.1 | 2.0 | 388.4 |
| 1984 | 26,844 | 12.8 | 343.6 | 22,311 | 2.5 | 55.8 | 19,617 | 0.1 | 2.0 | 401.4 |
| 1985 | 27,760 | 12.8 | 355.3 | 22,863 | 2.5 | 57.2 | 19,990 | 0.1 | 2.0 | 414.5 |
| 1986 | 27,289 | 12.8 | 349.3 | 24,463 | 2.5 | 61.2 | 20,458 | 0.1 | 2.1 | 412.6 |
| 1987 | 27,275 | 12.8 | 349.1 | 25,256 | 2.5 | 63.1 | 21,450 | 0.1 | 2.2 | 414.4 |
| 1988 | 28,159 | 12.8 | 360.4 | 25,868 | 2.5 | 64.7 | 22,091 | 0.1 | 2.2 | 427.3 |
| 1989 | 28,984 | 12.8 | 371.0 | 27,002 | 2.5 | 67.5 | 22,401 | 0.1 | 2.2 | 440.7 |
| 1990 | 30,456 | 12.8 | 389.8 | 27,661 | 2.5 | 69.2 | 22,730 | 0.1 | 2.3 | 461.3 |
| 1991 | 31,581 | 12.8 | 404.2 | 27,169 | 2.5 | 67.9 | 24,289 | 0.1 | 2.4 | 474.5 |
| TOTAL | | | 3575.1 | | | 614.0 | | | 21.4 | 4210.5 |

Projected Births Among White Females Residing In PHA 2
by Selected Age Cohorts for Years 1982-1991

| YEAR | 35-39 Cohort Total Projected Females | 35-39 Cohort Birth Rate Per 1000 | 35-39 Cohort Expected Births | 40-44 Cohort Total Projected Females | 40-44 Cohort Birth Rate Per 1000 | 40-44 Cohort Expected Births | 45-49 Cohort Total Projected Females | 45-49 Cohort Birth Rate Per 1000 | 45-49 Cohort Expected Births | Total Expected Births |
|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 5,643 | 12.8 | 72.2 | 4,772 | 2.5 | 11.9 | 4,340 | 0.1 | .4 | 84.5 |
| 1983 | 5,854 | 12.8 | 74.9 | 4,946 | 2.5 | 12.4 | 4,381 | 0.1 | .4 | 87.7 |
| 1984 | 6,084 | 12.8 | 77.9 | 5,131 | 2.5 | 12.8 | 4,437 | 0.1 | .4 | 91.1 |
| 1985 | 6,324 | 12.8 | 81.0 | 5,328 | 2.5 | 13.3 | 4,498 | 0.1 | 1.0 | 95.3 |
| 1986 | 6,949 | 12.8 | 89.0 | 5,357 | 2.5 | 13.4 | 4,630 | 0.1 | 1.0 | 103.4 |
| 1987 | 6,875 | 12.8 | 88.0 | 5,414 | 2.5 | 13.5 | 4,911 | 0.1 | 1.0 | 102.5 |
| 1988 | 6,739 | 12.8 | 86.3 | 5,651 | 2.5 | 14.1 | 5,140 | 0.1 | 1.0 | 101.4 |
| 1989 | 6,592 | 12.8 | 84.4 | 5,979 | 2.5 | 15.0 | 5,200 | 0.1 | 1.0 | 100.4 |
| 1990 | 6,546 | 12.8 | 83.8 | 6,300 | 2.5 | 15.8 | 5,296 | 0.1 | 1.0 | 100.6 |
| 1991 | 6,058 | 12.8 | 77.5 | 6,917 | 2.5 | 17.3 | 5,317 | 0.1 | 1.0 | 95.8 |
| TOTAL | | | 815.0 | | | 139.5 | | | 8.2 | 962.7 |

Projected Births Among White Females Residing In PHA 3
by Selected Age Cohorts for Years 1982-1991

| YEAR | 35-39 Cohort Total Projected Females | 35-39 Cohort Birth Rate Per 1000 | 35-39 Cohort Expected Births | 40-44 Cohort Total Projected Females | 40-44 Cohort Birth Rate Per 1000 | 40-44 Cohort Expected Births | 45-49 Cohort Total Projected Females | 45-49 Cohort Birth Rate Per 1000 | 45-49 Cohort Expected Births | Total Expected Births |
|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 25,080 | 12.8 | 321.0 | 20,779 | 2.5 | 52.0 | 18,754 | 0.1 | 1.9 | 374.9 |
| 1983 | 26,314 | 12.8 | 336.8 | 21,593 | 2.5 | 54.0 | 18,995 | 0.1 | 1.9 | 392.7 |
| 1984 | 27,653 | 12.8 | 354.0 | 22,487 | 2.5 | 56.2 | 19,297 | 0.1 | 1.0 | 412.1 |
| 1985 | 28,977 | 12.8 | 370.9 | 23,371 | 2.5 | 58.4 | 19,599 | 0.1 | 2.0 | 431.3 |
| 1986 | 28,978 | 12.8 | 370.9 | 24,724 | 2.5 | 61.8 | 20,344 | 0.1 | 2.0 | 434.7 |
| 1987 | 28,854 | 12.8 | 369.3 | 25,556 | 2.5 | 63.9 | 21,579 | 0.1 | 2.2 | 435.4 |
| 1988 | 29,155 | 12.8 | 373.2 | 26,503 | 2.5 | 66.3 | 22,336 | 0.1 | 2.2 | 441.7 |
| 1989 | 29,490 | 12.8 | 377.5 | 27,662 | 2.5 | 69.1 | 22,865 | 0.1 | 2.3 | 448.9 |
| 1990 | 29,947 | 12.8 | 383.2 | 28,871 | 2.5 | 72.2 | 23,231 | 0.1 | 2.3 | 457.7 |
| 1991 | 30,190 | 12.8 | 386.4 | 28,846 | 2.5 | 72.1 | 24,547 | 0.1 | 2.5 | 461.0 |
| TOTAL | | | 3643.2 | | | 626.0 | | | 21.2 | 4290.4 |

Projected Births Among White Females Residing in PHA 4
by Selected Age Cohorts for Years 1982-1991

| YEAR | 35-39 Cohort Total Projected Females | 35-39 Cohort Birth Rate Per 1000 | 35-39 Cohort Expected Births | 40-44 Cohort Total Projected Females | 40-44 Cohort Birth Rate Per 1000 | 40-44 Cohort Expected Births | 45-49 Cohort Total Projected Females | 45-49 Cohort Birth Rate Per 1000 | 45-49 Cohort Expected Births | Total Expected Births |
|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 14,658 | 12.8 | 187.6 | 11,928 | 2.5 | 29.8 | 10,617 | 0.1 | 1.1 | 218.5 |
| 1983 | 15,355 | 12.8 | 196.5 | 12,427 | 2.5 | 31.1 | 10,673 | 0.1 | 1.1 | 228.7 |
| 1984 | 16,082 | 12.8 | 205.9 | 12,950 | 2.5 | 32.4 | 10,746 | 0.1 | 1.1 | 239.4 |
| 1985 | 16,852 | 12.8 | 215.7 | 13,510 | 2.5 | 33.8 | 10,845 | 0.1 | 1.1 | 250.6 |
| 1986 | 17,202 | 12.8 | 220.2 | 14,342 | 2.5 | 35.9 | 11,176 | 0.1 | 1.1 | 257.2 |
| 1987 | 17,145 | 12.8 | 219.5 | 14,888 | 2.5 | 37.2 | 11,787 | 0.1 | 1.2 | 257.9 |
| 1988 | 17,447 | 12.8 | 223.2 | 15,270 | 2.5 | 38.2 | 12,496 | 0.1 | 1.3 | 262.8 |
| 1989 | 17,416 | 12.8 | 222.9 | 16,097 | 2.5 | 40.2 | 12,963 | 0.1 | 1.3 | 264.4 |
| 1990 | 17,643 | 12.8 | 225.8 | 16,790 | 2.5 | 42.0 | 13,429 | 0.1 | 1.3 | 269.1 |
| 1991 | 17,533 | 12.8 | 224.4 | 17,123 | 2.5 | 42.8 | 14,239 | 0.1 | 1.4 | 268.6 |
| TOTAL | | | 2141.8 | | | 363.4 | | | 12.0 | 2517.2 |

Projected Births Among White Females Residing in PHA 5
by Selected Age Cohorts for Years 1982-1991

| YEAR | 35-39 Cohort Total Projected Females | 35-39 Cohort Birth Rate Per 1000 | 35-39 Cohort Expected Births | 40-44 Cohort Total Projected Females | 40-44 Cohort Birth Rate Per 1000 | 40-44 Cohort Expected Births | 45-49 Cohort Total Projected Females | 45-49 Cohort Birth Rate Per 1000 | 45-49 Cohort Expected Births | Total Expected Births |
|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 19,585 | 12.8 | 250.7 | 15,938 | 2.5 | 39.9 | 13,723 | 0.1 | 1.4 | 292.0 |
| 1983 | 20,596 | 12.8 | 263.6 | 16,703 | 2.5 | 41.8 | 13,974 | 0.1 | 1.4 | 306.8 |
| 1984 | 21,611 | 12.8 | 276.6 | 17,469 | 2.5 | 43.7 | 14,224 | 0.1 | 1.4 | 321.7 |
| 1985 | 22,635 | 12.8 | 289.7 | 18,250 | 2.5 | 45.6 | 14,476 | 0.1 | 1.5 | 336.8 |
| 1986 | 23,424 | 12.8 | 299.8 | 19,557 | 2.5 | 48.9 | 14,846 | 0.1 | 1.5 | 350.2 |
| 1987 | 23,451 | 12.8 | 300.2 | 20,484 | 2.5 | 51.2 | 15,729 | 0.1 | 1.6 | 353.0 |
| 1988 | 23,795 | 12.8 | 304.6 | 21,110 | 2.5 | 52.8 | 16,694 | 0.1 | 1.7 | 359.1 |
| 1989 | 23,930 | 12.8 | 306.3 | 21,804 | 2.5 | 54.5 | 17,553 | 0.1 | 1.8 | 362.6 |
| 1990 | 24,403 | 12.8 | 312.4 | 22,548 | 2.5 | 56.4 | 18,142 | 0.1 | 1.8 | 370.6 |
| 1991 | 23,943 | 12.8 | 306.5 | 23,313 | 2.5 | 58.3 | 19,419 | 0.1 | 1.9 | 366.7 |
| TOTAL | | | 2910.4 | | | 493.1 | | | 16.0 | 3419.5 |

Projected Births Among White Females Residing In PHA 6
by Selected Age Cohorts for Years 1982-1991

| YEAR | 35-39 Cohort Total Projected Females | 35-39 Cohort Birth Rate Per 1000 | 35-39 Cohort Expected Births | 40-44 Cohort Total Projected Females | 40-44 Cohort Birth Rate Per 1000 | 40-44 Cohort Expected Births | 45-49 Cohort Total Projected Females | 45-49 Cohort Birth Rate Per 1000 | 45-49 Cohort Expected Births | Total Expected Births |
|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 16,044 | 12.8 | 205.4 | 12,745 | 2.5 | 31.9 | 11,014 | 0.1 | 1.1 | 238.4 |
| 1983 | 16,893 | 12.8 | 216.2 | 13,344 | 2.5 | 33.4 | 11,207 | 0.1 | 1.1 | 250.7 |
| 1984 | 17,757 | 12.8 | 227.3 | 13,963 | 2.5 | 34.9 | 11,417 | 0.1 | 1.1 | 263.3 |
| 1985 | 18,656 | 12.8 | 238.8 | 14,601 | 2.5 | 36.5 | 11,639 | 0.1 | 1.2 | 276.5 |
| 1986 | 18,660 | 12.8 | 238.9 | 15,860 | 2.5 | 39.7 | 12,178 | 0.1 | 1.2 | 279.8 |
| 1987 | 19,146 | 12.8 | 245.1 | 16,665 | 2.5 | 41.7 | 12,971 | 0.1 | 1.3 | 288.1 |
| 1988 | 19,897 | 12.8 | 254.7 | 17,147 | 2.5 | 42.9 | 13,722 | 0.1 | 1.4 | 299.0 |
| 1989 | 20,806 | 12.8 | 266.3 | 17,856 | 2.5 | 44.7 | 14,181 | 0.1 | 1.4 | 312.4 |
| 1990 | 21,933 | 12.8 | 280.7 | 18,591 | 2.5 | 46.5 | 14,515 | 0.1 | 1.5 | 328.7 |
| 1991 | 22,635 | 12.8 | 289.7 | 18,580 | 2.5 | 46.5 | 15,750 | 0.1 | 1.6 | 337.8 |
| TOTAL | | | 2463.1 | | | 398.7 | | | 12.9 | 2874.7 |

Projected Births Among White Females Residing in Alabama
by Selected Age Cohorts for Years 1982-1991

| YEAR | 35-39 Cohort Total Projected Females | 35-39 Cohort Birth Rate Per 1000 | 35-39 Cohort Expected Births | 40-44 Cohort Total Projected Females | 40-44 Cohort Birth Rate Per 1000 | 40-44 Cohort Expected Births | 45-49 Cohort Total Projected Females | 45-49 Cohort Birth Rate Per 1000 | 45-49 Cohort Expected Births | Total Expected Births |
|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 106,039 | 12.8 | 1357.3 | 87,372 | 2.5 | 218.4 | 77,353 | 0.1 | 7.7 | 1583.4 |
| 1983 | 110,952 | 12.8 | 1420.2 | 90,775 | 2.5 | 226.9 | 78,493 | 0.1 | 7.9 | 1655.0 |
| 1984 | 116,031 | 12.8 | 1485.2 | 94,311 | 2.5 | 235.8 | 79,738 | 0.1 | 8.0 | 1729.0 |
| 1985 | 121,204 | 12.8 | 1551.4 | 97,923 | 2.5 | 244.8 | 81,047 | 0.1 | 8.1 | 1804.3 |
| 1986 | 122,502 | 12.8 | 1568.0 | 104,303 | 2.5 | 260.8 | 83,632 | 0.1 | 8.4 | 1837.2 |
| 1987 | 122,746 | 12.8 | 1571.2 | 108,263 | 2.5 | 270.7 | 88,427 | 0.1 | 8.8 | 1850.7 |
| 1988 | 125,192 | 12.8 | 1602.5 | 111,549 | 2.5 | 278.9 | 92,479 | 0.1 | 9.3 | 1890.7 |
| 1989 | 127,218 | 12.8 | 1628.4 | 116,360 | 2.5 | 290.9 | 95,163 | 0.1 | 9.5 | 1928.8 |
| 1990 | 130,928 | 12.8 | 1675.9 | 120,761 | 2.5 | 301.9 | 97,343 | 0.1 | 9.7 | 1987.5 |
| 1991 | 131,940 | 12.8 | 1688.8 | 121,948 | 2.5 | 304.9 | 103,561 | 0.1 | 10.4 | 2004.1 |
| TOTAL | | | 15548.9 | | | 2634.0 | | | 87.7 | 18270.7 |

Projected Births Among Nonwhite Females Residing in PHA 1
by Selected Age Cohorts for Years 1982-1991

| YEAR | 35-39 Cohort Total Projected Females | 35-39 Cohort Birth Rate Per 1000 | 35-39 Cohort Expected Births | 40-44 Cohort Total Projected Females | 40-44 Cohort Birth Rate Per 1000 | 40-44 Cohort Expected Births | 45-49 Cohort Total Projected Females | 45-49 Cohort Birth Rate Per 1000 | 45-49 Cohort Expected Births | Total Expected Births |
|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 2,960 | 31.4 | 92.9 | 2,305 | 10.2 | 23.5 | 2,084 | o.5 | 1.0 | 117.4 |
| 1983 | 3,118 | 31.4 | 97.9 | 2,405 | 10.2 | 24.5 | 2,088 | 0.5 | 1.0 | 123.4 |
| 1984 | 3,289 | 31.4 | 103.3 | 2,490 | 10.2 | 25.4 | 2,095 | 0.5 | 1.1 | 129.8 |
| 1985 | 3,452 | 31.4 | 108.4 | 2,588 | 10.2 | 26.4 | 2,092 | 0.5 | 1.1 | 135.9 |
| 1986 | 4,056 | 31.4 | 127.4 | 2,657 | 10.2 | 27.1 | 2,193 | 0.5 | 1.1 | 155.6 |
| 1987 | 4,336 | 31.4 | 136.2 | 2,744 | 10.2 | 28.0 | 2,343 | 0.5 | 1.2 | 165.4 |
| 1988 | 4,567 | 31.4 | 143.4 | 2,941 | 10.2 | 30.0 | 2,422 | 0.5 | 1.2 | 174.6 |
| 1989 | 4,714 | 31.4 | 148.0 | 3,179 | 10.2 | 32.4 | 2,501 | 0.5 | 1.3 | 181.7 |
| 1990 | 4,907 | 31.4 | 154.1 | 3,441 | 10.2 | 35.1 | 2,577 | 0.5 | 1.3 | 190.5 |
| 1991 | 4,815 | 31.4 | 151.2 | 4,041 | 10.2 | 41.2 | 2,643 | 0.5 | 1.3 | 193.7 |
| TOTAL | | | 1262.8 | | | 293.6 | | | 11.6 | 1568.0 |

Projected Births Among Nonwhite Females Residing in PHA 2
by Selected Age Cohorts for Years 1982-1991

| YEAR | 35-39 Cohort Total Projected Females | 35-39 Cohort Birth Rate Per 1000 | 35-39 Cohort Expected Births | 40-44 Cohort Total Projected Females | 40-44 Cohort Birth Rate Per 1000 | 40-44 Cohort Expected Births | 45-49 Cohort Total Projected Females | 45-49 Cohort Birth Rate Per 1000 | 45-49 Cohort Expected Births | Total Expected Births |
|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 1,825 | 31.4 | 57.3 | 1,666 | 10.2 | 17.0 | 1,713 | 0.5 | .9 | 75.2 |
| 1983 | 1,938 | 31.4 | 60.1 | 1,667 | 10.2 | 17.0 | 1,683 | 0.5 | .8 | 77.9 |
| 1984 | 2,051 | 31.4 | 64.4 | 1,670 | 10.2 | 17.0 | 1,662 | 0.5 | .8 | 82.2 |
| 1985 | 2,172 | 31.4 | 68.2 | 1,679 | 10.2 | 17.1 | 1,641 | 0.5 | .8 | 86.1 |
| 1986 | 2,498 | 31.4 | 78.4 | 1,647 | 10.2 | 16.8 | 1,622 | 0.5 | .8 | 96.0 |
| 1987 | 2,816 | 31.4 | 88.4 | 1,612 | 10.2 | 16.4 | 1,689 | 0.5 | .8 | 105.6 |
| 1988 | 3,055 | 31.4 | 95.9 | 1,773 | 10.2 | 18.1 | 1,664 | 0.5 | .8 | 114.8 |
| 1989 | 3,289 | 31.4 | 103.3 | 1,917 | 10.2 | 19.6 | 1,615 | 0.5 | .8 | 123.7 |
| 1990 | 3,445 | 31.4 | 108.2 | 2,163 | 10.2 | 22.1 | 1,671 | 0.5 | .8 | 131.1 |
| 1991 | 3,505 | 31.4 | 110.1 | 2,488 | 10.2 | 25.4 | 1,637 | 0.5 | .8 | 136.3 |
| TOTAL | | | 834.3 | | | 186.5 | | | 8.1 | 1028.9 |

Projected Births Among Nonwhite Females Residing in PHA 3
by Selected Age Cohorts for Years 1982-1991

| YEAR | 35-39 Cohort Total Projected Females | 35-39 Cohort Birth Rate Per 1000 | 35-39 Cohort Expected Births | 40-44 Cohort Total Projected Females | 40-44 Cohort Birth Rate Per 1000 | 40-44 Cohort Expected Births | 45-49 Cohort Total Projected Females | 45-49 Cohort Birth Rate Per 1000 | 45-49 Cohort Expected Births | Total Expected Births |
|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 6,933 | 31.4 | 217.7 | 5,923 | 10.2 | 60.4 | 5,886 | 0.5 | 2.9 | 281.0 |
| 1983 | 7,364 | 31.4 | 231.2 | 5,980 | 10.2 | 61.0 | 5,802 | 0.5 | 2.9 | 295.1 |
| 1984 | 7,806 | 31.4 | 245.1 | 6,049 | 10.2 | 61.7 | 5,726 | 0.5 | 2.9 | 309.7 |
| 1985 | 8,251 | 31.4 | 259.1 | 6,116 | 10.2 | 62.4 | 5,649 | 0.5 | 2.8 | 324.3 |
| 1986 | 9,026 | 31.4 | 283.4 | 6,228 | 10.2 | 63.5 | 5,649 | 0.5 | 2.8 | 349.7 |
| 1987 | 9,834 | 31.4 | 308.8 | 6,519 | 10.2 | 66.5 | 5,749 | 0.5 | 2.9 | 378.2 |
| 1988 | 10,483 | 31.4 | 329.2 | 6,974 | 10.2 | 71.1 | 5,888 | 0.5 | 2.9 | 403.2 |
| 1989 | 11,125 | 31.4 | 349.3 | 7,577 | 10.2 | 77.3 | 5,911 | 0.5 | 3.0 | 429.6 |
| 1990 | 11,642 | 31.4 | 365.6 | 8,222 | 10.2 | 83.9 | 6,081 | 0.5 | 3.0 | 452.5 |
| 199 | 11,983 | 31.4 | 376.3 | 8,987 | 10.2 | 91.7 | 6,184 | 0.5 | 3.1 | 471.1 |
| TOTAL | | | 2965.7 | | | 699.5 | | | 29.2 | 3694.4 |

Projected Births Among Nonwhite Females Residing in PHA 4
by Selected Age Cohorts for Years 1982-1991

| YEAR | 35-39 Cohort Total Projected Females | 35-39 Cohort Birth Rate Per 1000 | 35-39 Cohort Expected Births | 40-44 Cohort Total Projected Females | 40-44 Cohort Birth Rate Per 1000 | 40-44 Cohort Expected Births | 45-49 Cohort Total Projected Females | 45-49 Cohort Birth Rate Per 1000 | 45-49 Cohort Expected Births | Total Expected Births |
|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 2,688 | 31.4 | 84.4 | 2,184 | 10.2 | 22.3 | 2,057 | 0.5 | 1.0 | 107.7 |
| 1983 | 2,838 | 31.4 | 89.1 | 2,235 | 10.2 | 22.8 | 2,039 | 0.5 | 1.0 | 112.9 |
| 1984 | 2,999 | 31.4 | 94.2 | 2,293 | 10.2 | 23.4 | 2,027 | 0.5 | 1.0 | 118.6 |
| 1985 | 3,175 | 31.4 | 99.7 | 2,356 | 10.2 | 24.0 | 2,017 | 0.5 | 1.0 | 124.7 |
| 1986 | 3,635 | 31.4 | 114.1 | 2,439 | 10.2 | 24.9 | 1,992 | 0.5 | 1.0 | 140.0 |
| 1987 | 3,989 | 31.4 | 125.3 | 2,514 | 10.2 | 25.6 | 2,096 | 0.5 | 1.1 | 152.0 |
| 1988 | 4,272 | 31.4 | 134.1 | 2,646 | 10.2 | 27.0 | 2,224 | 0.5 | 1.1 | 162.2 |
| 1989 | 4,537 | 31.4 | 142.5 | 2,882 | 10.2 | 29.4 | 2,250 | 0.5 | 1.1 | 173.0 |
| 1990 | 4,700 | 31.4 | 147.6 | 3,161 | 10.2 | 32.2 | 2,342 | 0.5 | 1.2 | 181.0 |
| 1991 | 4,691 | 31.4 | 147.3 | 3,617 | 10.2 | 36.9 | 2,424 | 0.5 | 1.2 | 185.4 |
| TOTAL | | | 1178.3 | | | 268.5 | | | 10.7 | 1457.5 |

Projected Births Among Nonwhite Females Residing in PHA 5
by Selected Age Cohorts for Years 1982-1991

| YEAR | 35-39 Cohort Total Projected Females | 35-39 Cohort Birth Rate Per 1000 | 35-39 Cohort Expected Births | 40-44 Cohort Total Projected Females | 40-44 Cohort Birth Rate Per 1000 | 40-44 Cohort Expected Births | 45-49 Cohort Total Projected Females | 45-49 Cohort Birth Rate Per 1000 | 45-49 Cohort Expected Births | Total Expected Births |
|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 7,410 | 31.4 | 232.7 | 6,003 | 10.2 | 61.2 | 5,363 | 0.5 | 2.7 | 296.6 |
| 1983 | 7,826 | 31.4 | 245.7 | 6,171 | 10.2 | 63.0 | 5,327 | 0.5 | 2.7 | 311.4 |
| 1984 | 8,249 | 31.4 | 259.0 | 6,337 | 10.2 | 64.6 | 5,320 | 0.5 | 2.7 | 326.3 |
| 1985 | 8,684 | 31.4 | 272.7 | 6,516 | 10.2 | 66.5 | 5,305 | 0.5 | 2.7 | 341.9 |
| 1986 | 9,693 | 31.4 | 304.4 | 6,682 | 10.2 | 68.2 | 5,481 | 0.5 | 2.7 | 375.3 |
| 1987 | 10,576 | 31.4 | 332.1 | 6,847 | 10.2 | 69.8 | 5,736 | 0.5 | 2.9 | 404.8 |
| 1988 | 11,270 | 31.4 | 353.9 | 7,282 | 10.2 | 74.3 | 6,033 | 0.5 | 3.0 | 431.2 |
| 1989 | 11,733 | 31.4 | 368.4 | 7,937 | 10.2 | 81.0 | 6,176 | 0.5 | 3.1 | 452.5 |
| 1990 | 12,177 | 31.4 | 382.4 | 8,641 | 10.2 | 88.1 | 6,482 | 0.5 | 3.2 | 473.7 |
| 1991 | 12,342 | 31.4 | 387.5 | 9,641 | 10.2 | 98.3 | 6,641 | 0.5 | 3.3 | 489.1 |
| TOTAL | | | 3138.8 | | | 735.0 | | | 29.0 | 3902.8 |

Projected Births Among Nonwhite Females Residing in PHA 6
by Selected Age Cohorts for Years 1982-1991

| YEAR | 35-39 Cohort Total Projected Females | 35-39 Cohort Birth Rate Per 1000 | 35-39 Cohort Expected Births | 40-44 Cohort Total Projected Females | 40-44 Cohort Birth Rate Per 1000 | 40-44 Cohort Expected Births | 45-49 Cohort Total Projected Females | 45-49 Cohort Birth Rate Per 1000 | 45-49 Cohort Expected Births | Total Expected Births |
|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 6,733 | 31.4 | 211.4 | 5,472 | 10.2 | 55.8 | 5,329 | 0.5 | 2.7 | 269.9 |
| 1983 | 7,172 | 31.4 | 225.2 | 5,563 | 10.2 | 56.7 | 5,289 | 0.5 | 2.6 | 284.5 |
| 1984 | 7,613 | 31.4 | 239.1 | 5,656 | 10.2 | 57.7 | 5,253 | 0.5 | 2.6 | 299.4 |
| 1985 | 8,077 | 31.4 | 253.6 | 5,755 | 10.2 | 58.7 | 5,217 | 0.5 | 2.6 | 314.9 |
| 1986 | 8,801 | 31.4 | 276.4 | 5,970 | 10.2 | 60.9 | 5,265 | 0.5 | 2.6 | 339.9 |
| 1987 | 9,731 | 31.4 | 305.6 | 6,205 | 10.2 | 63.3 | 5,394 | 0.5 | 2.7 | 371.6 |
| 1988 | 10,551 | 31.4 | 331.3 | 6,649 | 10.2 | 67.8 | 5,537 | 0.5 | 2.8 | 401.9 |
| 1989 | 11,273 | 31.4 | 354.0 | 7,337 | 10.2 | 74.8 | 5,537 | 0.5 | 2.8 | 431.6 |
| 1990 | 11,928 | 31.4 | 374.5 | 8,046 | 10.2 | 82.1 | 5,718 | 0.5 | 2.9 | 459.5 |
| 1991 | 12,451 | 31.4 | 391.0 | 8,760 | 10.2 | 89.4 | 5,924 | 0.5 | 3.0 | 483.4 |
| TOTAL | | | 1962.1 | | | 667.2 | | | 27.3 | 3656.6 |

Projected Births Among Nonwhite Females Residing in Alabama
by Selected Age Cohorts for Years 1982-1991

| YEAR | 35-39 Cohort Total Projected Females | 35-39 Cohort Birth Rate Per 1000 | 35-39 Cohort Expected Births | 40-44 Cohort Total Projected Females | 40-44 Cohort Birth Rate Per 1000 | 40-44 Cohort Expected Births | 45-49 Cohort Total Projected Females | 45-49 Cohort Birth Rate Per 1000 | 45-49 Cohort Expected Births | Total Expected Births |
|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 28,549 | 31.4 | 896.4 | 23,553 | 10.2 | 240.2 | 22,432 | 0.5 | 11.2 | 1147.8 |
| 1983 | 30,256 | 31.4 | 950.0 | 24,021 | 10.2 | 245.0 | 22,228 | 0.5 | 11.1 | 1206.1 |
| 1984 | 32,007 | 31.4 | 1005.0 | 24,495 | 10.2 | 249.9 | 22,083 | 0.5 | 11.0 | 1265.9 |
| 1985 | 33,811 | 31.4 | 1061.7 | 25,010 | 10.2 | 255.1 | 21,929 | 0.5 | 11.0 | 1327.8 |
| 1986 | 37,709 | 31.4 | 1184.1 | 25,623 | 10.2 | 261.4 | 22,202 | 0.5 | 11.1 | 1456.6 |
| 1987 | 41,282 | 31.4 | 1296.3 | 26,441 | 10.2 | 269.7 | 23,007 | 0.5 | 11.5 | 1577.5 |
| 1988 | 44,198 | 31.4 | 1387.8 | 28,265 | 10.2 | 288.3 | 23,768 | 0.5 | 11.9 | 1688.0 |
| 1989 | 46,671 | 31.4 | 1465.5 | 30,829 | 10.2 | 314.5 | 23,990 | 0.5 | 12.0 | 1792.0 |
| 1990 | 48,799 | 31.4 | 1532.3 | 33,674 | 10.2 | 343.5 | 24,871 | 0.5 | 12.4 | 1888.2 |
| 1991 | 49,787 | 31.4 | 1563.3 | 37,534 | 10.2 | 382.9 | 25,452 | 0.5 | 12.7 | 1958.9 |
| TOTAL | | | 12342.4 | | | 2850.5 | | | 115.9 | 15308.8 |

GRADUATE SCHOOL
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DISSERTATION APPROVAL FORM

**Name of Candidate** Clyde Henry Barganier

**Major Subject** Public Health

**Title of Dissertation** Amniocentesis for Chromosomal Evaluation of the Fetus: An Analysis

**Dissertation Committee:**

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**Date** 12/3/82