PHENYLKETONURIA: RECOMMENDATIONS FOR PARENTS AND TEACHERS

By

LOUISE FARHA ROBERDS

Bachelor of Science
Oklahoma State University
Stillwater, Oklahoma
1938

Master of Science
Oklahoma State University
Stillwater, Oklahoma
1941

Educational Specialist
Oklahoma State University
Stillwater, Oklahoma
1965

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
DOCTOR OF EDUCATION
July, 1974

PHENYLKETONURIA: RECOMMENDATIONS FOR

PARENTS AND TEACHERS

Thesis Approved:

Thesis Adviser

Dean of the Graduate College

ACKNOWLEDGMENTS

The completion of this dissertation is not the efforts of one, but of many interested, cooperative and helpful persons. The writer is grateful for the encouragement received throughout the continuation of the study.

Sincerest appreciation is expressed to Dr. Idella Lohmann, chairman, for her guidance, assistance, and support throughout this study. A special note of thanks is given to Dr. Josephine Hoffer for her generous investment of time, encouragement, and guidance. Appreciation is also expressed to her other committee members, Dr. Nick Stinett, for encouragement in this study; and Dr. Richard Jungers and Dr. Judson Milburn, for their invaluable assistance in the preparation of the final manuscript.

Thanks is expressed to those who served as jurors, respondents, Saint Mary's Medical Library in Enid, Oklahoma, for their efforts in supplying data and research, and to those persons who gave of their time and efforts to this study.

The writer is grateful to Phillips University for release time from her teaching duties to puruse the study and to Delta Kappa Gamma and Kappa Kappa Iota for the scholarships which financed this study.

Finally, special gratitude is due my husband, Loren, and my children, Lance, Lynne, Lane, Lu, and Angela, for their loving understanding and support throughout this study.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

The Problem and Its Importance

This investigation is concerned with phenylketonuria, one of a newly discovered group of physical disorders known as an inborn error of metabolism. Because of a defective gene, the liver of the afflicted infant lacks the enzyme phenylalanine hydroxylose and cannot metabolize phenylalanine, an amino acid found in all protein foods. The phenylalanine accumulates in the infant's body and results in a serious disorder manifested by brain damage and mental retardation. Phenylketonuria, commonly referred to as PKU, has recently become a familiar word in the vocabularies of hospital personnel across the country. Unfortunately, it is still a strange and unknown word to parents, teachers, and others who work with children. However, this disorder can be identified in newborns by a simple blood test which is now required by law in several states (Appendix E).

Metabolism is the chemical and physical process by which foods become part of the body. It is the breaking down of complex substances, such as proteins and carbohydrates, into simple ones which the body cells can use for energy and body needs. Metabolism is a miracle process of converting foods into simple digestible substances, then reconverting them into blood, nerves, bones, and tissues. To aid in a step-by-step progression in this complex change, one or more enzymes are

needed. If the essential enzyme is not present in the body, serious results occur. This is referred to by Taylor (107) as an "inborn error of metabolism."

One of the most dramatic and tragic errors recently "discovered" is commonly known as PKU, which, if not diagnosed and treated at an early age, causes mental retardation. The disorder PKU results when the enzyme needed to change phenylalanine (one of the amino acids from protein foods) is not present in the body. This is a genetic lack. As a result of the missing enzyme, an excess of amino acid builds up in blood and body tissues, causing physical and mental disorders.

To date little is known about early diagnosis and treatment of PKU. Through this study, the writer wishes to aid parents, teachers, and others who work with children to become knowledgeable about this malady. Thus, the major problem of this study is to report results of medical research in PKU and to translate medical terminology into lay language.

Need for the Study

Phenylketonuria is a rare disorder transmitted by the inheritance of a recessive gene. It is estimated that this gene is carried by one in forty of the population, and that in one in five thousand marriages both partners carry the gene. These couples appear normal and have no reason to suspect that they are PKU carriers. Desper (41) reported that when both parents have the gene, the chances are one in four that the child will be a carrier and one in four that he will have the disorder.

The immediate study is significant in that it organizes information about PKU which may be made available to the public. If the public had information concerning the devastating conditions resulting from PKU,

they could demand early screening of all babies by the time they are four or five days old, or before the baby leaves the hospital. This could facilitate early treatment. Under the present conditions, by the time recognizable physical symptoms begin to appear, PKU has already caused some brain damage. Irreversible mental retardation usually is a result of PKU. About one in every hundred patients in institutions for the mentally retarded has PKU, and it has been estimated that keeping such a patient for life costs about one hundred thousand dollars (U.S. Department of Health, Education, and Welfare, 1964). Early identification could prevent mental retardation as a result of PKU and simultaneously conserve public funds which could be diverted to other areas of health.

Purposes of Study

The literature indicates that there is much information and research knowledge available which would be of great value to parents, teachers, or counselors who may encounter PKU children. However, the information has not been evaluated and organized into "lay language" for the public. There is a need for the development of a handbook which would make available information about phenylketonuria in lay language for the medical profession to give parents, teachers, counselors, and others who may need help in this field. The data obtained for this study will be used by the investigator or other persons to develop a handbook on PKU at a later date. Therefore, the purposes of this study are to:

(1) Review and interpret medical literature concerning PKU.

(2) Ascertain the incidence of PKU in Oklahoma.

(3) Summarize findings from literature and other sources which could be used in a handbook for parents of PKU individuals.

Definitions of Terms

The following definitions are presented to provide the reader a point of reference for terms used in this study (84) (104).

Disease. Disease is a condition in which bodily health is impaired; a sickness; an illness; also, a malady; an ailment.

Disorder. Disorder is a disturbance of the natural functions of the body or mind. In this study, disorder will be used instead of disease.

Enzyme. An enzyme refers to a complex organic substance that accelerates chemical transformation in the digestion of foods.

Gene. A gene is an element of the germ plasm, regarded as a small part of a chromosome that passes traits.

Lofenalac. Lofenalac is a compound that is a low phenylalanine food developed by Mead Johnson of Evansville, Indiana. To make dietary management of phenylketonuria easier and more effective, Lofenalac has been developed as a service to physicians and is available on prescription. Lofenalac provides balanced, well-tolerated nourishment as a formula for phenylketonuric infants or as a basic food for older patients.

Mental retardation. Mental retardation refers to slowness of development or progress of the mind.

Metabolism. Metabolism is the chemical and physical process by which foods become a part of the body. It is the breaking down of complex substances.

Phenylalanine (fe-nil-al'-ah-nin). Phenylalanine is found in large amounts in all protein-rich foods and in lesser amounts in cereals, vegetables, and other foods. It is an essential amino acid which means that some is needed by the body.

Phenylketonuria (fen"il-ke-to-nu-re-ah). Phenylketonuria is one of a large number of disorders now identified as an inborn error of metabolism. It is easier to understand phenylketonuria if one thinks of it in terms of food. Foods such as meat, fish, milk, eggs, cheese, dried beans and peas, and most breads and cereals have proteins which are necessary for growth and development. When a person eats such foods, the proteins are broken down into amino acids which the body uses with the help of body chemicals called enzymes. In phenylketonuria, a particular liver enzyme is lacking. As a result, the amino acid phenylalanine is not all used by the body and collects in large amounts in the blood, preventing the brain from developing normally and causing other harm to the body.

PKU. PKU is the shorter name for phenylketonuria. The letters stand for Phenyl-Keton-Uria.

Summary

The detection of phenylketonuria (PKU), a disorder caused by an inborn error of metabolism, and the development of dietary treatment to prevent mental retardation as a result of PKU have been among the most dramatic of the advances in the treatment of those affected by this disorder. Although phenylketonuria is the cause of only a small proportion of the total number of retarded persons, the fact is that PKU can now be easily identified and that treatment can be prescribed.

CHAPTER II

RELATED LITERATURE

The purpose of this chapter is to present the literature associated with the research of phenylketonuria. This review is presented under seven subheadings entitled: (1) history of phenylketonuria; (2) inheritance; (3) identification by screening tests and observation, (4) laboratory procedure, (5) diet treatment, (6) problems in parent education, and (7) legislation.

History of Phenylketonuria

In a study of the history of PKU, Centerwall and Centerwall (28) reported that the knowledge of it dates back to the early 1930's to a family in Norway with two retarded children. The mother's efforts to get help for her retarded children and to learn the cause of a peculiar odor which emanated from them sent her from doctor to doctor over a period of years. Finally, a Norwegian physician and biochemist, Dr. Asbjorn Folling became interested. In the process of examining the children, Dr. Folling discovered that the urine of both reacted with ferric chloride to give an unusual green color. This, he proved, was due to the presence of phenylpyruvic acid, which he was able to crystallize in pure form from the urine samples. Centerwall (33), Berry (14), and Gibbs (48), found that some simple ferric chloride urine tests and modifications were the means of case detection among the retarded.

Guthrie (49, McCaman (82), and Shaw (98) agreed that simplified blood tests which measure elevated phenylalanine levels would make early screening for PKU in the newborn period possible. These early studies provided information by which much of the metabolic error was identified and transmitted from parent to child. Penrose (91) suggested the name phenylketonuria because phenylpyruvic acid, the substance responsible for the green color reaction with ferric chloride in the urine, is a phenylketone, and Brecher (19) shortened the name to PKU. To date, this is the preferred name.

As awareness of this newly discovered disorder increased, patients in institutions for the mentally retarded in many countries were tested for PKU. Studies by Jervis (63), Penrose (91), and Brecher (19) reveal prevalence, determinations of type of inheritance, and a fairly complete clinical picture of the untreated disorder.

Inheritance

Incidence and Genetics

Jervis (63) discovered that PKU can be found in 0.5-1.0 percent of institutionalized mentally retarded persons. Jervis's study estimated that PKU occurs once in every 20,000 to 40,000 live births. Armstrong and Low (6) completed a comparison of birth statistics and cases of PKU and discovered over a 10-year period in Utah that the incidence must be somewhat more than 1 in 20,000. Guthrie and Whitney (51) and a report to the 1970 California Legislature on Medical Tests for Newborn Infants (95) suggested according to extensive mass testing of blood phenylalanine levels of newborns in the United States, with the confirmation of diagnoses, that the incidence is closer to 1 in 15,000 live births.

Both sexes are affected and all races appear to be involved. Jervis's (63) research incidence is higher in people of European stock and is particularly low in people of Ashkenozi Jewish and Negro ancestry. PKU has been reported by Krupanidhi and Punekar (77) from India; and Centerwall and Kapur (31), Hindu and Muslim; by Tanaka, Matsunaga, Handa, Murata and Takehara (105) from Japan; and Tu, Chen, Blackwell and Chen (107) from China.

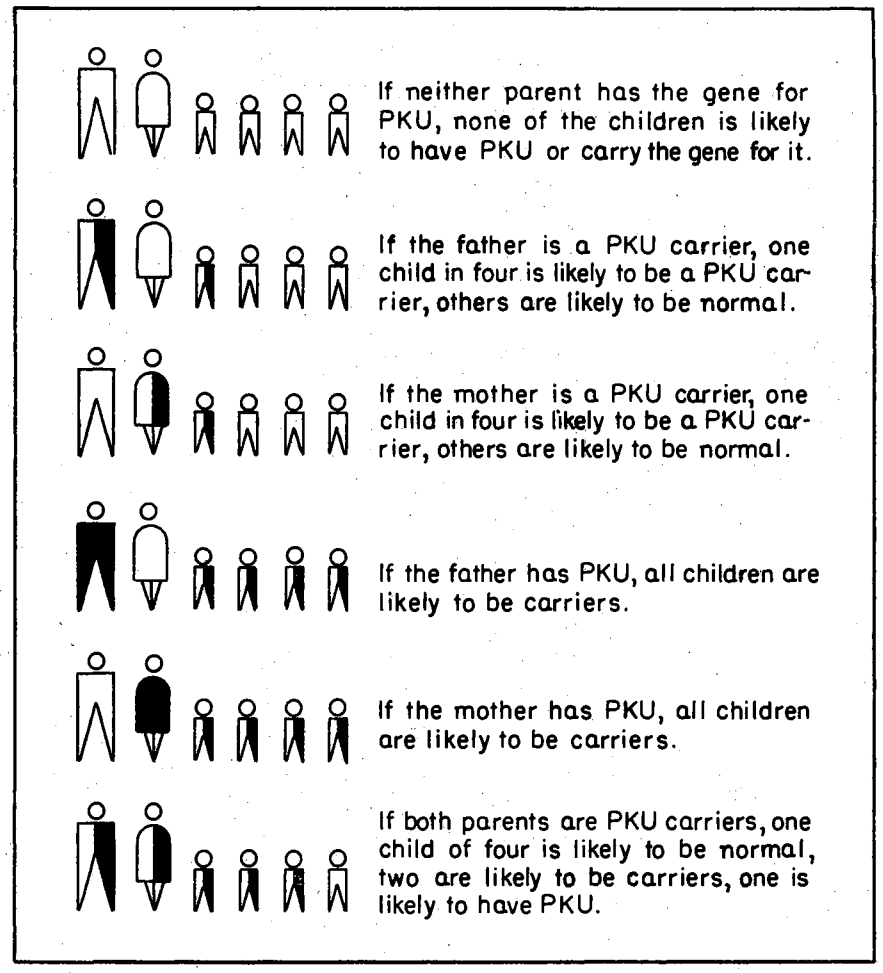
Because PKU often involves more than one child in a family, Folling (45) recognized it from the beginning as a familiar disorder. When it was determined that the parents were clinically normal and that approximately 1 in 4 subsequent children in the involved families had PKU, Jervis (63) and Penrose (91) concluded that PKU was inherited by a simple, autosomal, recessive gene (Figure 1).

An explanation of the inheritance of the disorder is an important part of counseling parents of a child found to have PKU (Figure 2). Parents have a strong desire to know how this happened to them. Counseling helps parents to know that many people carry this gene. Also of importance is for them to understand the chances of having other affected children.

Biochemistry

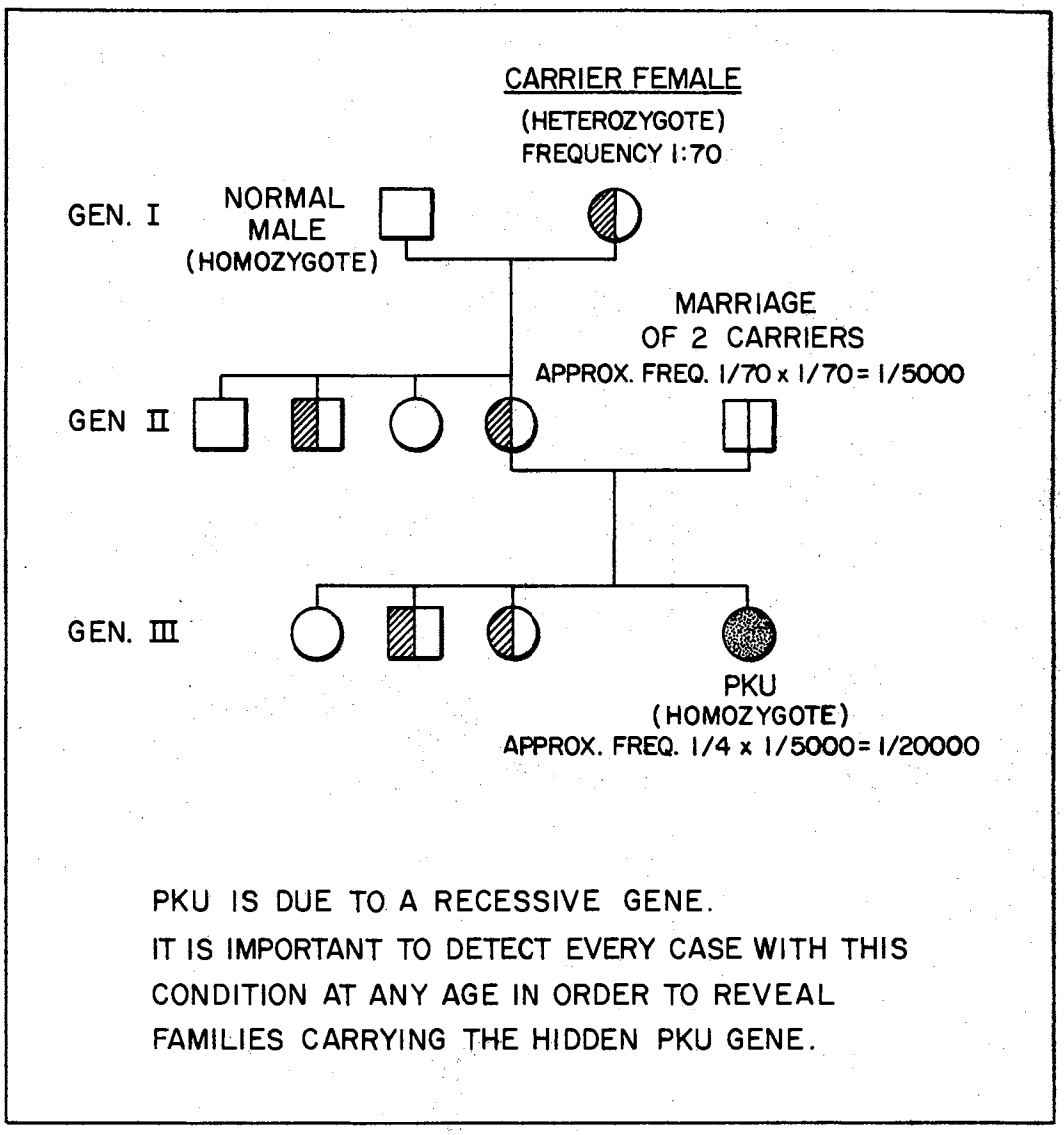
Phenylketonuria is an inborn error of metabolism. The basic defect caused by the PKU gene is in the enzyme phenylalanine hydroxylase, which in the normal individual, according to the research of Jervis (62), Udenfriend and Bessman (108), and Kaufman (69), converts the essential amino acid phenylalanine to tyrosine (Figure 3).

As soon as a newborn baby with PKU begins to take milk (breast



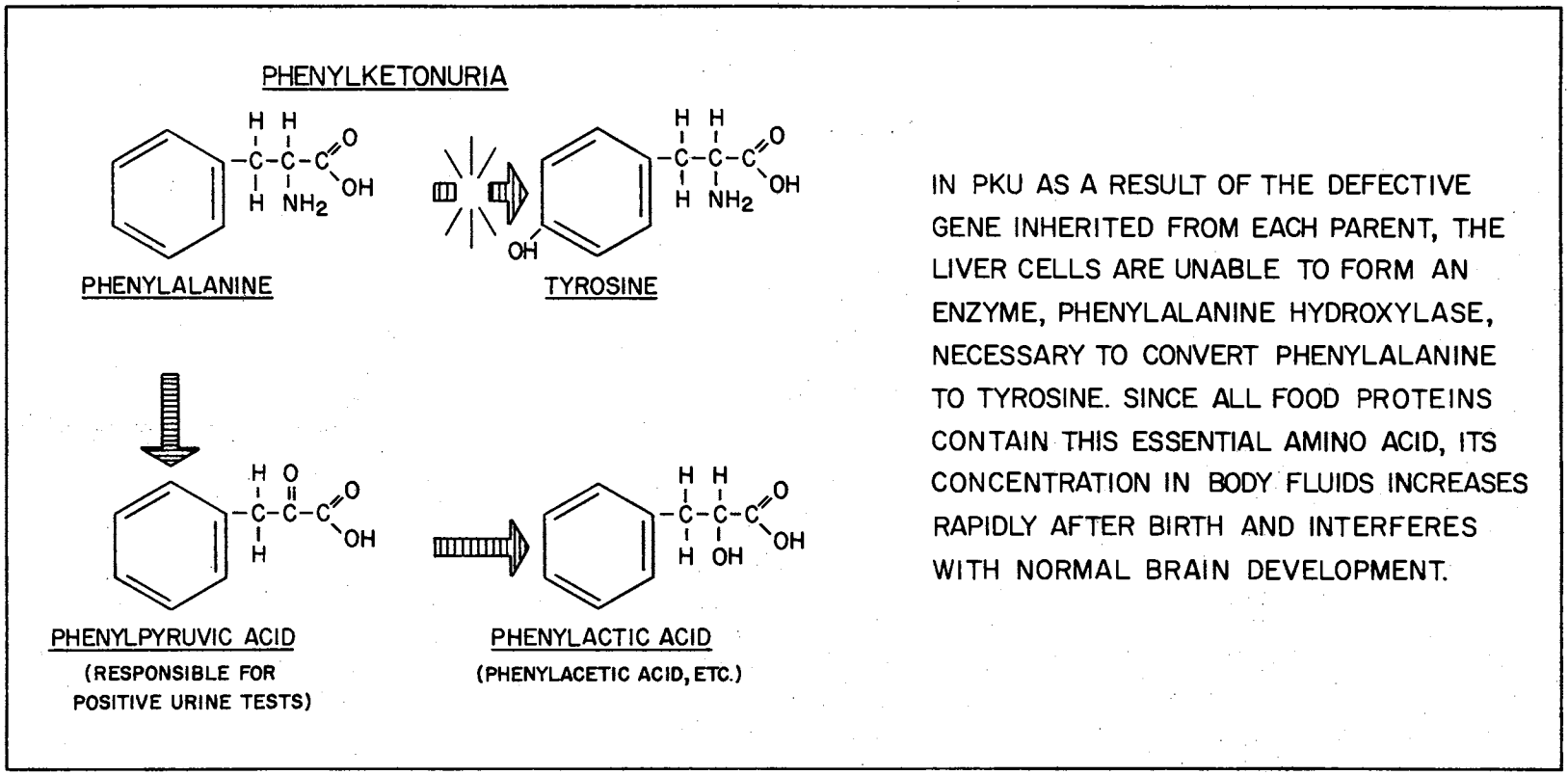
SOURCE: Charles F. Johnson, "Spotlight on a New Kind of PKU," Consultant (Sept., 1971), 68-70.

Figure 1. Heredity and Classic PKU



SOURCE: Robert Guthrie, Ph.D., M.D., "Early PKU Detection in the Hospital - A New Blood Screening Test to Prevent Mental Retardation." New York: University of Buffalo, Department of Pediatrics, Children's Hospital of Buffalo. Adapted from Scientific Exhibit. Presented at the Annual Meeting of the American Public Health Association, Detroit, Michigan, November 13-17, 1961.

Figure 2. What is PKU? (Genetics)



SOURCE: Robert Guthrie, Ph.D., M.D., "Early PKU Detection in the Hospital - A New Blood Screening Test to Prevent Mental Retardation." New York: University of Buffalo, Department of Pediatrics, Children's Hospital of Buffalo. Adapted from Scientific Exhibit. Presented at the Annual Meeting of the American Public Health Association, Detroit, Michigan, November 13-17, 1961.

Figure 3. What is PKU? (Biochemistry)

milk or milk formula) he begins to absorb phenylalanine, which makes up approximately 5 percent of the protein and is utilized in the synthesis of protein and other metabolic products. Blocked in its normal metabolic pathway, the phenylalanine builds up fairly rapidly to a serum level of more than 20 times normal. Armstrong, Centerwall, Horner, Low, and Weil (5) and Horner and Streamer (57) have reported that by the time the infant is one to six weeks of age, by-products of this high serum phenylalanine begin to appear in the urine. It is believed that the continued high level of phenylalanine or its related metabolites is responsible directly or indirectly for the mental retardation. This view is amply confirmed by the studies made by Horner and Streamer (57), Knox (74), and Koch, Acosta, Fishler, Schaeffler and Wahlers (70) and by the fact that PKU infants started on low-phenylalanine diets in the early months of life (so that serum phenylalanine levels remain within the normal or preferably slightly above normal range) have attained normal mental development.

Although the mechanism of the adverse effect of elevated levels of phenylalanine or its abnormal metabolites has not been clarified, some facts are beginning to emerge. Studies by Hanson (53), Davison and Sandler (40), Neame (85), and Pare, Sandler, and Stacey (89) indicate that there is experimental evidence of an active inhibitory effect on enzyme systems in metabolic and transport processes. Pare, Sandler, and Stacey (89) agreed that there appears to be a significant inhibition of serotonin products in untreated patients with PKU which can be normalized under therapeutic dietary control.

Identification by Screening Tests and Observation

Observation

The untreated PKU patient is clinically normal at birth, but begins to show retardation early in life. At three to four months of age, a subtle change may be noticed. The infant begins to lose interest in his surroundings, and thereafter development is slowed down or arrested until by two or three years of age most are in the "below 50 I.Q." range of mental retardation. Jervis's (63) and Paine's (87) studies reported that of the known untreated cases in institutions, approximately ninety percent fall into this bracket. Studies by Knox (74) and Caudle (24) found that rarely will a person with untreated PKU have a normal mentality. The rarity of this has been established by screening of normal populations. Waisman (119) and Levey, Karolkewiez, Houghton, and MacCready (78) found that out of 349,000 persons who were tested in the United States and Europe, none with normal mentality were found to have PKU.

Young children with untreated PKU are usually fairly well-developed physically and have no truly diagnostic stigmata other than the characteristic musty odor. Older children may exhibit slight stunting of height. Some have smaller than average head sizes; a few are severely microcephalic. In a study of the characteristics of PKU children, Paine (87) found that the average age at which untreated PKU children sit alone is 12 to 15 months; their average age for walking is 2½ years; for talking, 3½ years. Some never learn to walk; many never learn to talk. Approximately 80 percent are blonder than their normal

siblings. Behavior patterns are frequently autistic, hyperirritable, and destructive. About 30 percent have abnormal EEG's and approximately 25 percent have convulsions. Convulsions are uncommon after 10 years of age. The more severely involved cases may show signs of upper motor neuron damage such as positive Babinski and ankle clonus. About 25 percent of untreated PKU patients have eczema which is pruritic and not limited to any specific area of the body.

Developing a Screening Program

The Maternal and Child Health Service (94) recommends that all newborn infants be screened for phenylketonuria (PKU). The objective of screening programs is to find affected children at a time when intervention may prevent the ill effects of the disorder, especially mental retardation. The ultimate value of screening programs, however, should be measured in terms of the final outcome of patients placed under treatment or following programs. Follow-up services are an integral part of a total PKU program.

In developing a program for screening newborn infants for PKU, the Committee on Fetus and Newborn of the American Academy of Pediatrics (116) recommended the following points:

(1) A test should be chosen which is of proven efficiency as a screening tool. It should permit simplicity and economy in the collection, storage, and determination of samples.

(2) The testing of the samples should be done by a laboratory with adequate facilities which handles a sufficient volume of samples to maintain skill in recognizing abnormal findings. A system of quality control developed on a statewide or regional basis would insure flexibility of results.

(3) The initial test should be applicable before newborn infants are discharged from the nursery and thereby becomes less accessible.

(4) A follow-up screening test on blood or urine may be desirable at a few weeks of age.

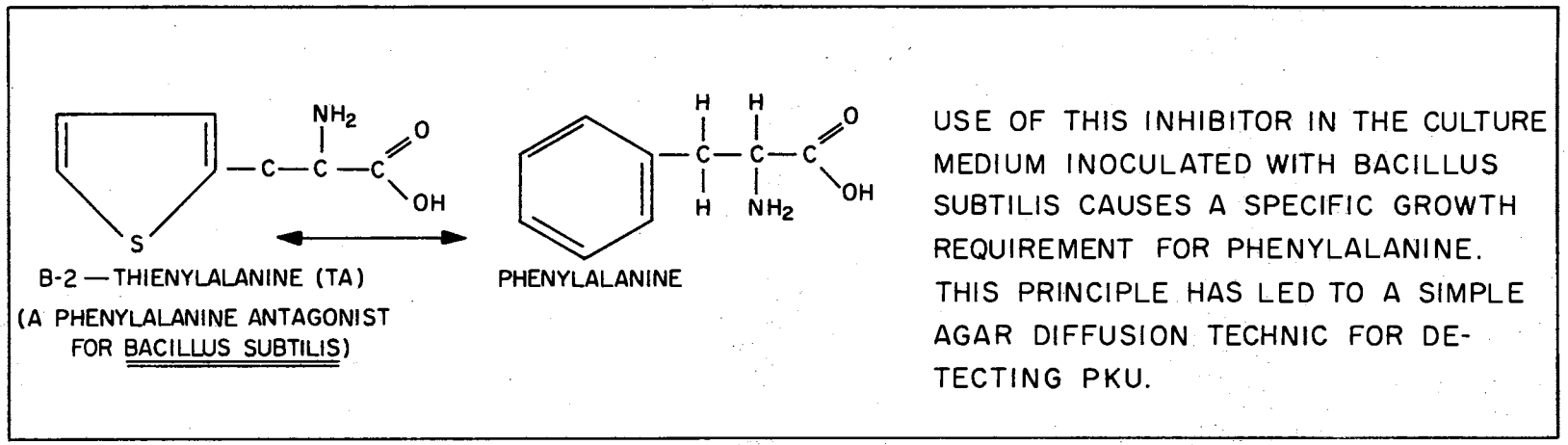
(5) All presumptive positive cases should be checked by a specific confirmatory test for an elevated blood phenylalanine level.

(6) Adequate procedures for referral of infants to evaluation and treatment centers should be an integral part of the program.

Screening Tests

Newborn Infants. In the United States, where most babies are born in hospitals, the inhibition assay blood test by Guthrie (49), Guthrie and Whitney (51), or the fluorimetic blood test by McCaman and Robins (82) is recommended on the third day of life, after adequate dietary intake has been established. These tests are simple, inexpensive, and can be performed in large numbers (Figure 4). Public Health departments in many states have set the example by initiating screening programs for PKU. As late as 1970, 43 of the 50 states had legislation for PKU screening of newborn infants (Appendix D).

Specimens for these blood tests are collected simply by placing drops of blood on a piece of filter paper. In a phenylketonuria baby the blood level of phenylalanine rises rapidly after birth, and blood taken on the third day of life will usually give strong indication for suspicion, but confirmatory tests must be administered. Recommended Guidelines for PKU Programs for the Newborn by the U. S. Department of Health, Education, and Welfare, 1971, (116) states that the great advantage of these methods is the possibility of systematically testing practically all babies.



SOURCE: Robert Guthrie, Ph.D., M.D. "Early PKU Detection in the Hospital - A New Blood Screening Test to Prevent Mental Retardation." New York: University of Buffalo, Department of Pediatrics, Children's Hospital of Buffalo. Adapted from Scientific Exhibit. Presented at the Annual Meeting of the American Public Health Association, Detroit, Michigan, November 13-17, 1961.

Figure 4. An Inhibition Assay for Blood Phenylalanine

Mentally Retarded Populations. Jervis (63) stated that the screening of mentally retarded populations for PKU has been done for many years in many institutions for the retarded whereas, Allen (3) found that in others detection effects were begun more recently. This type of screening usually has been done with a urine test for phenylpyruvic acid, using either the ferric chloride or phenistix test (92). It is unlikely that the intelligence of children picked up by this method can be improved much by dietary control, although modified low-phenylalanine diets are sometimes used to improve the behavior of older PKU children. The U. S. Department of Health, Education, and Welfare (112) reported that diagnosing older children is an important way, however, of detecting parents who are PKU "carriers" and who may still be in the childbearing age range, thus protecting subsequent siblings and other related infants with PKU.

Routine screening is strongly recommended in all institutions and schools or classes for the retarded, both public and private. The success of such programs will depend on many cooperating organizations. The U. S. Department of Health, Education, and Welfare (112) stated that in some situations casefinding may have to be carried systematically into the homes of the families in which an active case has been found.

Centerwall and Centerwall (29) found that in a home survey of the siblings of 20 PKU patients at an institution of 3,000 population uncovered three previously undiagnosed cases. Two of them were still young enough to receive benefit from treatment. On the basis of this experience, several recommendations have been made by Centerwall and Centerwall (25), Jones and Henkin (66), and the Department of Public Health in the State of California (43) for follow-up work with families

of PKU patients:

(1) The families should be carefully oriented and counseled as soon as possible. The orientation should also include an explanatory letter or literature that describes the problem. Information pamphlets for parents are available.

(2) All siblings of PKU patients should be screened as soon as possible, even if the parents do not think they are retarded, and any positive findings followed up with confirmatory testing. Sometimes retardation in young children is unsuspected by the parents.

(3) The families should be alerted to have subsequent babies tested. All newborn siblings should have serum phenylalanine determinations just prior to discharge from the newborn nurseries (at 3 or more days of age). Even if the test is normal, as an extra precaution, it is advisable to do a follow-up blood test between 2 and 4 weeks of age. If blood tests are not immediately available, local or State Health Departments can give advice on sending samples through the mail. As an alternative, the urine should be tested at biweekly intervals during the first 3 months of life.

(4) The families should be encouraged to notify relatives so that they, especially any youngsters, can be tested for PKU.

Other High-Risk Groups. Because of the associated findings of behavior disturbances, convulsions, eczema and cerebral palsy in PKU patients, it is advisable to screen children presenting such problems in

clinics, medical centers, or private practice. The U. S. Department of Health, Education, and Welfare (112) reported that urine tests are useful but blood tests are preferred when available.

In addition, mothers of retarded children should be screened. Studies by Mabry, Denniston, Nelson and Son (81) and Frankenburg, Duncan, Coffelt, Koch, Coldwell, and Son (46) reveal that maternal PKU has been reported as a cause of mental retardation in non-PKU offspring, presumably due to the damaging effect of the mother's high phenylalanine blood levels on the unborn baby.

Follow-up of Screening

Phenylketonuria has serious and long-term implications for both the individual and the family with regard to hereditary aspects of the disease and the dietary treatment when this is indicated. The U. S. Department of Health, Education, and Welfare (112) stated that it is of great importance that screening programs have an adequate follow-up plan for verification of the diagnosis and to provide treatment for the child and counseling to the family.

Koch, Shaw, Acosta, Fishler, Schaeffler, Wenz, and Wohlers (72) agreed that experience has shown that confirmation of the diagnosis of PKU can be complicated in the newborn screening programs. In the initial screening of newborns, out of many tens of thousands tested in each state, several hundred are found to have a positive screening test (blood phenylalanine level of 4 mg. percent or above). On each of these infants, the blood screening test is repeated as soon as is feasible. On this second test, the great majority drop into the normal range, leaving around 10 per 10,000 screened who are still testing above 4 mg.

percent. Only about a half dozen of these will have classical PKU. Anderson and Swaiman (4) found that the rest have elevated blood phenylalanine due to other conditions. The program must be prepared to give adequate testing and follow-up to all of these children until a definite diagnosis is reached.

Shaw, Gutenstein, Jacobs, and Blaskovics (99) agreed that the classical PKU patient is identified by the relatively high phenylalanine and normal tyrosine levels in the blood following the intake of milk, and by a prolonged high rise in blood phenylalanine and the usual subsequent spillage of phenylpyruvic acid and large amounts of orthohydroxy-phenyl-acetic acid in the urine.

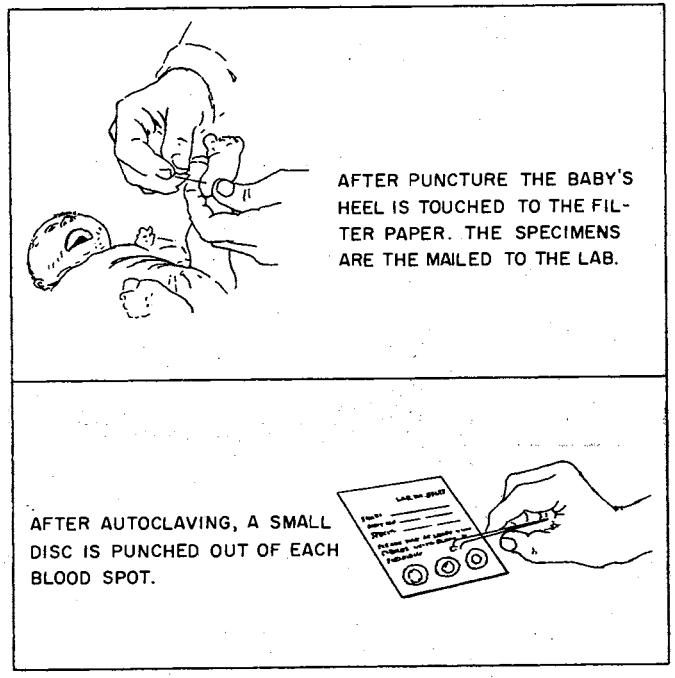
Blaskovics, Shaw, Donnell, and Koch (18) agreed that if a urine test has been the means of identifying a child as possibly having PKU (by a positive ferric chloride or similar test), it is mandatory that a blood test be done to confirm the diagnosis. At present it is advised that only children with classical PKU be kept on a fully restricted low-phenylalanine diet.

Laboratory Procedures

Blood Tests for Phenylalanine

Centerwall (33) and Jervis (63) reported that the most widely used screening test for PKU among newborn infants is the inhibition assay method of determining phenylalanine in the blood. Only a small amount of blood is needed, which can be obtained easily by heel puncture and collected on a filter paper (Figure 5).

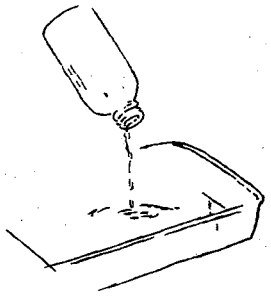
McCaman and Robins (82) found that another test utilized for screening by many laboratories is based upon enhancement of the



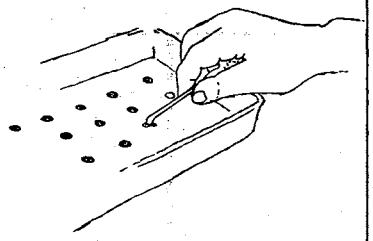
AFTER PUNCTURE THE BABY'S HEEL IS TOUCHED TO THE FILTER PAPER. THE SPECIMENS ARE THE MAILED TO THE LAB.

AFTER AUTOCLAVING, A SMALL DISC IS PUNCHED OUT OF EACH BLOOD SPOT.

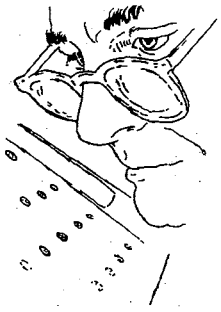
SOURCE: Robert Guthrie, Ph.D., M.D. "Early PKU Detection in the Hospital - A New Blood Screening Test to Prevent Mental Retardation." New York: University of Buffalo, Department of Pediatrics, Children's Hospital of Buffalo. Adapted from Scientific Exhibit. Presented at the Annual Meeting of the American Public Health Association, Detroit, Michigan, November 13-17, 1961.



THE MELTED AGAR CULTURE MEDIUM, CONTAINING THE PHENYLALANINE ANTAGONIST B-2 THIENYLALANINE, IS INOCULATED WITH BACILLUS SUBTILIS SPORES, POURED INTO FLAT DISHES AND ALLOWED TO SOLIDIFY.



THE BLOOD PAPER DISC FROM 100 PATIENTS, IN ADDITION TO 7 CONTROL DISCS, ARE PLACED UPON THE AGAR SURFACE IN ROWS, AND AFTER OVERNITE INCUBATION, THE RESULTS ARE OBSERVED.



AN INDICATION OF PKU IS A BLOOD DISC PRODUCING A GROWTH HALO CORRESPONDING TO ANY ONE OF THE FIVE HIGHEST CONTROL DISCS. THIS INDICATION IS THEN CONFIRMED BY A QUANTITATIVE BLOOD DETERMINATION.

Figure 5. Test Method

fluorescence of a phenylalanine-ninhydrin reaction product by a peptide, leucylalanine. This method is inexpensive and requires as little as five microliters of serum. It is a fluorometric method which can be performed in most laboratories with accuracy. Hill, Summer, Pender, and Roszel (55) found that microadaption of this procedure has been developed for use with an autoanalyzer, facilitating ease of determination considerably. Earlier methods of determining serum phenylalanine required from 2 to 5 cc. of blood and, thus, were not suitable for mass screening of small babies. The newer procedures are simple and inexpensive and can be performed in large numbers. The blood spots on filter paper can be sent through the mails for analysis in a centralized laboratory, a blood-saturated filter paper can remain at room temperature for several weeks without significantly affecting the test results.

Confirmatory Tests. Quantitative serum phenylalanine determinations are used for confirmation of the diagnosis of PKU in cases seemingly positive by screening blood tests or urine studies. Hsia, Driscoll, Troll, and Knox (58) reported that these tests have the quantitative precision necessary for research, such as in studies of the "carrier" state by phenylalanine tolerance tests. Berry (13) stated that blood paper chromatography is simple, and the accuracy, though somewhat lower than that of the others, is adequate for diagnosis and dietary control. Shaw and Gortatowski (98) reported that urine paper chromatography also can be utilized for confirmatory purposes.

Urine Tests for PKU

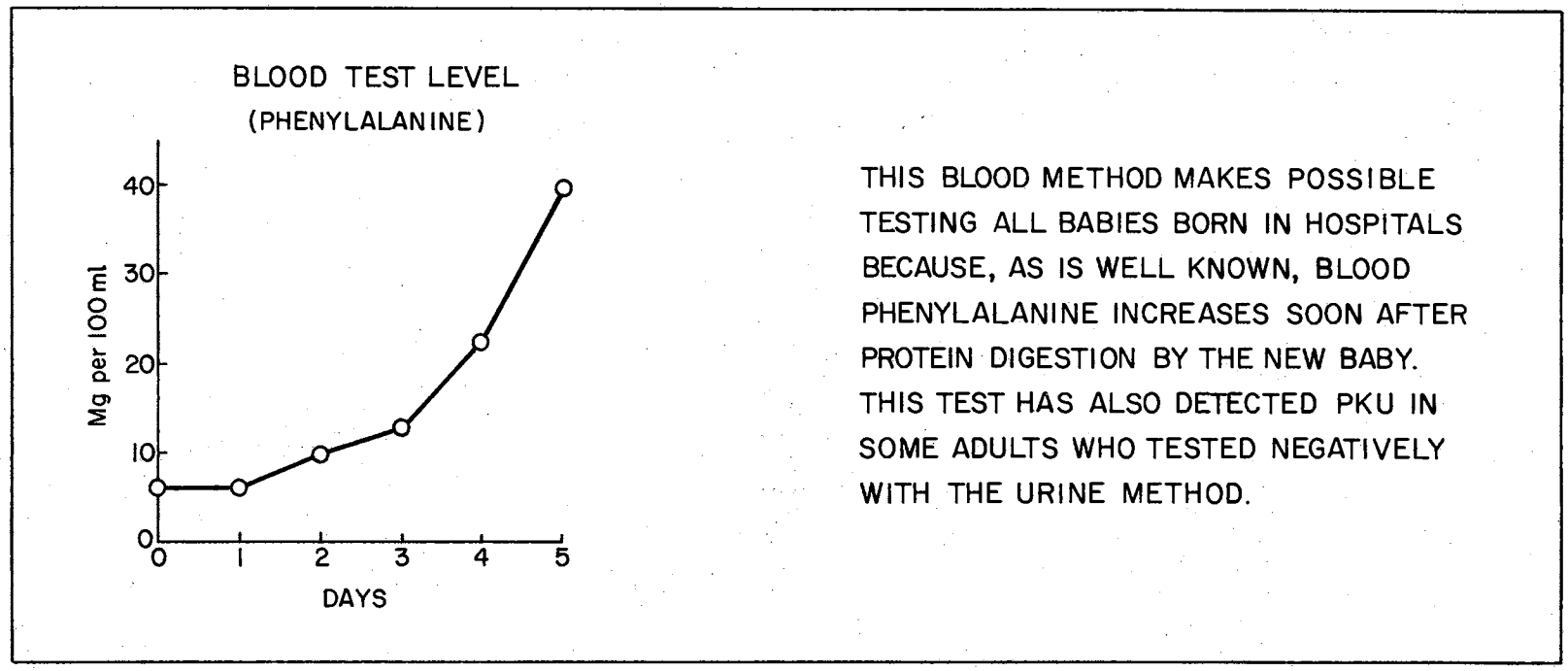
Centerwall and Centerwall (28) reported that historically urine tests preceded other methods in the diagnosis of PKU. They still

provide a good method of testing for PKU on occasions or places when more sophisticated laboratory analysis is not available. Frankenburg, Duncan, Coffelt, Koch, Coldwell and Son (46) agreed that demonstration of metabolites in the urine which can be done by these tests, is still a useful method of helping to confirm the diagnosis of most cases of classical PKU. Centerwall, Chinnock, and Pusavat (30) reported that when variables affecting the reliability of urine tests for PKU were tested, the most important variable which affected all tests was the freshness of the urine sample. Unless the urine has been frozen or a preservative such as thymal crystals added, it should be freshly voided for accurate results.

Other factors which influence the intensity of the reaction are the concentration of metabolites in the urine, which is related to the serum phenylalanine level and the diluteness of the urine--which in turn are influenced by protein and fluid intake. Variation in blood levels from time to time in the same patient may cause occasional negative tests in a PKU patient. Also as PKU children grow older, blood phenylalanine levels usually become lower compared to infant values. All this explains why a blood test for phenylalanine is now the screening test of choice (Figure 6).

Ferric Chloride Tests

According to the studies of Folling (45) and Centerwall, Chinnock and Pusavat (30) the ferric chloride is the oldest, best known, and most widely used of any of the urine tests for PKU. The color reaction of ferric chloride with phenylpyruvic acid is highly distinctive. When ferric chloride is added to an acidified PKU urine, immediately there



SOURCE: Robert Guthrie, Ph.D., M.D. "Early PKU Detection in the Hospital - A New Blood Screening Test to Prevent Mental Retardation." New York: University of Buffalo, Department of Pediatrics, Children's Hospital of Buffalo. Adapted from Scientific Exhibit. Presented at the Annual Meeting of the American Public Health Association, Detroit, Michigan, November 13-17, 1961.

Figure 6. Phenylketonuria Without Phenylketone Detectable in the Urine

is a medium-dark, blue-green to gray-green color which fades in a matter of seconds or minutes, depending upon the concentration of the phenylpyruvic acid in the urine and the strength of the ferric chloride solution being used.

The ferric chloride solution is very inexpensive and, when made with distilled water and stored in polyethylene bottles, it is stable indefinitely; it has a clear, yellow-orange appearance. A 10 percent solution is preferred because of its quick, intense color reaction. This is the preferred reagent for urine testing.

Urine collection from infants often is not easy and, thus, the "diaper test" was devised as a modification of the ferric chloride test-tube test. A drop of 10 percent ferric chloride is placed on a baby's wet diaper (or even if the diaper has dried since being wet), and a blue-green to gray-green color appears immediately if phenylpyruvic acid is present.

Phenistix. Centerwall, Chinnock, and Pusavat (30) have reported that another modification of the ferric chloride test is the phenistix (92) dipstick, a paper strip which is impregnated with a buffered ferric salt. This reagent, according to a recent study by Shaw, Gutenstein, Jacobs, and Blaskovics (99), is less sensitive than ferric chloride in the detection of phenylpyruvic acid. This is especially convenient for use in the home by the parents of phenylketonuria patients.

In summary, urine screening procedures have not proved to be effective or efficient for detection of PKU in newborn infants. Urine tests have been used widely for screening of older infants and children, and such testing should be continued as an effective and inexpensive check on the newborn blood-screening programs. A blood-screening

procedure for newborn infants complemented by urine screening at appropriate times with appropriate age groups appears at this time to be the ideal program.

Dietary Treatment

Bickel, Gerrard, and Hickmans (17); Woolf, Griffiths, and Moncrieff (121); and Armstrong and Tyler (8) have reported that dietary treatment for PKU was first described in the early 1950's and was being reported as successful by many medical centers. Hundreds of children throughout the world are now on dietary treatment for PKU. When the diet is started in the first several months of life (the earlier the better), mental retardation is usually prevented. The rate and irreversibility of the deterioration are somewhat variable; however, it is generally felt that the diet should be tried on all children under three years of age and that many of these may be significantly improved. The cases of children above three years of age have to be considered individually. It is felt by some workers in this field that older PKU children who are only mildly retarded or who have marked behavioral or convulsive disorders are more likely to show benefit from diet management than others in the same age group.

While on the special diet, the PKU child must be under a doctor's care. This is to assure the maintenance of optimal levels of phenylalanine, low enough to give maximum benefit to the child's mentality and high enough to prevent dietary deficiency. The physical growth and mental development of the individual child is the real test of whether the diet is the best one for that child. Therefore, it is particularly important to have regular height, weight, and head circumference

measurements plotted on a standard growth curve. Psychological testing is also advisable at yearly intervals. A normal disposition is another helpful sign of a well-controlled PKU child. If the mother is giving too much phenylalanine, the child may become irritable, and mental development will be retarded. An EEG on an uncontrolled child may show an abnormal irregular spiking pattern. Berry, Hunt, and Sutherland (12) reported that failure to grow as expected or loss of weight probably indicates that the phenylalanine in the diet or other essential amino acids and possible calories have been kept below basic minimum requirements. An adequate intake of Lofenalac (79), a synthetic food made in this country for PKU patients, is particularly important because it supplies over 80 percent of the proteins in the diet. In the extreme situation, when a child is sick or is refusing to eat, there may be a breakdown of body tissue protein and the blood will show a paradoxical rise in phenylalanine.

The purpose of the diet is to lower the blood phenylalanine from the abnormally high levels caused by the disorder to nearer the normal levels. Because all proteins in normally available foods contain five to six percent phenylalanine, it is impossible to devise a diet from natural foods that will lower the phenylalanine level and still provide sufficient protein for growth and repair. Therefore, all low-phenylalanine diets are based on synthetic foods which provide amino acids but little phenylalanine. Most of these synthetic foods have been made from a modified casein hydrolysate. Several products have been available commercially in the United States, Europe, and Asia (79). Rose, Leach, Coon, and Lambert (96) reported that these special products are so low in phenylalanine that if given by themselves they would

produce a phenylalanine deficiency. In the studies made by Snyderman, Pratt, Cheung, Norton, Holt, Hansen, and Panos (101), they pointed out that phenylalanine is an essential amino acid, and the body requires a certain minimal daily amount. Paine and Hsia (88) found that an opportunity is, thus, provided to varying the diet by the addition of low-protein vegetables and fruits--with the goal of maintaining a serum level of from 3 to 8 mg. of phenylalanine per 100 ml. of serum. This range, a little above normal values of 1-2 mg., is relatively easy to maintain and more likely to avoid deficiency complications while still promoting optimal mental development. How high the phenylalanine can be kept and optimal results still be obtained has not been determined; the level may not be the same for all PKU children nor the same throughout infancy and early childhood (37). No unanimity exists as to the correct range, e.g., some investigators feel that anything below 5 mg. is too low while some believe anything above 6 mg. is too high. Keeping levels between 3 and 8 mg. would seem to be a compromise consistent with the majority opinion to date.

Armstrong and Tyler (8) reported from their investigation that the serum level of phenylalanine at which phenylpyruvic acid will begin to appear in the urine is usually between 10 and 15 mg. per 100 ml. Urine tests are, thus, inadequate as effective checks of dietary control. There is a need for periodic serum phenylalanine determinations. It is advised that these serum levels be obtained at intervals not less than every four weeks while a child is on the low-phenylalanine diet and more frequently during the early months of control. The serum levels are necessary to detect both excesses and deficiencies of phenylalanine so the diet can be adjusted accordingly. Shaw and Gortatowski (98) stated

that periodic paper chromatography studies of the urine may also indicate inadequate protein intake by revealing a moderate generalized aminoaciduria.

Any physician who starts and supervises this diet must be prepared to spend extra time with the family. Public health nurses, nutritionists, and social workers are valuable assistants in working with the family. From the studies made by Umbarger (109); Shaw, Koch, Schild, Ragsdale, Fishler, and Acosta (100); Schild (97); and Koch, Fishler, Schild, and Ragsdale (71); it was agreed that conscientious, continued follow-up guidance and counseling are essential for long-range success of the program.

Benefits of the diet on the mind of an already somewhat retarded older PKU infant or young child may not begin to be obvious until after many months on the diet. Koch, Fishler, Schild, and Ragsdale (71) agreed that at least a one-year trial is suggested before a decision is made to discontinue the diet.

The length of time that a child should be kept on the diet to obtain optimal and permanent benefit has been the subject of much interesting discussion. In the natural course of the disorder, it seems that deterioration is less obvious beyond three years of age, and this has been quoted as the age after which the special diet may not be necessary. The issue has been confused by the fact that some PKU children who were not treated until after three years have shown good improvement. Hackney, Hanley, Davidson, and Lindsao (52) and Kang, Sallee, and Gerald (67) stated that at the present time, scattered experiences are indicating that some, but not all, children over five years are maintaining their I.Q.'s off the diet. However, since it seems to be

true that the adverse personality effects of phenylketonuria are also responsive to the low phenylalanine diet, it will be interesting to see whether this will be a factor in the duration of treatment. Koch, Fishler, Schild, and Ragsdale (71) and Bickel (16) believe that discontinuance of the diet should occur in adolescence rather than at 3-5 years of age. There is evidence suggesting that pregnant female phenylketonurics should be on a low-phenylalanine diet during the entire pregnancy. Mabry, Denniston, Nelson, and Son (81) and Frankenburg, Duncan, Coffelt, Koch, Coldwell, and Son (46) reported that from studies of retarded children being born to PKU mothers elevated maternal serum phenylalanine causes fetal damage in utero. Yu and O'Halloran (122) reported that in the few reports of women with PKU producing normal children, the actual I.Q. data is lacking. It will take a few more years to be certain of the long-term effects of diet treatment on both mentality and personality.

The Low Phenylalanine Diet

In the United States, experience to date with low phenylalanine diets has largely involved use of Lofenalac (79), a synthetic food made in this country by Mead Johnson and Company, for PKU patients. Lofenalac has fat, carbohydrate, and certain minerals and vitamins incorporated with the low-phenylalanine casein hydrolysate. One measure, a tablespoon, of Lofenalac powder has approximately 1½ gm. of protein equivalent, with 7½ mg. of phenylalanine. One measure added to 2 ounces of water makes a 20-calories-to-the-ounce formula which has almost the same consistency, appearance, and components as milk minus 90 percent of its phenylalanine. It has a nut-like flavor which has

been well-accepted by almost all patients, especially when introduced early in life. Most of the children have taken it as a beverage, either standard strength or somewhat concentrated. Several have preferred it mixed directly into their low-protein foods. Acosta and Centerwall (1) and Lyman and Lyman (80) stated that the powder can also be utilized in special low-phenylalanine recipes for pastries, breads, puddings, ice creams, and sauces. Realization on the part of the mother or others responsible for feeding the child of how the diet can be varied and still meet the child's needs will lead to easier control and success with the diet.

In the early months of life, the baby's low-phenylalanine formula should be supplemented with a small quantity of milk. As the baby grows older, all varieties of fruits and certain low-protein vegetables are added, i.e., carrots, beets, string beans, squash, turnips, tomatoes, etc. These low-protein foods then continue to form the basis of the food supplements. Later, depending on the amount of phenylalanine allowed and the child's preferences, two or three small servings of cereal, potato, or cookies may be added to the daily menu. The mineral and vitamin supplements in Lofenalac are adequate for most youngsters. Several sample diets for infants and young children are given in Appendix F (Table XIV).

Centerwall, Centerwall, Acosta, and Chinnock (26) reported that infants one year of age need approximately one measure, a tablespoon, of Lofenalac per pound of body weight each day. This will be the main source of protein. For younger infants the need is proportionately greater, and for older children, it is proportionately less. This general rule is outlined more graphically in (Table I, p. 47) along

with a guide to average daily calorie and phenylalanine requirements. It is important to recognize that these are only general guides and that the individual child should be given as much Lofenalac and natural foods as he seems to need and tolerate.

Acosta and Centerwall (1) and Lyman and Lyman (80) agree that one way of helping parents is to provide them with the food lists and special recipes that have been devised for low-phenylalanine diets. The food lists show the quantities of food that provide specific amounts of phenylalanine. By substituting a variety of foods, the parents can easily vary the diet and still keep within the prescribed amount of phenylalanine.

Not every child will take to a low-phenylalanine diet without difficulty. Depending on his personality, the older the child is, the more he will miss his previous diet, and the more resistance he will put up to the new diet. Hsia, Knox, Quinn, and Paine (59) and Dodge, Mancall, Crawford, Knapp, and Paine (44) stated that with proper management and control, the difficulties that were encountered with older low-phenylalanine mixtures, i.e., diarrhea, starvation, severe weight loss, hypoglycemia, anemia and convulsions, have not been a problem. Within a week, even two and three year olds have been drinking Lofenalac and liking it--and without the use of special flavoring or sweetening. (Tables X, XI, XII, XIII, and XIV of dietary requirements and goods for the low-phenylalanine diet are included in Appendix F.)

Umbarger (109) asserted that hospitalization to initiate the diet is not usually necessary and, except in special circumstances, may not be desirable.

Summary

The mental retardation associated with PKU can be prevented or favorably modified if a special low-phenylalanine diet is started early in life. Those concerned with child health are forced with the challenge of finding these children during early infancy. The identification of the retarded child with PKU is of importance at any age, however, because the family can then be alerted to the possibility of this condition in a younger sibling who could be treated; they can also be given genetic counseling about the possibility of PKU in future children. The tests used in screening and diagnosing PKU have been described (Appendix E). It is suggested that all children under three years of age discovered to have PKU should be given a trial of treatment. Some, but not all, children on the low-phenylalanine diet from early infancy have continued to do well when the diet was discontinued after four or five years of age. It has not yet been established with certainty how long the special diet will be necessary in every situation. The actual upper limit for the serum phenylalanine level which will permit normal development is unknown, but it is suggested that levels within the range of 3 to 8 mg. per 100 ml. are safe and satisfactory.

Problems of Parent Education

Averbach, Newbauer, and Langer (9) reported that since the family of the PKU child is responsible for the implement of the diet, parent education is the key to the clinical control of this condition. The predominant method of parent education regarding dietary instructions and guidance in the daily management of the child has been largely

through individualized, information-giving consultations with the pediatrician at the clinic and with a public health nurse in the home of the family.

Family planning is an area of grave concern to young parents. When contraception is not acceptable on religious grounds, counseling from the religious adviser based on information from the physician may be helpful.

Other problems faced by these families are the financial ones posed by the constant need for dietary supplement, medical and psychological supervision, and frequent laboratory procedures. In some states, the Children Services will provide the diet and assist with medical costs when the family is unable to meet them. The U. S. Department of Health, Education, and Welfare (118) reported that the untreated child will cost his state more for institutional care than for the financial assistance required to treat the child in the community.

Schild (97) reported that parents of phenylketonuric children have many fears: of producing children who might continue to add to the perpetuation of a defective gene; of becoming impatient with the constant self-discipline required to maintain the rigid diet consistently; and of being inadequate to the ongoing task and unable to cope with the children as they grow older.

Schild (97) stated that another problem is the parents' inadequacy in the area of child-rearing practices. Confusion, uncertainty, and inconsistency governed the parental management of the children in most families of PKU children. The homes are generally child-centered with the parents more often than not manipulated by the children. Consequently, when faced with the difficult task of putting a restrictive

dietary regimen into effect, the parents have to take on a new role orientation and become stricter, more consistent disciplinarians.

Inner conflicts may be precipitated in some parents by this necessity to perform in a new and different way. Unresolved conflicts of their own parent-child relationships may be reactivated. Alongside this new stress is the feeling of guilt inherent in the genetic aspect of the problem, which tends to reinforce defense mechanisms of overprotection and denial. Depriving the child of desired foods adds further to the guilt feelings and heightens the difficulties in maintaining firm limits on the child's behavior and diet. Adams (2) points to the need for normal siblings to be included in parent conferences, and that they be allowed to participate in the helping process.

Family Attitudes and the Low-Phenylalanine Diet

Treatment of the child with phenylketonuria by a restrictive diet regimen has important implications for the health of the child. Schild (97) reported that eating is the child's earliest emotional contact and quickly equated with parental love and attention, particularly that of the mother. Very often, eating becomes the center of many problems of infants and children as they attempt to resolve difficulties engendered by parental inner conflicts, attitudes, and management directed around feeding. When certain food is withheld, the child is faced with learning new eating habits and patterns. The heightened parental anxiety and concerns about what the child eats is easily transmitted to the child. Koch and Acosta (73) states that feeding can be an anxiety-inducing situation, creating further tensions in the parent-child relationship.

The restrictive diet can be equally stressful for parents whose

attitudes towards feeding reflect their own experiences and feelings about food and who have their own ideas of what and how their child should eat. The parent must guard against oversolicitousness and overemphasis on the diet, learn to withhold food from the child without feeling punitive, and must not use the diet as a weapon in dealing out other aspects of the parent-child relationship. Koch and Acosta (73) emphasized that the diet must not be allowed to dominate the family functioning completely or to a large degree, or it may affect the mental health of the family unit.

Parents need help in understanding their own attitudes about food and special diets. These feelings are often projected onto the child and interfere with successful maintenance of the diet. Knox (74) reported that an understanding of the disease process dictating the dietary treatment is basic so that the parents have a sound rationale to adhere to the diet, and are realistic as to results obtainable for their child by virtue of the treatment.

Parents of newborn PKU children progress and are highly motivated to keep their babies on the diet, particularly if there is an older PKU child who was not diagnosed early. According to the studies of Horner and Streamer (57), when the diagnosis of phenylketonuria is made from 10 months of age and up, parents struggle with the shifting food patterns, and their strong feelings that they are depriving their children of normal satisfactions. Almost every one of the families under care have reported problems with the child "sneaking" food. The parents need to be given considerable support that some dietary breaks will occur through no fault of their own as the child becomes more autonomous in his behavior.

The problem of diet supervision imposes much strain on the parent-child relationship. Occasionally in an effort to attain some relief, the parents tend to place or shift too much responsibility on the normal siblings, creating problems in sibling relationships. Parents require much help in understanding how the normal child uses food as an attention getting device, as a manipulative maneuver, or as a method of testing the affection of the parent. Schild (97) emphasized that the parents of phenylketonuric children have to learn to discriminate the appropriate developmental behavior around food from behavior related to actual physiologic hunger, so as to learn what behavior is and is not due to the restrictions of the low-phenylalanine diet.

Shaw, Koch, Schild, Ragsdale, Fishler, and Acosta (100) agree that in terms of the PKU child, it can be generally said that if sound child rearing practices exist in the family and if the child is well disciplined, there will be reasonably little difficulty with the dietary regimen over a long period of time. Schild (97) reported that the diet is established in such a way that the child learns to use food as one way of dealing out his emotional frustrations and problems, there will be continual difficulty in maintaining adequate dietary control.

Nursing Assistance to the Family

The U. S. Department of Health, Education, and Welfare (110) stated that the task of the public health nurse is to assist the family of the PKU child to translate the evaluation and recommendations of the physician into effective management of both diet and child. Ragsdale and Koch (93) agreed that the nurse should seek to reinforce the teaching of the nature of the disorder, to assist the family to provide good

health care, and to assist the family to integrate the PKU child into their usual pattern of living.

Family members must have a good understanding of the nature of the disorder and resolve some of their feelings about it before undertaking dietary management. Shaw, Koch, Schild, Ragsdale, Fishler, and Acosta (100) agreed that the nurse's work with the family often begins with further interpretation, particularly of the hereditary aspects. Although the parents may receive the most careful counseling in the medical setting, they are anxious and frequently fail to absorb what they were taught or they misinterpret the information. Requesting the parents to review their understanding of the problem will often elicit the areas needing clarification. Parental anxieties must be supported until they are comfortable in discussing the problem. Until they are comfortable, they cannot be receptive to further teaching. It may help to clarify thinking if the nurse can interpret the fact that the child's problem is a liver problem, not a problem of a congenital malformation of the brain. The slow development is the result of the metabolic problem, not the cause. Acosta and Centerwall (1) believe that the management of the problem of phenylketonuria is a parental responsibility which in time is passed on to the phenylketonuric individual himself. The nurse should guide the parents to shift the responsibility for dietary control to the child as he is able to assume part or all of the responsibility. The very young child should first learn that parental authority is final. He can then be taught to refrain from snitching, to refuse foods from other than parental sources, to learn the foods permitted on the diet, and finally, to calculate and prepare his own meals. Successful management by the parents and by the patient is

related to the help given to the total family at the time of diagnosis and in the ongoing professional supervision. The total family can utilize help with this difficult problem to learn and mature. The end product of a healthy, productive, self-disciplined adult is well worth the efforts of parents and professional personnel.

Legislation

The Federal Government has only recently begun to assume an activist role in conduct of medical programs affecting the general public. Legislation has been enacted in a large number of states to screen newborn infants for phenylketonuria. Anderson and Swaiman (4) reported that the general public, and most of the medical profession were led to believe the screening tests for hyperphenylalaninemia are tests for phenylketonuria. This is not true. A great deal of impetus for the passage of legislation came from preliminary medical data which indicated favorable effects of the low phenylalanine diet.

Guthrie (49), a member of the Public Health Committee of the National Association of Retarded Children, advised Parents' Association to the type of legislation they should press. A number of the laws that were passed in the states almost coincided with the type of law that was recommended by the National Association of Retarded Children. This recommendation was that it would be extremely desirable that the law would leave decisions concerning all regulations involved to the State Health Department, such as the type of specimen to be collected, the test that was to be carried out, and what laboratories were to be approved.

The U. S. Department of Health, Education, and Welfare (116)

reported that there was not treatment prescribed in the law. The laws included the provision that parents could refuse testing of their child on the basis of their conscience or religious grounds. The effect was that the laws compel the collection of a specimen. The details concerning the specimen are left up to the State Health Department.

Mandatory Testing Laws

Statutes making the screening of newborn infants for phenylketonuria mandatory now exist in 27 states (Appendix D). The majority of these laws were passed during the 1965 legislative sessions of these states.

A survey in March, 1965 by the Children's Bureau, Welfare Administration, Department of Health, Education, and Welfare, found that more than 2600 hospitals in the country were having newborn babies tested for PKU, using the blood test devised by Robert Guthrie, M.D., of Children's Hospital, Buffalo, N. Y. An estimated $1 million in Children's Bureau funds is currently being used by the various states for screening newborns and for treating infants found to have PKU.

States with mandatory screening statutes are: Alabama, Alaska, California, Colorado, Connecticut, Hawaii, Idaho, Illinois, Kansas, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Montana, New Hampshire, New York, Ohio, Pennsylvania, Rhode Island, South Carolina, Texas, and Utah. States with statutes encouraging screening are: Florida, Indiana, Iowa, New Jersey, Oklahoma, Oregon, and West Virginia.

Oklahoma's PKU Program. A routine testing program to check for PKU in newborn infants was enacted in 1965 by the Oklahoma legislature

and is administered by the State Health Department (Appendix D). As a result, ten cases of PKU have been diagnosed since its enactment.

Oklahoma's law is not mandatory, but defines the testing as being "public policy." The Oklahoma Medical Association leadership, at the time the legislature was considering the bill, argued that a physician who did not order such tests would be open to lawsuits for disregarding "public policy."

Thirty-six states (excluding Oklahoma) have now enacted laws specifying testing of newborns for PKU (Appendix D). In addition, one attempt was made in 1965 to pass a federal law making PKU testing mandatory throughout the United States. Medical World News reported that recently, under one program, tests were made on more than 400,000 babies in one year. The cost: about $200,000, only twice what it takes to care for a single institutionalized PKU patient in his lifetime.

Summary

A review of the literature indicated that specific data concerning PKU has been established: (1) Phenylketonuria (PKU) previously known as phenylpyruvic Oligophrenia, is now recognized to be an "Inborn Error of Metabolism" almost invariably associated with severe mental retardation. It was first described in 1934 by the Norwegian biochemist Asbjorn Folling, in Oslo. (2) Investigations of the last ten years have demonstrated that in PKU the liver enzyme phenylalanine-hydroxylase is either absent or reduced in its activity to 7-10 percent of the norm. Due to this enzymatic defect phenylalanine, an essential amino-acid present in all food proteins, is not oxodized to tyrasine.

It accumulates in blood and spinal fluid, possibly also in the brain, and is excreted in the urine as phenylpyruvic acid. Phenylpyruvic acid gives the blue color reaction with ferric chloride. (3) The consensus is that in the majority of cases, mental retardation can be prevented when phenylketonuria children are placed on the phenylalanine-free or phenylalanine-restricted diet in early infancy. (4) PKU is only one of a number of metabolic disorders, and knowing how to deal with PKU gives clues as to how to treat the other disorders. (5) Literature leads one to believe that eventually all babies will be given the protection of routine screening for a number of such disorders. (6) Many undetected cases of phenylketonuria exist in public and private school programs for mentally retarded children. (7) PKU cases can be discovered by an accurate, inexpensive urine test. (8) This test can be administered economically and efficiently by a joint public-health school effort. (9) There is a need to develop and refine the materials and methodology for wide scale testing for PKU. (10) Unrecognized maternal PKU may be producing as many mentally defective children as PKU itself. (11) Maternal PKU is almost certain to produce fetal damage because the fetus is bathed in high levels of phenylalanine that the mother cannot oxidize. (12) Many parents have an inadequacy in the area of child-rearing practices. (13) The development of the Guthrie Test in 1963 makes mass testing of newborns possible. (14) Mental retardation can be prevented in most PKU patients if they are placed on a restricted phenylalanine diet in early infancy. (15) With the increased knowledge of biochemistry and nutrition in recent years, a whole new field of causes of different types of mental disorders has developed. (16) It is now well recognized that the disorder

may vary considerably in its clinical manifestations, including the level of intelligence. The disorder is difficult to recognize clinically, and the diagnosis can only be made on the basis of a positive urinary test for phenylpyruvic acid or by the more difficult determination of serum phenylalanine tests. (17) Studies now indicate that a child on a regular diet (a child whose phenylalanine blood level remains below 20 mg.%) will not become retarded. (Such a patient is called a phenylketonuric variant.) (18) Normal children are rarely born to phenylketonuric mothers. (19) Normal intelligence in the PKU mother is not a guarantee of normal offspring.

CHAPTER III

PROCEDURE

To achieve the purposes of this study which were to (1) review and interpret medical literature concerning PKU, (2) ascertain the incidence of PKU in Oklahoma, and (3) summarize findings from literature and other sources which could be used in a handbook for parents of PKU individuals, the following steps were pursued:

(1) Medical literature was reviewed and presented in Chapter II.

(2) A questionnaire was developed with pediatricians, general practitioners, nurses, special education teachers, administrators and directors of state and private schools for the mentally retarded and others in the professional fields of child development as jurors.

Development of the Questionnaire

In developing the questionnaire, the following criteria were considered. The instrument: (1) should not place excessive demands upon the time of the respondents, (2) could be checked easily and accurately, (3) could be planned in light of the objectives of the investigation, (4) would avoid ambiguous statements, and (5) would use terms that are understood and commonly used in the professional literature.

Validating the Questionnaire

The questionnaire in its original form, together with a cover letter explaining the study, was sent to ten medical and professional educators who were involved with PKU children or working with the mentally retarded children in state or private institutions and special education classes. These jurors were requested to indicate any revisions needed in the questions and to suggest questions which they felt should be included. In addition, they were asked to validate from a medical point of view the accuracy of the statements. They were, also, asked to critique the questionnaire in regard to clearness of statements and directions. All ten professionals responded to the questionnaire.

Jurors' responses to the questionnaire, including suggestions for revisions, new questions, a change in the directions and general comments are presented in Appendix A. The final questionnaire may be found in Appendix B.

Subjects

The 150 subjects for this study were professionals having had contact with mentally retarded children. This included pediatricians, general practitioners, registered nurses, special education teachers, directors and administrators of state and private institutions for the mentally retarded, clinical psychologists, school counselors, obstetricians and genealogists, surgeons, and orthopedics. All counties in Oklahoma were contacted and a questionnaire was sent to the director or administrator of the institution or agency. Selection of these institutions was taken from a directory of services for child care and placement. This director, Oklahoma Association of Children Institutions and

Agencies, Volume 1 and 2, was published in November, 1972.

Other respondents were identified by recommendations from the Oklahoma Medical Association and by the investigator's knowledge of professionals. A total of 150 respondents participated; 10 pediatricians, 26 general practitioners, 20 registered nurses, 22 special education teachers, 24 directors or administrators of state and private institutions for the mentally retarded and 40 in related areas. There were 98 males and 52 females who responded. Table I indicates the present position of these respondents.

TABLE I

PRESENT POSITION OF RESPONDENTS

N = 150

Present Position	Frequency	Percent
Pediatrician	10	6.66
General Practitioner	26	17.33
Registered Nurse	20	13.33
Special Education Teacher	22	14.66
Administrator or Director of state or private institutions for the mentally retarded	24	16.00
Other professional personnel	48	32.00

The educational level of the 150 respondents is indicated in Table II.

TABLE II

EDUCATIONAL LEVEL OF RESPONDENTS

N = 150

Highest Degree Held	Frequency	Percent
High School Diploma	2	1.33
Bachelor's Degree	22	14.66
Master's Degree	36	24.00
Specialist Certificate	12	8.00
Ed. D. Degree	0	0.00
Ph. D. Degree	8	5.33
M. D. Degree	62	41.33
Other: Laboratory Technician X-ray Technician Nursing Diploma	8	5.33

Table III reveals the years of experience of the 150 respondents according to their professions.

TABLE III

YEARS OF EXPERIENCE OF RESPONDENTS ACCORDING TO PROFESSION

N = 150

Years of Experience	Frequency	Percent
0-5 years	14	9.33
6-10 years	32	21.33
11-15 years	16	10.66
16-20 years	18	12.00
21-25 years	16	10.66
26-30 years	14	9.33
31-35 years	16	10.66
36-40 years	11	7.33
Over 41 years	13	8.66

Administration of the Questionnaire

Letters describing the study, along with the questionnaire and a face sheet, were mailed to 200 individuals. The total completed questionnaires returned were 150. In addition to the 150, seven were returned by others who indicated the person was deceased, retired, or no longer was employed.

CHAPTER IV

ANALYSIS OF THE DATA

To achieve the purposes of the study which were to (1) review and interpret medical literature concerning PKU, (2) ascertain the incidence of PKU in Oklahoma, and (3) summarize findings from literature and other sources which could be used in a handbook for parents of PKU individuals, data are presented by frequency and percentage.

Results

Subjects' responses to the questionnaire reflecting frequency and percentages are presented in Table IV. Table IV indicates that although all respondents had some knowledge about PKU, only 74 percent had actually seen a PKU patient. Only 51 percent had read any medical research related to this disorder; however, 68.66 percent indicated that they had worked with mentally retarded children. Only 15.33 percent of all respondents indicated they had attended in-service programs. Sixty-eight percent were interested in receiving results of this study. In addition to checking the questionnaire, additional comments concerning the study were made. These responses in descriptive form may be found in Appendix C.

TABLE IV

SUBJECTS' RESPONSES TO QUESTIONNAIRE REFLECTING FREQUENCY AND PERCENTAGE

N = 150

Statements	Yes		No		Not Applicable	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
1. Are you familiar with the disorder known as Phenylketonuria, commonly known as PKU?	150	100	0	0	0	0
2. Have you ever seen a person with PKU? Which characteristics have you observed in PKU patients?	74	49.33	76	50.66	0	0
(a) usually hyperactive	22	14.66	0	0	4	2.66
(b) exhibits unpredictable behavior	20	13.33	2	1.33	2	1.33
(c) eczema	10	6.66	8	5.33	2	1.33
(d) urine odor	22	14.66	4	2.66	2	1.33
(e) mental deficiency	48	32.00	4	2.66	2	1.33
(f) seizures	20	13.33	4	2.66	2	1.33
(g) blond hair and blue eyes	26	17.33	6	4.00	4	2.66
3. In your professional training was the disorder of PKU included?	88	58.66	51	34.00	11	7.33
(a) its causes?	68	45.33	12	8.00	4	2.66
(b) its characteristics?	60	40.00	16	10.66	4	2.66
(c) its treatment?	54	36.00	18	12.00	6	4.00
4. Have you read any medical research on PKU in the last year?	51	34.00	94	62.66	5	3.33
5. Have you had any PKU patients?	30	20.00	74	49.66	46	30.66
(a) When you have a PKU patient do you make this disorder known to the parents?	20	13.5	2	1.33	26	17.33

TABLE IV (Continued)

Statements	Yes		No		Not Applicable	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
5. (b) Have you used Lofenalac for the diet of PKU patients?	6	4.00	22	14.66	18	12.00
6. Have you treated mentally retarded children?	71	47.33	47	31.33	32	21.33
Have you worked with mentally retarded children?	103	68.66	19	12.66	28	18.66
7. To your knowledge, is there a referral service available in your county?	115	76.66	25	16.66	10	6.66
8. In your area, is there a clinic or agency for parents seeking answers to problems of PKU children?	70	46.66	50	33.33	30	20.00
9. Have you attended an in-service program or workshop concerning PKU children?	23	15.33	126	84.00	1	6.66
10. Would you like to receive the results of this study?	102	68.00	24	16.00	24	16.00

TABLE V

MEDICAL DOCTORS' RESPONSES INDICATED BY FREQUENCY AND PERCENTAGES

N = 36

Item Number	Yes		No		Not Applicable	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
1	36	100	0	0	0	0
2	19	52.77	17	47.22	0	0
3	20	55.55	14	38.88	2	5.55
4	10	27.73	26	72.26	0	0
5	8	22.22	27	75.00	1	2.77
6a	25	69.44	11	30.55	0	0
6b	22	61.11	12	33.33	2	5.55
7	24	66.60	7	19.94	5	13.38
8	14	38.88	14	38.88	8	22.22
9	2	5.55	34	94.44	0	0
10	20	55.55	13	36.11	3	8.33

In Table V, all medical doctors responding indicated familiarity with the disorder known as PKU; however, only 52.77 percent had ever seen a PKU person. Only 55 percent of the medical doctors responding stated that the study of PKU was included in their training. It was revealed that only 27.73 percent of the medical doctors had read any medical research on PKU in the last year and 84 percent had never attended an in-service program or workshop concerning PKU children.

TABLE VI

NURSES' RESPONSES INDICATED BY FREQUENCY AND PERCENTAGE

N = 20

Item Number	Yes		No		Not Applicable	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
1	20	100	0	0	0	0
2	8	40	12	60	0	0
3	8	40	10	50	2	10
4	10	50	8	40	2	10
5	4	20	16	80	0	0
6a	0	0	14	70	6	30
6b	14	70	6	30	0	0
7	8	40	10	50	2	10
8	10	50	6	30	4	20
9	6	30	14	70	0	0
10	2	10	0	0	18	90

In Table VI, all nurses responding indicated familiarity with the disorder known as PKU; however, only 40 percent had ever seen a PKU patient or had the disorder included in their training. In the treatment of mentally retarded children, 70 percent of the nurses had had no experience with PKU patients. Concerning PKU in-service programs or workshops, only 30 percent of the nurses had participated.

TABLE VII

SPECIAL EDUCATION TEACHERS' RESPONSES INDICATED BY FREQUENCY AND PERCENTAGE

N = 22

Item Number	Yes		No		Not Applicable	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
1	22	100	0	0	0	0
2	10	45.18	12	54.81	0	0
3	15	68.18	5	22.72	2	9.09
4	5	22.72	15	68.18	2	9.09
5	4	18.18	5	22.72	13	59.09
6a	0	0	7	31.81	15	68.18
6b	22	100	0	0	0	0
7	22	100	0	0	0	0
8	15	68.18	4	18.18	3	13.63
9	2	9.09	20	90.90	0	0
10	22	100	0	0	0	0

In Table VII, all special education teachers responding indicated familiarity with the disorder known as PKU. Persons with PKU had been seen by 45.18 percent of these special education teachers. In the professional training of these teachers, 68.18 percent indicated the inclusion of the study of PKU. Only 22.72 percent had read any medical research on PKU in the last year and only 18.18 percent had ever had a PKU student in their classes.

TABLE VIII

ADMINISTRATORS' AND DIRECTORS' RESPONSES INDICATED BY FREQUENCY AND PERCENTAGE

N = 24

Item Number	Yes		No		Not Applicable	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
1	24	100	0	0	0	0
2	13	54.16	11	45.83	0	0
3	7	29.16	15	62.50	2	8.33
4	10	41.66	13	54.16	1	4.16
5	7	29.16	10	41.66	7	29.16
6a	8	33.33	8	33.33	8	33.33
6b	21	87.50	1	4.16	2	8.33
7	21	87.50	1	4.16	2	8.33
8	7	29.16	10	41.66	7	29.16
9	6	25.00	18	75.00	0	0
10	18	75.00	4	16.66	2	8.33

In Table VIII, all administrators and directors of state or private institutions or agencies of mentally retarded children indicated familiarity with the disorder known as PKU, while 54.16 percent had seen persons with PKU. In their professional training, only 29.16 percent indicated that the disorder of PKU was included. Medical research on PKU had been read by 41.66 percent of these respondents. Only 29.16 percent of the respondents have had PKU patients in the care of their agencies. Twenty-five percent of the administrators and directors have attended an in-service program or workshop concerning PKU children.

TABLE IX

OTHER PROFESSIONAL PERSONNEL RESPONSES INDICATED BY FREQUENCY AND PERCENTAGE

N = 48

Item Number	Yes		No		Not Applicable	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
1	48	100	0	0	0	0
2	24	50.00	24	50	0	0
3	38	79.16	7	14.58	3	6.25
4	16	33.33	32	66.66	0	0
5	7	14.58	16	33.33	25	52.08
6a	38	79.16	7	14.58	3	6.25
6b	24	100	0	0	24	50.00
7	40	83.33	7	14.58	1	2.08
8	24	50.00	16	33.33	8	16.66
9	7	14.58	40	83.33	1	2.08
10	40	83.33	7	14.58	1	2.08

In Table IX, other professional personnel indicated familiarity with the disorder known as PKU. Other professional personnel included clinical psychologists, school counselors, psychiatrics, practicing psychologists, medical students, genetic counselors, obstetricians, genealogists, surgeons, and orthopedics. Of these, 50 percent had seen persons with PKU. In their professional training, 79.16 percent stated that the disorder of PKU was included and 33.33 percent had read medical research on PKU in the last year. In-service programs or workshops concerning PKU children had been attended by only 14 percent of the respondents.

Summary

Responses to the questionnaire concerning Phenylketonuria were arranged by frequency and percentage. The tabulated responses were analyzed to ascertain the degree of knowledge, experience, training, and concern of those groups having association with mentally retarded children.

CHAPTER V

SUMMARY, FINDINGS, IMPLICATIONS, AND RECOMMENDATIONS

Summary

The purposes of this study were to (1) review and interpret medical literature concerning PKU, (2) ascertain the incidence of PKU in Oklahoma, and (3) summarize findings from literature and other sources which could be used in a handbook for parents, nurses, teachers, and others working with PKU individuals.

A questionnaire was developed for use from items in the literature and submitting them to a jury of medical and medical-related persons with respect to mental retradation and PKU. The questionnaire was revised according to the jurors' suggestions. The subjects for this study were professional individuals having had contact with mentally retarded children. A total of 150 respondents participated. Responses to the questionnaire including suggestions, remarks, information, and sharing of personal experiences were presented in Appendix C.

A review of the literature revealed the following: (1) that there are many questions about PKU that still need to be answered through research and experience; (2) because PKU is not a common condition, scientists have had difficulty in collecting kinds of information that will allow them to fully understand all of the problems about it; (3) that PKU is only one of a number of metabolic disorders that create

similar problems; (4) large scale screening programs, which discover about 225 PKU babies a year, and the growing experience in treating and observing the children will make it easier to increase the understanding of PKU; (5) phenylketonuria is an inherited disorder characterized by gross mental defects consequent to an inability to metabolize the amino acid phenylalanine in a normal manner. The only effective treatment involves restriction of the dietary intake of phenylalanine in order to restore normal levels in body fluids; optimal results depend upon early diagnosis and careful dietary management; (6) the importance of early diagnosis in phenylketonuria cannot be over-emphasized. In spite of the rarity of the disorder, it is of great social importance to the affected family and of economic concern to the government; and (7) regardless of when treatment is initiated, its beneficial effect is almost universally manifested in behavioral improvement of the child, even though the intellectual gains may be minimal.

Major Findings

The major findings from this study are summarized as follows:

(1) 100 percent of the respondents were familiar with the disorder of PKU ranging from barely or vaguely to actual contact with the patients.

(2) 29.33 percent of the respondents had seen a PKU person.

(3) 53.66 percent of the respondents stated that the study of PKU was included in their professional training.

(4) 34 percent of the respondents had read medical research on PKU in the last year.

(5) 20 percent of the respondents had PKU patients under their

supervision or care.

(6) 47.33 percent of the medical oriented respondents have treated mentally retarded children and 68.66 percent of the non-medical oriented respondents have worked with mentally retarded children.

(7) 76.66 percent of the respondents indicated there was a referral service for retarded children in their county.

(8) 46.66 percent of the respondents indicated there was a clinic or agency for parents seeking answers to problems of PKU children in their area.

(9) 15.33 percent of the respondents have attended an in-service program or workshop concerning PKU children.

(10) At the present time, the Oklahoma State Department of Health reports 48 known cases of PKU in Oklahoma.

Implications

There is evidence that PKU children can be detected through observation by parents and teachers. Literature revealed the following symptoms of abnormal behavior may suggest that PKU may be present such as: (1) average age for sitting alone is 12 to 15 months; (2) average age for walking is 2½ years; (3) average age for talking is 3½ years; (4) behavior patterns are frequently autistic, hyperirritable, and destructive; and (5) presence of a musty odor. Lay people should be made aware of these symptoms so they can make referrals to the proper authorities.

The study further implies: (1) that all women who bear mentally defective children should be examined for phenylketonuria; (2) that

those found to have this disorder should be placed on low-phenylalanine diets during subsequent pregnancies to decrease the chance of brain damage to their unborn children; (3) that parent groups could be formed where parents can meet other parents of phenylketonuric children and discuss with the medical staff their anxieties, problems parents face, and hear informal lectures by clinic staff members or invited speakers, followed by informal group discussions; (4) that statutes should be enacted making the screening of newborn infants for phenylketonuria mandatory in all fifty states; (5) that speech pathologists be made aware of phenylketonuria as a cause of delayed language development in children who otherwise may appear near normal; (6) that universal premarital testing be adopted such as a routine test for syphillis.

Since phenylketonuria is so rare, the question may be legitimately raised whether these programs are worth the money and time being spent on them. The significance to the individual family to have a child saved from severe mental retardation is obvious. Apart from this, two factors may be considered: (1) the cost of the program versus the cost of the care of a severely retarded child, and (2) in the research reports indicated that between 200 and 300 phenylketonuric infants are born in the United States each year and most of these will require custodial care at public expenses for the greater part of their lives. Over the lifetime of these children, the care of those born in one year alone will be around $10 million.

Recommendations

The investigator poses the following questions to stimulate further research studies:

(1) Why are the offspring of phenylketonuric mothers mentally deficient instead of phenylketonuric?

(2) If diet is not the ultimate answer for treatment of PKU, what other alternatives need to be explored (i.e., liver tissue transplant from a normal individual to one with phenylketonuria without his rejecting it)?

(3) Is there a significant relationship between levels of phenylalanine and the degree of mental retardation?

(4) Why do some phenylketonuric children have high IQ's while others do not, even though they are chemically identical?

(5) In spite of the exact knowledge of the metabolic error concerning PKU, why is there no information yet available concerning the exact pathogenesis of this condition?

In addition to the questions posed to stimulate further research, the investigator proposes to take the data and compile a handbook for parents and teachers and for those working with mentally retarded children. This handbook could be used as a guide in detecting symptoms of PKU and for information as to what agencies are available for referral of PKU persons.

A SELECTED BIBLIOGRAPHY

(1) Acosta, P. B., and W. R. Centerwall. "Phenylketonuria, Dietary Management, Special Low-Phenylalanine Recipes." Journal of the American Dietetic Association, XXXVI (1960), 206-211.

(2) Adams, M. "Siblings of the Retarded: Their Problems and Treatment." Paper presented at the A.A.M.D. Conference in Chicago, Illinois, 1966.

(3) Allen, R. "Collaborative Research Pilot Survey of Known Cases of Phenylketonuria." In Minutes, Technical Committee on Clinical Programs for Mentally Retarded Children. Children's Bureau, U. S. Department of Health, Education, and Welfare, February 26-27, 1959.

(4) Anderson, J. A., and K. F. Swaiman. Phenylketonuria and Allied Metabolic Diseases. Washington, D. C.: Children's Bureau, U. S. Department of Health, Education, and Welfare, 1967.

(5) Armstrong, M. D., W. R. Centerwall, F. A. Horner, N. L. Low, and W. B. Weil. "The Development of Biochemical Abnormalities in Phenylketonuric Infants." Chemistry Pathology of the Nervous System. Folch-Pi, J. (ed.) New York: Pergamon Press, 1961, 38-50.

(6) Armstrong, M. D., and N. L. Low. "Phenylketonuria. VIII. Relation Between Age, Serum, Phenylalanine Level, and Phenylpyruvic Acid Excretion." Proceedings of the Society for Experimental Biology and Medicine, XCIV (1957), 142-146.

(7) Armstrong, M. D., N. L. Low, and J. P. Basam. "Studies on Phenylketonuria." American Journal of Clinical Nutrition, Vol. No. 5 (1957), 543-544.

(8) Armstrong, M. D., and F. H. Tyler. "Studies on Phenylketonuria I. Restricted Pehnylalanine Intake in Phenylketonuria." Journal of Clinical Investigation, XXXIV (1955), 565-580.

(9) Averbach, Aline, Peter Newbauer, and Marion Langer. Parent Group Education and Leadership Training. New York: Child Study Press, The Child Study Association of America, 1953.

(10) Berendes, H., J. A. Anderson, B. Priggie, D. Ruttenberg, and M. A. Ziegler. "Phenylketonuria (Phenylketonuria Oligophrenia)." University of Minnesota Medical Bulletin, XXIX (1958), 498-511.

(11) Berry, H., and G. Wright. "Conference on the Treatment of Phenylketonuria." Journal of Pediatrics, LXX (1967), 142-147.

(12) Berry, H. K., M. M. Hunt, and B. K. Sutherland. "Amino Acid Balance in the Treatment of Phenylketonuria." Journal of the American Dietetic Association LVIII (1971), 210-214.

(13) Berry, H. K. "Paper Chromatographic Method for Estimation of Phenylalanine." Proceedings of the Society for Experimental Biology and Medicine, XC (1957), 71-73.

(14) Berry, H. K., B. S. Sutherland, G. M. Guest, and J. Warkany. "Simple Method for Detection of Phenylketonuria." Journal of the American Medical Association, CLXVII (1958), 2189-2190.

(15) Berry, Helen K., Barbara Umbarger, and Betty Sutherland. "Procedures for Monitoring the Low-Phenylalanine Diet in Treatment of Phenylketonuria." The Journal of Pediatrics, LXVII (1965), 609-616.

(16) Bickel, H. "Management of Phenylketonuria." Chapter 8, Phenylketonuria. Frank Lyman (ed.). Springfield, Illinois: Charles C. Thomas, 1963, 136-172.

(17) Bickel, H., J. Gerrard, and E. M. Hickmans. "Influence of Phenylalanine Intake of Phenylketonuria." Lancet, II (1953), 812-813.

(18) Blaskovics, M., K. N. F. Shaw, G. N. Donnell, and R. Koch. "Phenylketonuria: Extended Phenylalanine Loading Studies." 38th Annual Meeting of the Society of Pediatric Research, Atlantic City, New Jersey, May 3-4, 1968, Abstracts, 158, 171.

(19) Brecher, R., and E. Brecher. "The Conquest of the Body-Chemistry Diseases." Family Circle, Vol. 67 (October, 1957), 21.

(20) Brown, Eleanor S., and Harry A. Waisman. "Mental Retardation in Four Offspring of a Hyperphenylalaninemic Mother." Pediatrics, XLVIII (1971), 401-410.

(21) Bruhl, H. H., J. F. Arnesen, and M. G. Bruhl. "Effect of a Low Phenylalanine Diet on Older PKU Patients." American Journal of Mental Deficiency, LXIX (1964), 225.

(22) Cameron, Janet L. "The Dramatic Story of PKU." School Lunch Journal, Vol. 24 (May, 1970), 49-50.

(23) Cameron, W. P., and S. A. Centerwall. "Phenylketonuria: A Report of a Survey to Discover Treatable Siblings of Institutionalized Patients." Medical Arts Science, XIII (1959), 173-175.

(24) Caudle, H. F. "Phenylketonuria Without Mental Retardation." Pediatrics, XXVI (1960), 5-12.

(25) Centerwall, S. A., and W. R. Centerwall. An Introduction to Your Child Who Has Phenylketonuria. Loma Linda, California: Loma Linda University Press, 1971.

(26) Centerwall, W. R., S. A. Centerwall, P. B. Acosta, and R. F. Chinnock. "Phenylketonuria I: Dietary Management of Infants and Young Children." Journal of Pediatrics, LIX (1961), 93-101.

(27) Centerwall, W. R., S. A. Centerwall, V. Armon, and L. B. Mann. "Phenylketonuria II: Results of Treatment of Infants and Young Children, A Report of Ten Cases." Journal of Pediatrics, LIX (1961), 102-118.

(28) Centerwall, W. R., and S. A. Centerwall. "Phenylketonuria (Folling's Disease): The Story of Its Discovery." Journal of the History of Medicine and Allied Sciences, XVI (1961), 292-296.

(29) Centerwall, W. R., and S. A. Centerwall. "Phenylketonuria: Report of a Survey to Discover Treatable Siblings of Institutionalized Patients." Medical Arts and Science, XIII (1959), 173-175.

(30) Centerwall, W. R., R. F. Chinnock, and A. Pusavat. "Phenylketonuria: Screening Programs and Testing Methods." American Journal of Public Health, L (1960), 1667-1677.

(31) Centerwall, W. R., and S. Kapur. "Phenylketonuria." Indian Pediatrics, I (1964), 440-454.

(32) Centerwall, W. R., and C. A. Neff. "Phenylketonuria: A Case Report of Children of Jewish Ancestry." Archives of Pediatrics, LXXVIII (1961), 379-384.

(33) Centerwall, W. R. "Phenylketonuria." Journal of the American Medical Association, CLXV (1957), 392, 2219.

(34) Clader, D. E. "Accelerated Intellectual Growth and Personality Development as Seen in Phenylketonuric Subjects During Medical Treatment." American Journal of Mental Deficiency, LXII (1957), 538-542.

(35) Cohen, B., A. Szeinberg, H. Borchis, and E. Bodonyl. "Phenylketonuria in Yemenite Jews." Pediatrics, XXXIV (1963), 1069-1073.

(36) Cohen, P., and P. J. Hozinn. "Phenylpruvic Oligophrenia in a Jewish Child." Journal of Pediatrics, XXXIV (1949), 66-70.

(37) Conference on Treatment of Phenylketonuria, sponsored by NARC in Cincinnati, Ohio, January 7, 1966. Reviewed by H. K. Berry in Journal of Pediatrics, Vol. 70 (1967), 142-147.

(38) Cooper, William S. "Hospital PKU Screening Laboratory Serves 75 Hospitals." Hospitals, XL (1966), 69-74.

(39) Crome, L., and C. M. B. Pare. "Phenylketonuria: A Review and Report of the Pathological Findings in 4 Cases." Journal of Mental Science, CVI (1960), 862-863.

(40) Davison, A. N., and M. Sandler. "Inhibition of 5-Hydroxy-tryptophan Decarboxylase by Phenylalanine Metabolites." Nature (London), CLXXXI (1958), 186-187.

(41) Desper, Mary M. "PKU: Symptoms, Diagnosis, Treatment, Prognosis." R.N., XXX (March, 1967), 63-67.

(42) Diedrich, William M., and Charles M. Paser. "Language and Mentation of Two Phenylketonuric Children." Journal of Speech and Hearing Disorders, XXV (1960), 124-134.

(43) A Diet Guide for Parents of Children with Phenylketonuria. Berkeley, California: California State Department of Public Health, Bureau of Public Health Nutrition, 1961, 30 pp.

(44) Dodge, P. R., E. Mancall, J. D. Crawford, J. Knapp, and R. S. Paine. "Hypoglycemia Complicating Treatment of Phenylketonuria with a Phenylalanine Deficient Diet: Report of Two Cases." New England Journal of Medicine, CCLX (1959), 1104-1111.

(45) Folling, A. "Phenylpyruvic Acid as a Metabolic Anomaly in Connection with Imbecility." Zeitschrift Fur Physiologische Chemie (German), CCXXVII (1934), 169-176.

(46) Frankenburg, William K., Burris R. Duncan, Wendell Coffelt, Richard Koch, James G. Coldwell, and Choon D. Son. "Maternal Phenylketonuria: Implications for Growth and Development." Journal of Pediatrics, CXXIII (1968), 560-570.

(47) Ghadimi, H., M. W. Partington, and A. Hunter. "A Familial Disturbance of Histidine Metabolism." New England Journal of Medicine, CCLXV (1961), 221.

(48) Gibbs, N. K., and L. I. Woolf. "Tests for Phenylketonuria: Results of a One-Year Programme for Its Detection in Infancy and Among Mental Defectives." British Medical Journal, II 1959), 523-535.

(49) Guthrie, R. "Blood Screening for Phenylketonuria." Journal of the American Medical Association, CLXXVIII (1961), 863.

(50) Guthrie, R., and A. Susie. "A Simple Phenylalanine Method for Detecting PKU in Large Populations of Newborn Infants." Pediatrics, XXXII, pp. 338-343.

(51) Guthrie, R., and S. Whitney. Phenylketonuria, Detection in the Newborn Infant as a Routine Hospital Procedure. Washington, D. C.: U. S. Department of Health, Education, and Welfare, Children's Bureau Publication, No. 419, 1964.

(52) Hackney, I. M., W. B. Hanley, W. Davidson, and L. Lindsao. "Phenylketonuria: Mental Development, Behavior and Termination of Low-Phenylalanine Diet." Journal of Pediatrics, CXXII (1968), 646-655.

(53) Hanson, A. "Inhibition of Brain Glutamic Acid Decarboxylase by Phenylalanine Metabolites." Naturwissen schafte, XLV (1958), 423.

(54) Henderson, Robert A., and Willard R. Centerwall. "The Attack on Phenylketonuria: A Pilot Study." Exceptional Children, XXVII (1961), 260-263.

(55) Hill, J. B., G. K. Summer, M. W. Pender, and Norris O. Roszel. "An Automated Procedure for Blood Phenylalanine. Clinical Chemistry, XI (1965), 541-546.

(56) Hillsman, Gladys M. "Genetics and the Nurse." Nursing Outlook, XIV (1966), 34-39.

(57) Horner, F. A., and C. W. Streamer. "Effect of a Phenylalanine-Restricted Diet on Patients with Phenylketonuria, Clinical Observations in Three Cases." Journal of the American Medical Association, CLXI (1956), 1628-1630.

(58) Hsia, D. Y. Y., K. W. Driscoll, W. Troll, and W. E. Knox. "Detection by Phenylalanine Tolerance Tests of Heterozygous Carriers of Phenylketonuria." Nature (London), CLXXVIII (1956), 1239-1240.

(59) Hsia, D. Y. Y., W. E. Knox, K. V. Quinn, and R. S. Paine. "A One-Year Controlled Study of the Effect of Low-Phenylalanine Diet on Phenylketonuria." Pediatrics, XXI (1958), 178-202.

(60) Hsia, D. Y. Y. "Phenylalanine-Tyrosine Ratio in the Detection of the Heterozygous Carrier." Journal of Mental Deficiency Research, II (1958), 8-16.

(61) Hunt, Melanie M., Betty S. Sutherland, Helen K. Berry. "Nutritional Management in Phenylketonuria." American Journal of Diseases of Children, CII (1971), 1-6.

(62) Jervis, G. A. "Phenylpyruvic Oligophrenia Deficiency of Phenylalanine-Oxidising System." Proceedings of the Society for Experimental Biology and Medicine, LXXXII (1953), 514-515.

(63) Jervis, G. A. "Phenylpyruvic Oligophrenia: Introductory Study of 50 Cases of Mental Deficiency Associated with Excretion of Phenylpyruvic Acid." Archives of Neurology and Psychiatry, XXXVIII (1937), 944-963.

(64) Johnson, Charles F. "Phenylketonuria and the Obstetrician." Obstetrics and Gynecology, XXXIX (1972), 942-947.

(65) Johnson, Charles F. "Spotlight on a New Kind of PKU." Consultant, Vol. 11 (1971), 68-70.

(66) Jones, M. H., and P. Henkin. Living with PKU. Evansville, Indiana: Mead Johnson Press, 1971.

(67) Kang, E. S., N. D. Sollee, and P. S. Gerald. "Results of Treatment of Termination of Diet in Phenylketonuria (PKU)." Pediatrics, XLVI (1970), 881-890.

(68) Katz, H. P., and J. H. Menkes. "Phenylketonuria Occurring in an American Negro." Journal of Pediatrics, LVI (1964), 71-74.

(69) Kaufman, S. "The Enzymic Conversion of Phenylalanine to Tyrosine." Biochemica Et Biophysica Acta, XXIII (1957), 445-446.

(70) Koch, R., P. Acosta, K. Fishler, G. Schaeffler, and A. Wolters. "Clinical Observations on Phenylketonuria." American Journal of Diseases of Children, CXIII (1967), 6-15.

(71) Koch, R., K. Fishler, S. Schild, and N. Ragsdale. "Clinical Aspects of Phenylketonuria." Mental Retardation, II (1964), 47-54.

(72) Koch, R., K. N. Shaw, P. B. Acosta, K. Fishler, G. Schaeffler, E. Wenz, and A. Wohlers. "An Approach to Management of Phenylketonuria." Journal of Pediatrics, LXXVI (1970), 815-828.

(73) Koch, Richard, and Phyllis Acosta. Clinical Observation in Phenylketonuria. California: Mead-Johnson Laboratories, 1965.

(74) Knox, W. E. "An Evaluation of the Treatment of Phenylketonuria with Diets Low in Phenylalanine." Pediatrics, XXVI (July, 1960), 1-11.

(75) Knox, W. E., and E. C. Messinger. "The Detection in the Heterozygote of the Metabolic Effect of the Recessive Gene for Phenylketonuria." American Journal of Human Genetics, X (1958), 53-60.

(76) Knox, W. E., J. B. Stanburg, et al. PKU — The Metabolic Basis of Inherited Diseases. New York: McGraw-Hill Book Co., 1960, 321-328.

(77) Krupanidhi, L., and B. D. Punekar. "A Study of the Incidence of Phenylketonuria in India." Indian Journal of Medical Research, LI (1963), 696-702.

(78) Levy, H. L., V. Karolkewicz, S. A. Houghton, and R. A. MacCready. "Screening the 'Normal' Population in Massachusetts for Phenylketonuria." New England Journal of Medicine, CCLXXXII (1970), 1455-1458.

(79) Lofenalac: Low Phenylalanie Dietary Management with Lofenalac. Evansville, Indiana: Mead Johnson and Company, 1964.

(80) Lyman, F. L., and J. K. Lyman. "Dietary Management of Phenylketonuria with Lofenalac." Archives of Pediatrics, LXXVII (1960), 212-220.

(81) Mabry, C. Carlton, Joseph C. Denniston, Thomas L. Nelson, and Choon D. Son. "Maternal Phenylketonuria, A Cause of Mental Retardation in Children Without the Metabolic Defect." The New England Journal of Medicine, XXVI (1963), 1404-1408.

(82) McCaman, M. W., and E. Robins. "Fluorimetric Method for the Determination of Phenylalanine in Serum." Journal of Laboratory and Clinical Medicine, CIX (1962), 885-890.

(83) Medical World News, VIII, No. 11 (March 17, 1967), 72-73.

(84) Merriam-Webster. Webster's New Collegiate Dictionary. Springfield, Massachusetts: G. & C. Merriam Co., 1970.

(85) Neame, K. D. "Phenylalanine as Inhibitor of Transport of Amino Acid in Brain." Nature (London), CXCII (1961), 173-174.

(86) O'Flynn, Margaret E. "Diet Therapy in Phenylketonuria." American Journal of Nursing, LXVII (1967), 1658-1660.

(87) Paine, R. S. "The Variability in Manifestations of Untreated Patients with Phenylketonuria (Phenylpyruvic Aciduria)." Pediatrics, XX (1957), 290-302.

(88) Paine, R. S., and D. Y. Y. Hsia. "The Dietary Phenylalanine Requirements and Tolerances of Phenylketonuric Patients." American Medical Association Journal of Diseases of Children, XCIV (1957), 224-230.

(89) Pare, C. M. B., M. Sandler, and R. S. Stacey. "Decreased 5-Hydroxytryptophan Decarboxylase Activity in Phenylketonuria." Lancet, II (1958), 1099-1101.

(90) Penrose, L. A., and J. H. Quastel. "Metabolic Studies on Phenylketonuria." Biochemical Journal, XXXI (1937), 266-274.

(91) Penrose, L. S. "Inheritance of Phenylpyruvic Amentia (Phenylketonuria)." Lancet, II (1935), 192-194.

(92) Phenistix, Programs for the Detection of PKU. Elhart, Indiana: Ames Company, 1964, 14 p.

(93) Ragsdale, Nancy, and Richard Koch. "Phenylketonuria, Detection and Therapy." American Journal of Nursing, LXIV (1964), 90-96.

(94) Recommended Guidelines for PKU Programs for the Newborn. Washington, D. C.: U. S. Department of Health, Education, and Welfare, Maternal and Child Health Service, Health Services and Mental Health Administration, 1971.

(95) Report to the 1970 (California) Legislature on Medical Tests for Newborn Infants, Pursuant to Health and Safety Code, Article 2.5, Chapter 2, Part 1 of Division 1. February 19, 1970.

(96) Rose, W. C., B. E. Leach, M. J. Coon, and G. F. Lambert. "The Amino Acid Requirements of Man. IX. The Phenylalanine Requirement." Journal of Biological Chemistry, CCXIII (1955), 913-922.

(97) Schild, S. "Parents of Children with Phenylketonuria." Children, XI (1964), 92-96.

(98) Shaw, K. N. F., and M. J. Gortatowski. "Analytical Methods in Phenylketonuria." Phenylketonuria. H. Bickel, F. Hudson, and L. I. Woolf (eds.). Stuttgart, Germany: Thieme Verlag, 1971.

(99) Shaw, K. N. F., M. Gutenstein, E. E. Jacobs, and J. C. Blaskovics. "Biochemical Screening and Monitoring of Patients with Phenylketonuria and Variant Forms of Hyperphenylalaninemia." Phenylketonuria. Stuttgart, Germany: Thieme Verlag, 1971.

(100) Shaw, K. N. F., R. Koch, S. Schild, N. Ragsdale, K. Fisher, and P. B. Acosta. The Clinical Team Looks at Phenylketonuria. Washington, D. C. U. S. Department of Health, Education, and Welfare, Children's Bureau, 1964.

(101) Snyderman, S. E., E. L. Pratt, M. W. Cheung, P. Norton, L. E. Holt, Jr., A. E. Hansen, and T. C. Panos. "The Phenylalanine Requirement of the Normal Infant." Journal of Nutrition, LVI (1955), 253-263.

(102) Solomons, Gerald, Lorelei Keleske, and Erica Opitz. "Evaluation of the Effects of Terminating the Diet in Phenylketonuria." Pediatrics, LXIX (1966), 596-602.

(103) Stadler, H. E., H. Meyer, and H. Leland. "Phenylpyruvic Oligophrenia in a Mulatto; Possible Manifestation of the Pleiotropic Effect." Journal of Nervous and Mental Disease, CXXV (1956), 205-207.

(104) Stedman's Medical Dictionary, 21 st. edition. Baltimore: Williams and Wilkins Co., 1966.

(105) Tanaka, K., E. Matsunaga, Y. Handa, T. Murat, and K. Takehara. "Phenylketonuria in Japan." Japanese Journal of Human Genetics, VI (1961), 65-77.

(106) Taylor, Fred M. Some Causes of Mental Retardation. Austin, Texas: Texas Medical Center and Baylor University. Paper reproduced by Texas Department of Health, June, 1964.

(107) Tu, J., C. Chen, T. Lin, R. Q. Blackwell, and Y. Chen. "Studies on Phenylketonuria in a Chinese Family." ACTA Paediatrica Sinica, V (1964), 56-64.

(108) Udenfriend, S., and S. P. Bessman. "The Hydroxylation of Phenylalanine and Antipyrene in Phenylpyruvic Okogophrenia." Journal of Biological Chemistry, CCIII (1953), 961-966.

(109) Umbarger, B. "Phenylketonuria: Treating the Disease and Feeding the Child." American Medical Association Journal of Disease of Children, C (1960), 908-913.

(110) U. S. Department of Health, Education, and Welfare. The Clinical Team Looks at Phenylketonuria. Washington, D. C.: U. S. Government Printing Office, 1965.

(111) U. S. Department of Health, Education, and Welfare. Phenylketonuria: A Comprehensive Bibliography, 1964. Washington, D. C.: U. S. Government Printing Office, 1966.

(112) U. S. Department of Health, Education, and Welfare. Phenylketonuria: An Inherited Metabolic Disorder Associated with Mental Retardation. Ed. by Willar R. Centerwall and Siebried O. Centerwall. Washington, D. C.: U. S. Government Printing Office, 1972.

(113) U. S. Department of Health, Education, and Welfare. Phenylketonuria and Allied Metabolic Diseases. Edited by John A. Anderson and Kenneth F. Swaiman. Washington, D. C.: U. S. Government Printing Office, 1967.

(114) U. S. Department of Health, Education, and Welfare. Phenylketonuria: Detection in the Newborn Infant as a Routine Hospital Procedure. Edited by Robert Guthrie and Stewart Whitney. Washington, D. C.: U. S. Government Printing Office, 1966.

(115) U. S. Department of Health, Education, and Welfare. Inborn Errors of Metabolism in Children with Mental Retardation. Edited by Donough O'Brien. Washington, D. C.: U. S. Government Printing Office, 1970.

(116) U. S. Department of Health, Education, and Welfare. Recommended Guidelines for PKU Program for the Newborn. Washington, D. C.: U. S. Government Printing Office, 1971.

(117) U. S. Department of Health, Education, and Welfare. State Laws Pertaining to Phenylketonuria as of November 1970. Washington, D. C.: U. S. Government Printing Office, 1971.

(118) U. S. Department of Health, Education, and Welfare. "What Do You Know About PKU?" Washington: Public Health Service, Child Health Service, 1964, 1-3.

(119) Waisman, H. Phenylalanine Levels on 44,000 Prenatal Sera. California Medical Conference, January, 1969.

(120) Wang, H. L., N. E. Morton, and H. A. Waisman. "Increased Reliability for the Determination of the Carrier State in Phenylketonuria." American Journal of Human Genetics, XIII (1961), 255-261.

(121) Woolf, L. I., R. Griffiths, and A. Moncrieff. "Treatment of Phenylketonuria with a Diet Low in Phenylalanine." British Medical Journal, I (1955), 56-64.

(122) Yu, J. S., and M. T. O'Halloran. "Children of Mothers with Phenylketonuria." Lancet, I (1970), 210-212.

APPENDIX A

FORM OF THE QUESTIONNAIRE AND JUROR RESPONSES

PILOT FORM OF THE QUESTIONNAIRE

Directions: (1) Please read each statement.

(2) Check the appropriate column: Yes, No, Does not Apply

(3) Additional comments may be made on the back of this questionnaire.

	Yes	No	Does Not Apply
1. Are you familiar with the disorder known as Phenylketonuria, commonly known as PKU?			
2. Have you ever seen a PKU patient?			
3. Have you had any PKU patients?			
4. When you have a PKU patient do you make this disorder known to the parents?			
5. Have you used Lofenalac for the diet of PKU patients?			
6. Are you aware of the current medical research in PKU?			
7. Have you treated mentally retarded children?			
8. To your knowledge is there a referral service available for doctors and others?			
9. In your area, is there a clinic or agency for parents seeking answers to problems of PKU children?			
10. Have you had the opportunity to attend an in-service program or workshop concerning PKU?			

Suggestions for Revision of Questionnaire

Item 2 Original Statement

Have you ever seen a PKU patient?

Comment

Would it be possible to change the wording and add a list of characteristics of PKU patients and ask which characteristics have been observed.

Item 4 Original Statement

Are you aware of the current medical research on PKU?

Comment

Statement would be more significant for your study if you would state it in a more direct approach by asking if they had read any medical research on PKU in the last year.

Item 5 Original Statement

Have you had any PKU patients?

Comment

This was item 3 in the original questionnaire. In sequential development, this item should be later. This item is acceptable but it should be followed by items 4 and 5 as subdivisions.

Item 6 Original Statement

Have you treated mentally retarded children?

Comment

Item is acceptable but should be followed by a statement of working with mentally retarded children.

Item 7 Original Statement

To your knowledge is there a referral service available for doctors and others?

Comment

This is not clear. Restate it by including service for mentally retarded children. Include . . . in your county instead of for doctors and others . . . .

Suggestions for Additional Items

Add: Have you attended an in-service program or workshop concerning PKU?

Would you like to be informed as to the results of this study?

Suggested Change in the Directions for the Questionnaire

Add word "carefully" to first direction. Suggest that additional comments be made on a separate sheet of paper or at the end of the questionnaire.

General Comments of Jurors

Very interesting study . . . .
Good checklist . . . .
Your study has merit.
Much-needed study.
Good luck on your research.
Most worthwhile.
Need more studies like this.
Too few people know anything about children's disorders.
Parents need to know about PKU.
I know very little about PKU--shows me a need for study.
Am interested in the results.

APPENDIX B

THE QUESTIONNAIRE

PHILLIPS UNIVERSITY UNIVERSITY STATION ENID, OKLAHOMA 73701

EDUCATION DIVISION

March 5, 1974

This questionnaire is being sent to you because of your interest in children's disorders. I hope you will agree to participate in this study. Your responses are vital because of your experience in working with mentally retarded children. The enclosed questionnaire has been tested with a sampling of interested persons, and has been revised in order to make it possible for you to apply necessary data in a minimum of time. This is a study concerned with the incidence of Phenylketonuri (PKU) in Oklahoma.

Please complete the face sheet and the questionnaire and return by March 22nd in the enclosed stamped envelope. Any comments that you may have concerning any aspect of Phenylketonuria (PKU) not covered in the questionnaire are welcomed.

Your cooperation and contribution are deeply appreciated.

Sincerely yours,

Louise Roberds

Professor Louise Roberds
Early Childhood Education
Phillips University

THE QUESTIONNAIRE

Directions: (1) Please read each statement carefully.
(2) Check the appropriate column: Yes, No, Not Applicable.
(3) Additional comments may be made at the end of this questionnaire.

		Yes	No	Not Applicable
1.	Are you familiar with the disorder known as Phenylketonuria, commonly known as PKU?			
2.	Have you ever seen a person with PKU?			
	Which characteristics have you observed in PKU patients?			
	(a) usually hyperactive			
	(b) exhibits unpredictable behavior			
	(c) eczema			
	(d) urine odor			
	(e) mental deficiency			
	(f) seizures			
	(g) blond hair and blue eyes			
3.	In your professional training was the disorder of PKU included?			
	(a) its causes?			
	(b) its characteristics?			
	(c) its treatment?			
4.	Have you read any medical research on PKU in the last year?			
5.	Have you had any PKU patients?			
	(a) When you have a PKU patient do you make this disorder known to the parents?			
	(b) Have you used Lofenalac for the diet of PKU patients?			
6.	Have you treated mentally retarded children?			
	Have you worked with mentally retarded children?			

	Yes	No	Not Applicable
7. To your knowledge, is there a referral service for retarded children available in your county?			
8. In your area, is there a clinic or agency for parents seeking answers to problems of PKU children?			
9. Have you attended an in-service program or workshop concerning PKU children?			
10. Would you like to receive the results of this study?			

Additional Comments:

APPENDIX C

DESCRIPTIVE COMMENTS ON QUESTIONNAIRE

DESCRIPTIVE STATEMENTS ON QUESTIONNAIRE

As a public health nurse, I have taken courses in mental retardation which included PKU. My work involves me with this type patient, their families, problems, etc.

I would be interested in the number of states that have this PKU testing at birth as a law. I would also be interested in the percentage of infants born here in Garfield County and in Oklahoma who have positive tests.

This should be a very interesting study and public information on the results should be valuable. Since this is one of the few conditions which can be diagnosed and treated to prevent mental retardation, more information should be made available to the public and medical profession alike.

I am not as familiar with this problem as I would like to be. I would be very interested in a workshop in this area for interested persons and professionals.

Am interested in learning more about this problem.

Our students wear badges with codes for various disabilities such as heart condition, allergy, seizures, diabetic, etc. PKU is probably in the classification "others." I am uninformed about any students who may have PKU. I am unfamiliar with the characteristics and know little about treatments received by students.

I have read some articles in publications on mental retardation regarding PKU, but not recently. A few years ago, two doctors in

Eastern United States were doing research on PKU by testing parents of mentally retarded children. My husband and I volunteered our services.

Glad to see the interest in this problem.

We have used PKU tests and observed all newborns for a number of years. We have attempted to keep pertinent data on the positive cases, also those that were not positive, but previous pregnancy of the mother had shown a positive reaction of newborn.

As an advisor, I cooperated in the early 1960's when PKU education was underway and we started PKU testing.

Hope this study stimulates a seminar on PKU.

Please send what information you can to--

Thank you for the opportunity to be of service.

A good many years ago, when Dr. Lucious Waites was Pediatric Neurologist at Children's Hospital in Oklahoma City, he did research on PKU and included the children at the Oklahoma Cerebral Palsy Center in this research. None of those who were checked here at the Oklahoma Cerebral Palsy Center was found to have PKU; and through the best data available, there was found to be no evident relationship between PKU and cerebral palsy.

While working at the Children's Medical Center, a study was started on all the mentally retarded children enrolled there to find the incidence of PKU in Sunnyside School. These are the two cases I'm

familiar with. One was a girl in her twenties; the other a boy, seven years old. She was not hyperactive; he was. Her condition was not discovered until that testing; his had been diagnosed as a baby.

APPENDIX D

STATE LAWS PERTAINING TO PHENYLKETONURIA

AS OF NOVEMBER, 1970

STATE LAWS PERTAINING TO PHENYLKETONURIA AS OF NOVEMBER, 1970

ALABAMA

Ala. Code tit. 22, Sec. 58(1) (Supp. 1969)

Sec. 58(1). Testing of infants for phenylketonuria; objection of parents; rules and regulations. (a) It shall be the duty of the administrative officer or other person in charge of each institution caring for infants twentyOeight days or less of age, or the physician attending a newborn child, or the person attending a newborn child that was not attended by a physician, to cause to have administered to every such infant or child in his care a reliable test for phenylketonuria (PKU), such as the Guthrie test or any other test considered equally reliable by the state board of health. Testing and the recording of the results of such tests shall be performed at such times and in such manner as may be prescribed by the state board of health. Provided, that no such test shall be given to any child whose parents object thereto on the grounds that such tests conflict with their religious tenets and practices.

(b) The state board of health shall promulgate such rules and regulations as it consideres necessary to provide for the care and treatment of those newborn infants whose tests are determined positive, including but not limited to advising dietary treatment for such infants. The state board of health shall promulgate any other rules and regulations necessary to effectuate the provisions of this section. (1965, No. 885, effective Nov. 1, 1965)

ALASKA

Alaska Stat. Sec. 18.15.200 (1969)

Sec. 18.15.200. Screening infants for phenylketonuria. (a) A physician who attends a newborn child shall cause this child to be tested for phenylketonuria (PKU). If the mother is delivered in the absence of a physician, the nurse who first visits the child shall cause this test to be performed.

(b) The Department of Health and Welfare shall prescribe regulations regarding the method used and the time or times of testing as accepted medical practice indicates.

(c) The necessary laboratory tests and the test materials, reporting forms and mailing cartons shall be provided by the department.

(d) All tests considered positive by the screening method shall be reported by the screening laboratory to the physician and to the

department. The department shall provide services for the performance of a quantitative blood phenylalanine test or its equivalent for diagnostic purposes. A confirmed diagnosis of phenylketonuria shall be reported to the physician and to the department. The department shall provide services for treatment and clinical follow-up of any diagnosed case.

(e) When presumptive positive screening tests have been reported to the department, it shall provide, on request, either the true blood phenylalanine test or subsidize the performance of this test at an approved laboratory.

(f) A licensed physician or licensed nurse attending a newborn or infant who violates this section is guilty of a misdemeanor, and upon conviction is punishable by a fine of not more than $500. However, a person attending a newborn or infant whose request for appropriate specimens from the newborn or infant is denied by the parent or guardian is not guilty of a misdemeanor. The fact that a child has not been subjected to the test because a request for appropriate specimens has been denied by the parents or guardian shall be reported to the department. The department shall administer and provide services for testing for other heritable diseases which lead to mental retardation and physical handicaps as screening programs accepted by current medical practice and as developed.

(g) In this section, "physician" means a doctor of medicine licensed to practice medicine in this State, or an officer in the regular medical service of the armed forces of the United States or the United States Public Health Service assigned to duty in this state.
(Sec. 1 ch. 90 SLA 1965; am Sec. 1 ch. 39 SLA 1967)

ARKANSAS

Ark. Stat. Ann. Sec. 82-625 through -628 (Supp. 1967)

Sec. 82-625. Phenylketonuria-Testing of Infants-State Board of Health authorized to prescribe regulations. The State Board of Health may, after proper notice and hearing, prescribe regulations requiring that all newborn infants must be tested for Phenylketonuria by such tests and in such manner as the said State Board of Health shall determine is safe and effective. If the State Board of Health issues such regulations prescribing for said tests, it shall provide by regulation that no birth certificate may be received by the Bureau of Vital Statistics unless proper proof is made that such test has been made. (Acts 1967, No. 192 Sec. 1)

Sec. 82-626. Duties of the State Board of Health. It shall be the duty of the State Board of Health:

(1) To enforce the provisions of this Act. (Sec. 82-625-82-628);

(2) To prescribe the test or tests that may be administered in compliance with this Act;

(3) To furnish copies of this Act and the rules promulgated hereunder to physicians, hospitals or other institutions or persons required by its regulations to have tests administered to newborn infants;

(4) To investigate and license laboratories determined by the State Board of Health to be qualified to test specimens from the newborn child for testing for Phenylketonuria or other metabolic defects;

(5) To establish a central laboratory and to equip, staff and operate the same for the purpose of receiving specimens from physicians, hospitals, or institutions and to make tests and report findings resulting from such tests without cost therefor;

(6) To disseminate information and advice to the public concerning the dangers and effects of Phenylketonuria and other metabolic defects and assist in the treatment and care of infants found to have said defects. (Acts 1967, No. 192 Sec. 2)

Sec. 82-627. Exceptions. The provisions of this Act (Sec. 82-625-82-628) shall not apply to any child whose parents or guardian object thereto on the grounds that it conflicts with the tenets and practices of a recognized church or religious faith of which said parent or guardian is an adherent or member. (Acts 1967 No. 192 Sec. 3)

Sec. 82-628. Enforcement-Injunction. The State Board of Health shall have the power to enforce this Act by appropriate action for injunction in the Chancery Courts of this State. (Acts 1967, No. 192 Sec. 4)

CALIFORNIA

Cal. Health and Safety Code Ann. Sec. 280 (West Supp. 1970)

Sec. 280. Detection of preventable heritable disorders; tests and regulations; reports; objections. It is the policy of the State of California to make every effort to detect, as early as possible, phenylketonuria and other preventable heritable disorders leading to mental retardation or physical defects.

The State Department of Public Health shall have the responsibility of designating tests and regulations to be used in executing this policy. Such tests shall be in accordance with accepted medical practices and shall be administered to each child born in California at such time as the department has established appropriate regulations and testing methods.

The department shall inform all hospitals or physicians, or both, of required regulations and tests and may alter or withdraw any such requirements whenever sound medical practice so indicates.

The department shall report to the Governor and the Legislature annually as to the progress and effect of testing programs.

The provisions of this section shall not apply if a parent or guardian of the newborn child objects to a test on the ground that the test conflicts with his religious beliefs or practices.

(Added Stats. 1965, c. 1329 p. 3215, Sec. 1 as amended Stats. 1967 c. 220 p. 1351; Sec. 1)

COLORADO

Colo. Rev. Stat. Ann. Sec. 66-27-1 through -27-4 (Supp. 1965)

Sec. 66-27-1. Legislative declaration. The general assembly hereby declares that as a matter of public policy of this state and in the interest of public health, every newborn infant should be tested for phenylketonuria and other metabolic defects in order to prevent mental retardation resulting therefrom; and that the people of this state should be extensively informed as to the nature and effects of such defects.

Sec. 66-27-2. Tests for metabolic defects. (1) It shall be the duty of:

(a) The chief medical staff officer or other person in charge of each institution caring for newborn infants; or

(b) If a newborn infant is not born in an institution or is discharged therefrom prior to the time prescribed for the taking of the specimen hereinafter designated, the person responsible for the signing of the birth certificate of such child;

to cause to be obtained from every such infant a specimen, of the type designated by the state board of health, which specimen shall be forwarded to the state department of public health or other laboratory approved by it for testing for phenylketonuria and testing for such other metabolic defects which may be prescribed from time to time by the state board of health to be conducted with respect to such specimen.

(2) The state board of health shall have the duty to prescribe from time to time effective tests and examinations designed to detect phenylketonuria and such other metabolic disorders or defects likely to cause mental retardation as accepted medical practice shall indicate.

(3) The performance of such tests and the reporting of results shall be done at such times, places, and in such manner as may be prescribed by the state department of public health.

(4) It shall be the duty of the state department of public health to contact as soon as possible all cases suspected of having any such

disorders or defects and to do any additional testing required to confirm or disprove the suepected disorder or defect.

Sec. 66-27-3. Rules and regulations. (1) The state board of health shall promulgate rules and regulations concerning the obtaining of samples or specimens from newborn infants required for the tests prescribed by the state board of health, for the handling and delivery of the same, and for the testing and examination thereof to detect phenylketonuria or other metabolic disorders found likely to cause mental retardation.

(2) The state department of public health shall furnish all physicians, public health nurses, hospitals, maternity homes, and departments of public welfare, available medical information concerning the nature and effects of phenylketonuria and other metabolic disorders and defects found likely to cause mental retardation.

Sec. 66-27-4. Exceptions. Nothing in the provisions of this act shall be construed to require the testing or medical treatment for the minor child of any person who is a member of a well-organized church or religious denomination, and whose religious convictions in accordance with the tenets or principles of his church or religious denomination are against medical treatment for disease or physical defects.

CONNECTICUT

Conn. Gen. Stat. Ann. Sec. 19-21b (1969)

Sec. 19-21b. Tests of infants for phenylketonuria. (a) The administrative officer or other person in charge of each institution caring for infants twenty-eight days or less of age shall cause to have administered to every such infant in its or his care a test for phenylketonuria and such other tests for inborn error of metabolism as shall be prescribed by the state department of health. Said department shall adopt regulations specifying the abnormal conditions to be tested for, the manner in which the tests are to be performed and the manner of recording and reporting results.

(b) The provisions of this section shall not apply to any infant whose parents object to the test or treatment as being in conflict with their religious tenets and practice. (1965, P.A. 108, Secs. 1, 2, eff. Jan. 1, 1966)

FLORIDA

Fla. Stat. Ann. Sec. 383.14 (Supp. 1970)

Sec. 383.14. Testing for metabolic disorders of infants. It shall be the duty of the division of health to promote the testing of all infants for phenylketonuria and other metabolic disorders known to result

in significant impairment of health or intellect, when such tests become available and practical in the judgment of the division and to keep a record of said tests. These tests shall be performed at such times and in such manne as may be prescribed by the division. (Laws 1965 c. 65-519, Sec. 1 eff. June 25, 1965. Amended by laws 1969; c. 69-106, Secs. 19, 35, eff. July 1, 1969)

GEORGIA

Ga. Code Ann. Secs. 88-1201.1 through -1201.2 (Supp. 1969)

Sec. 88-1201.1. Rules and Regulations for Tests for Phenylketonuria. The Department of Health shall promulgate appropriate rules and regulations governing tests for phenylketonuria so that as nearly as possible all newborn infants shall receive a test for phenylketonuria as soon after birth as successful treatment for such condition may be initiated. Provided, however, the provision of this section shall not apply to any infant whose parents object thereto on the grounds that such tests and treatment conflict with their religious tenets and practices. (Acts 1966, p. 140)

Sec. 88-1201.2. Rules and Regulations for Other Tests. The Department of Public Health is authorized and directed, by and through its board, to adopt rules and regulations relative to other inborn errors of metabolism and any other conditions which may be indicated as a result of medical research and findings which would, if left to run their course, militate against the health of the citizens of this State. (Acts 1966, p. 140)

HAWAII

Hawaii Rev. Laws Sec. 333-1 (1968)

Sec. 333-1. Test for phenylketonuria. The physician, midwife, or other person attending a newborn child shall cause a phenylketonuria test to be administered to the child; provided, that this section shall not apply if the parents, guardian or other person having the custody or control of such child objects thereto on the grounds that such test conflicts with their religious tenets and practices.

The department of health shall adopt rules and regulations to carry out the purposes and provisions of this section, including, but not limited to, administration of phenylketonuria tests, keeping of records and related data, and reporting of positive test results. (L. 1965, c. 19, Sec. 2; Supp., Sec. 46-47)

IDAHO

Idaho Code Ann. Secs. 39-909 through -912 (Supp. 1969)

Sec. 39-909. Tests for Phenylketonuria and preventable diseases in newborn infants. It shall be the duty of the administrative officer or other person in charge of each hospital or other institution caring for newborn infants and the person responsible for the registration of the birth of such infant under section 39-256, to cause to have administered to every newborn infant in its or his care a test for phenylketonuria and such other tests for preventable diseases as prescribed by the state board of health. The person administering such tests shall make such reports of the results thereof as required by the state board of health. (1965, ch. 223, Sec. 1, p. 510)

Sec. 39-910. Duties of state board of health in enforcing act. It shall be the duty of the state board of health:

1. To enforce the provisions of this act.

2. To prescribe what tests shall be made for preventable diseases in addition to the test for phenylketonuria.

3. To make and publish rules prescribing the time and manner of administering tests required by this act.

4. To furnish copies of this act and the rules promulgated hereunder to physicians, hospitals or other institutions or persons required by this act to have tests administered to newborn infants.

5. To maintain a record of all infants found to have phenylketonuria or other preventable diseases and to supervise local health agencies in the treatment and cure of such infants.

6. To disseminate information and advice to the public concerning the dangers and effects of phenylketonuria and other preventable diseases and their detection and treatment. (1965, ch. 223, Sec. 2, p. 510)

Sec. 39-911. Violations -- Penalty. Any person who violates the provisions of this act or rules promulgated by the state board of health thereunder, shall be guilty of a misdemeanor. (1965, ch. 223, Sec. 3, p. 510)

Sec. 39-912. Exemption because of religious belief. The provisions of this act shall not apply to any child whose parent or guardian objects thereto on the grounds that it conflicts with the tenets or practices of a recognized church or religious denomination of which said parent or guardian is an adherent or member. (1965, ch. 223, Sec. 4, p. 510)

ILLINOIS

Ill. Rev. Stat. ch. 91, Secs. 113f-113h (1966)

PHENYLKETONURIA

Sec. 113f. Rules and regulations.

The Illinois Department of Public Health shall promulgate and enforce rules and regulations requiring that every newborn be subjected to a test for phenylketonuria and such other metabolic diseases as the Department may deem necessary from time to time. The Department is empowered to promulgate such additional rules and regulations as are found necessary for the administration of this Act, including mandatory reporting of the results of all tests for these conditions to the Illinois Department of Public Health.

Sec. 113g. Department of Public Health -- Powers and duties.

The Department of Public Health shall: administer the provisions of this Act and shall:

(a) Institute and carry on an intensive educational program among physicians, hospitals, public health nurses and the public concerning the disease phenylketonuria and other metabolic diseases. This educational program shall include information about the nature of the disease and examinations for the detection of the disease in early infancy in order that measures may be taken to prevent the mental retardation resulting from the disease.

(b) Maintain a registry of cases including information of importance for the purpose of follow-up services to prevent mental retardation.

(c) Supply the necessary treatment product where practicable for diagnosed cases for as long as medically indicated, when the product is not available through other State agencies.

(d) Arrange for or provide public health nursing, nutrition and social services and clinical consultation as indicated.

Sec. 113h. Objections of parent or guardian.

The provisions of this Act shall not apply when parent or guardian of the child objects thereto on the grounds that such test conflicts with his religious tenets and practices. A written statement of such objection shall be presented to the physician or other person whose duty it is to administer and report such tests under the provisions of this Act. (Laws of 1965, p. 284)

INDIANA

Ind. Ann. Stat. Secs. 35-246 through -250 (1969)

Sec. 35-246. Phenylketonuria-Examination of infants-Religious objection. It is hereby deemed to be a matter of public policy of the

state of Indiana that in the interest of public health every infant shall be given examinations at the earliest feasible time for the detection of the disease phenylketonuria and/or other inborn errors of metabolism, in order to prevent mental retardation which results from this disease; Provided that, if parents, or a parent of an infant shall object, in writing, for reasons pertaining to their religious beliefs only, then said infant shall be exempt from the provisions of this act. (Secs. 35-246-35-250) (Acts 1965, ch. 81, Sec. 1, p. 117)

Sec. 35-247. Educational program by board. The state board of health shall institute and carry on an intensive educational program among physicians, hospitals, public health nurses and the public concerning the disease phenylketonuria and other inborn errors of metabolism. This educational program shall include information about the nature of these diseases and examinations for the detection of these diseases in infancy in order that measures may be taken to prevent the mental retardation resulting from these diseases. (Acts 1965 ch. 81, Sec. 2 p. 117)

Sec. 35-248. Appropriate tests determined and requested. The state board of health shall, with the advice of medical authorities, determine and report appropriate tests to be used in the detection of phenylketonuria and/or other inborn errors of metabolism. (Acts 1965, ch. 81 Sec. 3 p. 117)

Sec. 35-249. Plans and procedures promoted by boards. The state board of health and all local boards of health shall encourage and promote the development of plans and procedures for the detection of phenylketonuria and other inborn errors of metabolism in all local health jurisdictions of the state. (Acts 1965, ch. 81, Sec. 3a, p. 117)

Sec. 35-250. State board duties-Provide forms-Receive reports-Report findings-Promulgate rules and regulations. The state board of health shall provide forms on which the result of tests performed on each child for these diseases shall be reported to the state board of health by physicians in hospitals, and shall at least ascertain quarterly the extent of such testing and those findings shall be reported to all hospitals, physicians and other groups interested in child welfare. The state board of health shall have the power to promulgate the rules and regulations for the implementation of the intent of this act (Secs. 35-246-35-250). (Acts 1965, ch. 81 Sec. 4 p. 117)

IOWA

Iowa Code Ann. Sec. 135.31 (Supp. 1970)

Sec. 135.31. Test for phenylketonuria. It is hereby declared to be the policy of this state that every infant born within the borders of Iowa shall, insofar as practicable, be tested for the presence of the disease known as phenylketonuria within a reasonable period following birth. It shall be the responsibility of the state department of health to implement this policy at such time and with such rules and regulations as the commissioner of public health deems advisable. All state, district,

county, and city health or welfare agencies shall cooperate and participate in the implementation of this Act and such rules and regulations, when requested by the commissioner of public health. (Added Acts 1965 (61 G.A.) ch. 157, Sec. 1, as amended Acts 1967 (62 G.A.) ch. 163, Sec. 25, Eff. Aug. 15, 1967)

KANSAS

Kan. Gen. Stat. Ann. Secs. 65-180 through -183 (Supp. 1969)

PHENYLKETONURIA

Sec. 65-180. Educational program concerning phenylketonuria by department; screening and tests; registry of cases; treatment. The state department of health shall: (a) Institute and carry on an intensive educational program among physicians, hospitals, public health nurses and the public concerning the disease phenylketonuria. This educational program shall include information about the nature of the disease and examinations for the detection of the disease in early infancy in order that measures may be taken to prevent the mental retardation resulting from the disease. (b) Provide recognized phenylketonuria screening, diagnostic and treatment control tests for which laboratory services are required and such screenings and tests when made at the laboratory of the state board of health shall be made without charge. (c) Maintain a registry of cases including information of importance for the purpose of follow-up services to prevent mental retardation. (d) Provide the necessary treatment product for diagnosed cases for as long as medically indicated, when the product is not available through other state agencies.

Sec. 65-181. Tests in accordance with regulations of state board of health. It shall be the duty of the administrative officer or other person in charge of each institution or the attending physician, caring for infants twenty-eight(28) days or less of age to cause to have administered to every such infant or child in its or his care a test for phenylketonuria in accordance with rules or regulations prescribed by the state board of health. Testing and the recording of the results of such tests shall be performed at such times and in such manner as may be prescribed by such board.

Sec. 65-182. Provisions inapplicable where parents object on religious grounds. The provisions of this section shall not apply to any infant whose parents object thereto on the grounds that such tests and treatment conflict with their religious tenets and practices.

Sec. 65-183. Report by physicians to department. Every physician having knowledge of a case of phenylketonuria in one of his own patients shall report said case to the state department of health on forms provided by that department.

KENTUCKY

Ky. Rev. Stat. Sec. 214.155 (1969)

AN ACT relating to testing infants for inborn errors of metabolism.

Be it enacted by the General Assembly of the Commonwealth of Kentucky:

(1) The administrative officer or other person in charge of each institution caring for infants twenty-eight days or less of age and the person required in pursuance of the provisions of KRS 213.050 (1) shall register the birth of a child, and cause to have administered to every such infant or child in its or his care a test for inborn errors of metabolism in accordance with rules or regulations prescribed by the Commissioner of Health. Testing and the recording of the results of such tests shall be performed at such times and in such manner as may be prescribed by the Commissioner of Health.

(2) Nothing in this Act shall be construed to require the testing of any child whose parents are members of a nationally recognized and established church or religious denomination, the teachings of which are opposed to medical tests, and who object in writing to the testing of such child on that ground. (1966 c. 45 Eff. 6-16-66)

LOUISIANA

La. Stat. Ann. ch. 40, Secs. 1299-1299.3 (1965)

Sec. 1299. Program for combating phenylketonuria.

The State Board of Public Health and/or the State Department of Public Health are hereby authorized and directed to establish, maintain and carry out a program designed to combat mental retardation in children suffering from a genetic defect which causes phenylketonuria. The State Department of Public Health is authorized to adopt rules and regulations necessary to carry out any program which may be established. The said department shall establish and maintain a diagnostic laboratory for conducting experiments, projects and other undertakings as may be necessary to develop tests for the early detection of phenylketonuria, for developing ways and means or discovering methods to be used for the prevention and treatment of phenylketonuria in children, and for such other purposes as may be deemed necessary by the said department to carry out any program adopted under the authority of this Part. Acts 1964, No. 269, Sec. 1.

Sec. 1299.1 Tests.

The physician attending a newborn child, or the person attending a newborn child that was not attended by a physician, shall cause said child to be subjected to a phenylketonuria test that has been approved by the State Department of Public Health; provided, however, no such test shall be given to any child whose parents object thereto on the

grounds that such tests conflict with their religious tenets and practices. If the test is positive the attending physician or person shall notify the State Department of Public Health. The State Department of Public Health shall follow-up all positive tests with the attending physician who notified the department thereof and with the parents of the newborn child when such notification was made by a person other than a physician, and, when confirmed, the services and facilities of the said state department of public health, and those of other state boards, departments and agencies cooperating with the Department of Public Health in carrying out the program shall be made available to the extent needed by the family and physician. The State Department of Public Health and the other state departments and agencies cooperating with it shall, in cooperation with the attending physician, provide for the continued medical care, dietary and other related needs of such children where necessary or desirable. Acts 1964, No. 269, Sec. 2.

Sec. 1299.2 Cooperation with State Board and Department of Public Health.

The various boards, commissions, departments and agencies of the state and the parishes, municipalities and other political subdivisions capable of assisting or having services and facilities for assisting the State Board of Health and/or Department of Health in carrying out any program established under the authority of this Part may cooperate with the State Board of Public Health and the State Department of Public Health and may furnish any such services and facilities in aid of any such program. Acts 1964, No. 269, Sec. 3.

Sec. 1299.3 Cooperation of physicians and hospitals.

The State Board of Health may invite the cooperation of all physicians and hospitals in the state which provide maternity and newborn infant care to participate in any program established by the said board and/or the State Department of Public Health under the authority of this Part. Acts 1964, No. 269, Sec. 4.

MAINE

Me. Rev. Stat. Ann. tit. 22, Sec. 1522 (Supp. 1970)

Sec. 1522. Detection of mental retardation.

The department is authorized to require hospitals, maternity homes and other maternity services to test or cause to be tested newborn infants for the presence of metabolic abnormalities which may be expected to result in subsequent mental deficiencies. The department shall promulgate rules and regulations to define this requirement and the approved testing methods, materials, procedure and testing sequences. Reports and records of those making such tests may be required to be submitted to the department in accordance with departmental rules and regulations. The department may, on request, offer consultation, training and evaluation services to such testing facilities. This

section shall not apply if the parents of such child object thereto on the grounds that such test conflicts with their religious tenets and practices. (1965, c. 224)

MARYLAND

Md. Ann. Code art. 43, Sec. 38A (Supp. 1969)

Sec. 38A. Test of newborn child for phenylketonuria.

When a birth occurs in an institution the person in charge of the institution or his designated representative, or in the event that a birth occurs outside an institution, the person required to prepare and file the certificate of birth pursuant to Sec. 17 of this article, shall cause to have administered to every such newborn child a test for phenylketonuria in accordance with rules and regulations prescribed by the State Board of Health and Mental Hygiene. In the event the newborn infant leaves or is discharged from the institution and it has not been possible to secure a satisfactory screening test, the person in charge of the institution or his designated representative shall notify in writing the parents advising them to have administered to such infant a test for phenylketonuria by the private physicial or local health department, with a copy of the letter being sent to the private physician and local health department. It shall further be the responsibility of the person in charge of the institution or his designated representative to determine that a satisfactory test has been subsequently performed. The test and the recording of the results of the test shall be performed at such times and in such manner as the Board may direct. This requirement shall not apply to any child whose parent or parents object to the administration of the test on the grounds that the same would violate their religious beliefs. (1965 ch. 441; 1967, ch. 517)

MASSACHUSETTS

Mass. Ann. Laws ch. 111, Sec. 110A (1967)

Sec. 110A. Phenylketonuria Test Required of Certain Newborn Children.

The physician attending a newborn child shall cause said child to be subjected to a phenylketonuria test.

The department shall make such rules pertaining to such tests as accepted medical practice shall indicate.

The provisions of this section shall not apply if the parents of such child object thereto on the grounds that such test conflicts with their religious tenets and practices. (Added 1963, 545, approved July 17, 1963, effective 90 days thereafter)

MICHIGAN

Mich. Stat. Ann. Secs. 14.565(1) through -565(4) (1969)

Sec. 14.565(1). Phenylketonuria test; administration; report of results; time for administration. The physician in charge of the care of any newborn infant, or if none the physician in charge at the birth of any infant, shall administer or cause to be administered a phenylketonuria test approved by the state director of health and report the results of the test to the parents or guardian of the infant. The test shall be administered before the infant is discharged from its place of birth or within such time and under such conditions and regulations as shall be prescribed by the state director of health. (as amended by Pub. Acts 1967, No. 228 eff. Nov 2)

Sec. 14-565(2). Rules and regulations. The state health commissioner shall promulgate rules and regulations for the enforcement of this act in accordance with the provisions of Act No. 88 of the Public Acts of 1943, as amended, being sections 24.71 to 14.80 of the Compiled Laws of 1948.

Sec. 14.565(3). Violation; misdemeanor. Any person who shall fail to comply with any provision of this act or any rules and regulations promulgated thereunder shall be guilty of a misdemeanor.

Sec. 14.565(4). Effective date. This act shall be effective August 1, 1965.

MINNESOTA

Minn. Stat. Sec. 144.125 (Supp. 1970)

Sec. 144.125. Tests of infants for inborn metabolic errors causing mental retardation.

It is the duty of (1) the administrative officer or other person in charge of each institution caring for infants 28 days or less of age and (2) the person required in pursuance of the provisions of Minnesota Statutes, Section 144.159, to register the birth of a child, to cause to have administered to every such infant or child in its or his care tests for phenylketonuria and other inborn errors of metabolism causing mental retardation in accordance with rules or regulations prescribed by the state board of health. Testing and the recording and reporting of the results of such tests shall be performed at such times and in such manner as may be prescribed by the state board of health. The provisions of this section shall not apply to any infant whose parents object thereto on the grounds that such tests and treatment conflict with their religious tenets and practices. Added Laws 1965, c. 205, Sec. 1, eff. July 1, 1965.

MISSOURI

Mo. Rev. Stat. Sec. 210.065 (Supp. 1969)

Sec. 210.065. Infants to be tested for metabolic diseases -- reports -- exceptions -- penalties.

1. Every infant who is born in this state shall, prior to the tenth week of life, be subjected to a test for phenylketonuria and such other metabolic diseases as are prescribed by the division of health. The division of health shall make such rules pertaining to such tests as shall be dictated by accepted medical practice, and tests shall be of the types approved by the division of health. The parents, guardian or custodian of all such infants shall cause such tests to be performed through the attending physician, midwife, public health facility or hospital.

2. All physicians, public health nurses and administrators of hospitals shall report the discovery of cases of phenylketonuria and other metabolic defects as designated by the division of health to the division of health.

3. The division of health shall institute and carry on educational programs about phenylketonuria and other metabolic defects and examinations for detecting them for physicians, hospitals, public health nurses and the general public. The division shall prescribe and furnish all necessary reporting forms.

4. The provisions of this section shall not apply if the parents of such child object to the tests or examinations provided herein on the grounds that such tests or examinations conflict with their religious tenets and practices.

5. The parents of any child who fail to have such test or examination administered after notice of the requirement for such test or examination by the physician shall be guilty of a misdemeanor and upon conviction thereof shall be punished as provided by law. (Laws 1965, H.B. No. 55)

MONTANA

Mont. Rev. Codes Ann. Sec. 69-4116 (1970)

Sec. 69-4116. Newborn infants-test for phenylketonuria required. Persons in charge of any facility caring for newborn infants and persons responsible for the registration of births shall ensure that each infant has a test for phenylketonuria administered under rules adopted by the state board.

NEBRASKA

Neb. Rev. Stat. Secs. 71-604.01, 604.02 (as Revised by Leg. Bill No. 1099, Neb. CCH Advance Sessions Law Rept., 1969 New Laws p. 2537)

Sec. 1. That section 71-604.01, Revised Statutes Supplement, 1967 be amended to read as follows:

71-604.01. All infants born in the State of Nebraska shall be screened for metabolic disease. This screening shall be as prescribed by the Department of Health. The department is authorized to promulgate and enforce rules and regulations to aid in implementing the provisions of sections 71-604.01 and 71-604.02, and sections 3 and 4 of this act.

(1) In the event a screening test indicates a newborn infant may be afflicted with the phenylketonuria syndrome, it shall be the responsibility of the Department of Health to prescribe the procedures to be followed in order to determine if the syndrome is actually present.

(2) It shall be the responsibility of the Department of Health to follow the development of all children carrying the syndrome of any metabolic disease to insure that those persons responsible for the care of the child are fully informed of accepted medical procedures for the detection, prevention, and treatment of such condition.

(3) When tests for detecting a metabolic disease other than phenylketonuria are perfected the Director of Health may require that tests for the syndrome or syndromes be made and reported on the birth certificate.

Sec. 2. That section 71-604.02, Revised Statutes Supplement, 1967, be amended to read as follows:

71-604.02. (1) In cases where the required report to the Department of H alth shows that the newborn infant was not tested for phenylketonuria, the department is empowered to arrange for the infant to be tested.

(2) Where facilities are not available for the screening of newborn infants for the phenylketonuria syndrome the Department of Health shall perform the tests or may contract with any qualified laboratory for the testing of specimens.

Sec. 3. The tests for detecting metabolic disorders of the newborn infant, as prescribed by the Department of Health, shall include, but not be limited to, the testing for excessive phenylalanine in the serum of the newborn.

Sec. 4. Results of such tests for metabolic disorders in infants as prescribed by the Department of Health, may be included in the monthly report to the department on births as required by section 71-610; provided that a report of the result of such test shall be forwarded to the Department of Health no later than the tenth day of the succeeding month after the test is administered.

Sec. 5. That original sections 71-604.01 and 71-604.02, Revised Statutes Supplement, 1967, are repealed.

Sec. 6. Since an emergency exists, this act shall be in full force and take effect from and after its passage and approval, according to law.

Approved, September 19, 1969

NEVADA

Nev. Rev. Stat. Sec. 442.115 (1967)

442.115. Examination, testing of infants for discovery of phenylketonuria; reports; duties of physicians, others.

1. Any physician, surgeon, obstetrician, midwife, nurse, maternity home or hospital of any nature attendant on or assisting in any way whatever any infant, or the mother of any infant, at childbirth shall make or cause to be made an examination of such infant, including a standard test, to the extent necessary for the discovery of phenylketonuria.

2. If the examination and test reveal the existence of such a condition in an infant, the physician, surgeon, obstetrician, midwife, nurse, maternity home or hospital attendant on or assisting at the birth of such infant shall immediately:

(a) Report such condition to the local health officer of the county or city within which the infant or the mother of the infant resides, and the local health officer of the county or city in which the child is born; and

(b) Discuss the condition with the parent, parents or other persons responsible for the care of the infant and inform such person or persons of the treatment necessary for the cure of the condition.

3. An infant shall be exempt from examination if either parent files with the person or institution responsible for making such examination a written statement objecting to the examination. (Added to NRS by 1967, 208)

NEW HAMPSHIRE

N.H. Rev. Stat. Ann. Secs. 132:10a to 132:10c (Supp. 1969)

Sec. 132:10-a. Phenylketonuria Test Required. The physician and/or hospital attending a newborn child shall cause said child to be subject to a phenylketonuria test.

Sec. 132:10-b. Rules and Regulations. The director of the division of

public health services shall make such rules and regulations pertaining to such tests as accepted medical practice shall indicate.

Sec. 132:10-c. Exception. The provisions of sections 10-a and 10-b shall not apply if the parents of such child object thereto. (Laws of 1965, ch. 48)

NEW JERSEY

N. J. Stat. Ann. Secs. 26:2-82 to -85 (Supp. Feb. 1969)

Sec. 26:2-84. Public policy; tests for detection of phenylketonuria in newborn children.

It is hereby declared to be the public policy of this State that in the interests of public health every newborn infant should be given a test approved by the State Department of Health for the detection of phenylketonuria, commonly known as "PKU," in order to prevent mental retardation resulting from this disease. No such test shall be made as to any newborn infant if, the parents of said child object thereto on the grounds that such a test would conflict with their religious tenets or practices. L. 1964, c. 268, Sec. 1.

Sec. 26:2-85. Laboratory services; educational and training program; rules; fees.

The State Department of Health shall institute and carry on such laboratory services as are deemed necessary by the Public Health Council and an intensive educational and training program among physicians, hospitals, public health nurses and the public concerning the disease of phenylketonuria. This program shall include information concerning the nature of the disease and testing for the detection of this disease in infancy in order that measures may be taken to prevent mental retardation resulting from this disease. The State Commissioner of Health shall make rules governing the submission to the State Laboratory of specimens for PKU testing and may fix fees to be charged and collected therefor. L. 1964, c. 268, Sec. 2.

NEW MEXICO

N. M. Stat. Ann. Secs. 12-1-24 through -26 (1968)

Sec. 12-1-24. Tests for the detection of phenylketonuria in newborn children -- Public policy. It is hereby declared to be the public policy of this state that in the interests of public health every newborn infant should be given a test approved by the state department of public health for the detection of phenylketonuria, commonly known as "PKU", in order to prevent mental retardation resulting from this disease. No such test shall be made as to any newborn infant if the parents or guardians of said child object in writing thereto. (Laws

1966, ch. 33, Sec. 1.)

Sec. 12-1-25. Laboratory services -- Educational program. The state department of public health shall institute and carry on such laboratory services as are deemed necessary by the state board of public health and an educational program among physicians, hospitals, public health nurses and the public concerning the disease of phenylketonuria. This program shall include information concerning the nature of the disease and testing for the detection of this disease in infancy in order that measures may be taken to prevent mental retardation resulting from this disease. (Laws 1966, ch. 33, Sec. 2)

Sec. 12-1-26. PKU advisory committee created -- Membership -- Duties. A PKU advisory committee is created. The committee shall consist of representatives from organizations who have displayed an interest in the problem. The committee shall be appointed by the state health director. The committee shall advise with the state health director and the state board of public health in the implementation of this act (12-1-24 to 12-1-26). The committee members shall serve without pay. (Laws 1966, ch. 33, Sec. 3)

NEW YORK

N.Y. Public Health Law Sec. 2500-a (Supp. 1970)

Sec. 2500-a. Test for phenylketonuria. It shall be the duty of (1) the administrative officer or other person in charge of each institution caring for infants twenty-eight days or less of age and (2) the person required in pursuance of the provisions of section forty-one hundred thirty of this chapter to register the birth of a child, to cause to have administered to every such infant or child in its or his care a test for phenylketonuria in accordance with rules or regulations prescribed by the commissioner. Testing and the recording of the results of such tests shall be performed at such times and in such manner as may be prescribed by the commissioner. Added L. 1964, c. 785, eff. Jan. 1, 1965.

NORTH DAKOTA

N.D. Cent. Code Sec. 25-17-04 (1970)

Sec. 25-17-04. Physician to initiate test and report positive diagnosis. The physician attending a newborn child shall cause such child to be subjected to a phenylketonuria test, as well as other tests for errors of metabolism, in the manner prescribed by the state department of health. A physician attending a case of phenylketonuria or other metabolic disease which may cause mental retardation shall report such case to the state department of health. The provisions of this section shall not apply if the parents of such child object thereto on the grounds that such test conflicts with their religious tenets and practices.

OHIO

Ohio Rev. Code Ann. Sec. 3701.501 (Supp. 1969)

Sec. 3701.501. Phenylketonuria test required for newborn child.

(A) The person required to file a certificate of birth under section 3705.14 of the Revised Code shall cause such newborn child to be tested to determine the presence of phenylketonuria in accordance with regulations adopted by the public health council pursuant to Chapter 119. of the Revised Code. Regulations adopted by the public health council also shall prescribe laboratory methods and other procedures for the detection of phenylketonuria.

(B) Division (A) of this section does not apply if the parents of such child object thereto on the grounds that such test conflicts with their religious tenets and practices. (Laws of Ohio, Vol. 131, S. 19 (1965))

OKLAHOMA

Okla. Stat. Ann. tit. 63, Sec. 1-533 through -534 (Supp. 1969)

Sec. 1-533. Phenylketonuria and related inborn metabolic disorders -- Educational program.

The State Board of Health shall institute and carry on an intensive educational program among physicians, hospitals, public health nurses, and the public concerning phenylketonuria and related inborn metabolic disorders. This educational program shall include information about the nature of the diseases and examinations for the detection of the diseases in infancy in order that measures may be taken to prevent the mental retardation resulting from these diseases. Laws 1965, c. 252, Sec. 1.

Sec. 1-534. Tests.

The State Board of Health shall make such rules and regulations pertaining to such tests as accepted medical practice shall indicate, and is authorized to make such testing mandatory if sufficient evidence exists that the public has been negligent in accepting such practice and if the Board considers it in the public interest to do so. The State Board of Health is hereby authorized to set up laboratory facilities and use existing facilities for the performance of examinations and tests for the detection of these diseases and make a reasonable charge therefor; provided, however, that no child shall be denied such laboratory work or tests because of the inability of its parents or guardian to pay therefor. Provided, further, that the State Board of Health may approve other laboratories for the performance of such tests; provided that the provisions of this Section shall not apply to any infant whose parents object thereto on the grounds that such examination conflicts with their religious tenets and practices. Laws 1965, c. 252, Sec. 2.

OREGON

Ore. Rev. Stat. Secs. 433.285 through 433.295 (1968)

Control of Phenylketonuria

Sec. 433.285. Policy to control phenylketonuria. It hereby is declared to be a matter of public policy of the State of Oregon that in the interest of public health and the prevention of mental retardation, every infant, before becoming two weeks of age, should be given tests approved by the State Board of Health for the detection of the disease of phenylketonuria. (1962, c. 190 Sec. 1; 1965, c. 88 Sec. 1)

Sec. 433.290. Board to conduct educational program concerning phenylketonuria. The State Board of Health shall institute and carry on an intensive educational program among physicians, hospitals, public health nurses and the public concerning the disease of phenylketonuria. This educational program shall include information concerning the nature of the disease and examinations for the detection of the disease in infancy in order that measures may be taken to prevent the mental retardation resulting from the disease. (1963, c. 190 Sec. 2)

Sec. 433.295. Report of cases required; forms to be furnished.

(1) All physicians, public health nurses and the administrators of hospitals shall report the discovery of cases of phenylketonuria to the State Board of Health.

(2) The State Board of Health shall furnish all physicians, public health nurses and hospitals forms on which the result of tests for phenylketonuria shall be reported to the State Board of Health. (1963, c. 190 Sec. 3)

PENNSYLVANIA

Pa. Stat. tit. 35, Sec. 621 (Supp. 1970)

INFANTS

METABOLIC DISEASES

Sec. 621. Tests, newborn infants.

Every hospital or other institution caring for newborn infants, or any physician having in his care newborn infants shall administer or cause to be administered to every such infant in its or his care a test for phenylketonuria approved by the Advisory Health Board of the State Department of Health and tests for such other metabolic diseases of the newborn which may lead to mental retardation or physical defects and which may be approved by such Advisory Health Board. No such test shall be made if the parent or guardian of the newborn child dissents on the

ground that the test conflicts with his religious beliefs or practices. (1965, Sept. 9, P.L. 497, Sec. 1)

RHODE ISLAND

R.I. Gen. Laws Ann. Sec. 23-13-12 (1968)

Sec. 23-13-12. Phenylketonuria test. The physician attending a newborn child shall cause said child to be subject to a phenylketonuria test. The department of health shall make such rules pertaining to such tests as accepted medical practice shall indicate. The provisions of this section shall not apply if the parents of such child object thereto on the grounds that such test conflicts with their religious tenets and practices.

SOUTH CAROLINA

S.C. Code Ann. Sec. 32-555.1 (Supp. 1969)

Sec. 32-555.1. Testing infants for phenylketonuria. Every child born in any hospital licensed by the State Board of Health shall have a test for phenylketonuria. Testing and the recording of the results of the tests shall be performed at such times and in accordance with such rules and regulations as may be prescribed by the Board.

Provided, children of parents objecting to this test on religious grounds shall not be given this test. (1965 (54) 641)

TENNESSEE

Tenn. Code Ann. Secs. 53-624 through -633 (Supp. 1969)

Sec. 53-624. Phenylketonuria and other metabolic defects - Public policy. The general assembly hereby declares that as a matter of public policy of this State and in the interest of public health, every newborn infant shall be tested for phenylketonuria and other metabolic defects in order to prevent mental retardation resulting therefrom; and that the people of this State shall be extensively informed as to the nature and effects of such defects. (Acts 1968 (Adj. S.), ch. 462, Sec. 1)

Sec. 53-625. Tests and examinations to be prescribed by public health council. The Tennessee public health council shall prescribe from time to time effective tests and examinations designed to detect phenylketonuria and such other metabolic disorders or defects likely to cause mental retardation. Such tests shall be in accordance with accredited medical practices and the council may alter or withdraw such tests or examinations whenever sound medical practice so indicates. (Acts 1968 (Adj. S.), ch. 462, Sec. 2)

Sec. 53-626. Specimens for testing - Rules for obtaining - Persons responsible. The state department of public health shall promulgate rules and regulations concerning the obtaining of samples or specimens from newborn infants required for the tests prescribed by the Tennessee public health council, for the handling and delivery of the same, and for the testing and examination thereof to detect phenylketonuria or other metabolic disorders found likely to cause mental retardation. The commissioner of public health shall designate the person or persons to be charged with the duty of causing newborn children to be tested to determine the presence of phenylketonuria or other metabolic disorders, which person or persons may include:

(a) the person required to file a certificate of birth under provisions of Sec. 53-431; (b) the parents, guardian or custodian of the child during its first two (2) weeks of life; (c) such other person or persons as the commissioner of public health shall deem appropriate. (Acts 1968 (Adj. S.), ch. 462, Sec. 3)

Sec. 53-627. Performance and reporting of tests. The performance of such tests and reporting of the results shall be done at such times, places, and in the manner that may be prescribed by the state department of public health. (Acts 1968 (Adj. S.), ch. 462, Sec. 4)

Sec. 53-628. Suspected defects - Additional tests. It shall be the duty of the state department of public health to contact as soon as possible all cases suspected of having any such disorders or defects and to do or require to be done any additional testing required to confirm or disprove the suspected disorder or defect. (Acts 1968 (Adj. S.), ch. 462, Sec. 5)

Sec. 53-629. Information to medical profession - Department to furnish. The department of public health shall furnish all physicians, public health nurses, hospitals, maternity homes, midwives, and department (sic) of public welfare available medical information concerning the nature and effects of phenylketonuria and other metabolic disorders and defects found likely to cause mental retardation. (Acts 1968 (Adj. S.), ch. 462, Sec. 6)

Sec. 53-630. Cooperation of departments. All other state departments, including the department of public welfare, the department of mental health, and county and municipal health departments and education departments shall cooperate with the department of public health in carrying out the provisions of Secs. 53-624 to 53-633. (Acts 1968 (Adj. S.), ch. 462, Sec. 7)

Sec. 53-631. Exemptions for religious scruples. Nothing in the provisions of Secs. 53-624 to 53-633 shall be construed to require the testing or medical treatment for the minor child of any person who is a member of a well-organized church or religious denomination whose religious convictions in accordance with the tenets or principles of his church or denomination are against medical treatment for diseases or physical defects. (Acts 1968 (Adj. S.), ch. 462, Sec. 8)

Sec. 53-632. Failure to have child tested - Misdemeanor. Any person charged with the responsibility of causing any infant to be tested within the provisions of Sec. 53-624 to 53-633 who shall willfully refuse or willfully fail to have such child tested according to the rules and regulations promulgated by the department of public health shall be guilty of a misdemeanor. (Acts 1968 (Adj. S. , ch. 462, Sec. 9)

Sec. 53-633. Reports to governor and legislature. The department of public health shall report to the governor and to the legislature during each regular session of the legislature as to the progress and effect of testing programs. (Acts 1968 (Adj. S.), ch. 462, Sec. 10)

TEXAS

Tex. Civ. Stat. Sec. 4447e (1966)

PHENYLKETONURIA

Sec. 1. The State Department of Health shall establish, maintain, and carry out a program designed to combat mental retardation in children suffering from a genetic defect which causes phenylketonuria. The State Department of Health is authorized to adopt regulations necessary to carry out the program. The Department shall establish and maintain a diagnostic laboratory for conducting experiments, projects, and other undertakings necessary to develop tests for the early detection of phenylketonuria; for developing ways and means or discovering methods to be used for the prevention and treatment of phenylketonuria in children; and for such other purposes considered necessary by the Department to carry out the program.

Sec. 2. The physician attending a newborn child, or the person attending a newborn child that was not attended by a physician, shall cause the child to be subjected to the phenylketonuria test that has been approved by the State Department of Health. Providing, however, that such test shall not be given to any child whose parents or guardian object thereto on the grounds that such tests conflict with their religious tenets or practices. Provisions of this Act are mandatory with the exception above-stated: however, no physician, technician, or person giving such test shall be liable or responsible because of the failure or refusal of the parent or guardian to give permission or consent to tests herein provided. The county health officer shall follow up all positive tests with the attending physician who notified such officer or with the parent of the newborn child if such notification was made by a person other than a physician. When a positive test is confirmed, the services and facilities of the State Department of Health, and those of other boards, departments, agencies, and political subdivisions of the State cooperating with the Department in carrying out the program, shall be made available to the extent needed by the family and physician. The State Department of Health and the other departments, boards, agencies, and political subidivions of the State cooperating with it shall, in cooperation with an attending physician, provide

for the continued medical care, dietary, and other related needs of such children where necessary or desirable.

Sec. 3. The various boards, departments, agencies and political subdivisions of the State capable of assisting the State Department of Health in carrying out any program established under the authority of this Act may cooperate with the department and are encouraged to furnish their services and facilities in aid of any such program.

Sec. 4. The State Department of Health may invite the cooperation of all physicians and hospitals in the state which provide maternity and newborn infant care to participate in any program established by the Department under the authority of this Act. Acts 1965, 59th Leg., p. 506, ch. 262.

UTAH

Utah Code Ann. Sec. 26-17-21 (1969)

Sec. 26-17-21. PKU tests of newborn infants - Board of health to establish rules and regulations. The board of health shall establish rules and regulations requiring each newborn infant to be tested for the presence of phenylketonuria (PKU) and other metabolic diseases which may result in mental retardation or brain damage and for which a preventive measure or treatment is available and for which a laboratory diagnostic test method has been found reliable.

VIRGINIA

Va. Code Ann. Secs. 32-112.1 through -112.9 (1969)

Sec. 32-112.1. Infants to be subjected to tests; parent, guardian, etc., to cause tests to be made. Every infant who is born in this State shall be subjected to a test for phenylketonuria in order to prevent mental retardation. The parent, guardian, or other person having control or charge of any infant at childbirth shall cause such tests to be performed through the attending physician, public health facility, or hospital. (1966, c. 179)

Sec. 32-112.2. State Board of Health to adopt regulations and procedures, prescribe tests and examinations. The State Board of Health shall adopt regulations and procedures to establish, maintain, and carry out an intensive public education program concerning phenylketonuria designed to detect said disorder, and shall prescribe effective tests and examinations for phenylketonuria as accepted medical practice shall indicate. (1966, c. 179)

Sec. 32-112.3. Rules and regulations of State Board of Health. The State Board of Health shall promulgate rules and regulations concerning the obtaining of samples or specimens from newborn infants required for

the tests prescribed by the State Board of Health, for the handling and delivery of the same, and for the testing and examination thereof to detect phenylketonuria. (1966, c. 179)

Sec. 32-112.4. State Health Department to notify parent, guardian, etc., of necessity for test; performance of tests and reporting of results. The State Health Department shall notify the parent, guardian or other person having control or charge of any infant at childbirth of the necessity for such tests. The performance of such tests and the reporting of results shall be done at such times, places and in such manner as may be prescribed by the State Health Department, which shall prescribe and furnish all necessary reporting forms. (1966, c. 179)

Sec. 32-112.5. State Health Department to contact suspected cases; reports by physicians, public health nurses, etc. The State Health Department shall contact as soon as possible all cases suspected of having any such disorders or defects and do any additional testing required to confirm or disprove the suspected disorder or defect. All physicians, public health nurses and administrators of hospitals in this State shall report the discovery of all cases of phenylketonuria to the State Health Department. (1966, c. 179)

Sec. 32-112.6. Further treatment of infants found to have phenylketonuria. The State Board of Health shall recommend procedures for the further treatment of all infants who are detected to have phenylketonuria. (1966, c. 179)

Sec. 32-112.7. State Health Department to contact cases to which tests not administered. The State Health Department on forms prescribed by it shall contact all cases which it has reason to believe have not been administered such tests in order to cause such tests to be administered. (1966, c. 179)

Sec. 32-112.8. State Health Department to furnish information concerning phenylketonuria. The State Health Department on forms prescribed by it shall contact all cases which it has reason to believe have not been administered such tests in order to cause such tests to be administered. (1966, c. 179)

Sec. 32-112.9. Tests not to be given where parent or guardian objects on religious grounds. Such test shall not be given to any infant whose parent or guardian objects thereto on the grounds that such test conflicts with his religious practices or tenets. (1966, c. 179)

WASHINGTON

Wash. Rev. Code Secs. 70.83.010 through -70.83.060 (Supp. 1969)

Sec. 70.83.010. Declaration of policy and purpose. It is hereby declared to be the policy of the state of Washington to make every effort to detect as early as feasible and to prevent where possible phenylketonuria and other preventable heritable disorders leading to

mental retardation or physical defects. (Enacted Laws 1967 ch. 82 Sec. 1)

Sec. 70.83.020. Screening tests of newborn infants. It shall be the duty of the Washington state department of health to promote screening tests of all newborn infants for the detection of phenylketonuria and other heritable or metabolic disorders leading to mental retardation or physical defects when such tests are available, practical, and indicated by sound medical practice. (Enacted Laws 1967 ch. 82 Sec. 2)

Sec. 70.83.030. Report of positive test to department of health. Laboratories, attending physicians, hospital administrators, or other persons performing or requesting the performance of tests for phenylketonuria shall report to the department of health all positive tests. The state board of health by rule and regulation shall, when it deems appropriate, require that positive tests for other heritable and metabolic disorders covered by this chapter be reported to the state department of health by such persons or agencies requesting or performing such tests. (Enacted Laws 1967 ch. 82 Sec. 3)

Sec. 70.83.040. Services and facilities of state agencies made available to families and physicians. When notified of positive screening tests, the state department of health shall offer the use of its services and facilities, designed to prevent mental retardation or physical defects in such children, to the attending physician, or the parents of the newborn child if no attending physician can be identified.

The services and facilities of the state department of health, and other state and local agencies cooperating with the department of health in carrying out programs of detection and prevention of mental retardation and physical defects shall be made available to the family and physician to the extent required in order to carry out the intent of this act and within the availability of funds. (Enacted Laws 1967 ch. 82 Sec. 4)

Sec. 70.83.050. Rules and regulations to be adopted by state board of health. The state board of health shall adopt rules and regulations necessary to carry out the intent of this chapter. (Enacted Laws 1967 ch. 82 Sec. 5)

Sec. 70.83.060. Annual reports to governor and legislative council. The department shall report annually to the governor and the legislative council on the progress and effect of such testing programs. The first such report shall be delivered by January 1, 1968. (Enacted Laws 1967 ch. 82 Sec. 6)

WEST VIRGINIA

W. Va. Code Ann. Sec. 16-22-3 (Supp. 1969); W. Va. Code Ann. Secs. 16-22-1, 22-2, 22-4 through 22-6 (1966)

Article 22. Detection and control of phenylketonuria in newborn children.

Sec. 16-22-1. Findings: The legislature finds that phenylketonuria, a genetic defect affecting body metabolism, is usually associated with mental retardation. Laboratory tests are readily available to aid in the detection of this disease and its hazards to health of those suffering thereof may be lessened or prevented by early detection and treatment. Damage from the disease, if untreated in the early months of life, is usually rapid and not appreciably affected by treatment. (1965 c. 136)

Sec. 16-22-2. Program to combat mental retardation; rules and regulations; facilities for making tests. The State department of health is hereby authorized to establish and carry out a program designed to combat mental retardation in our State's population due to phenylketonuria, and may reasonable rules and regulations necessary to carry out such a program. The department of health shall establish and maintain facilities at its State hygienic laboratory for testing specimens for the detection of phenylketonuria. Tests shall be made by such laboratory of specimens upon request by physicians, hospital medical personnel and other individuals attending newborn infants. The State department of health is authorized to establish additional laboratories throughout the State to perform tests for the detection of phenylketonuria. (1965, c. 136)

Sec. 16-22-3. Test for phenylketonuria; reports; assistance to afflicted children. The physician attending a newborn child or any person attending a newborn child not under the care of a physician shall cause to be made a test for phenylketonuria approved by the State department of health. Any test found positive for phenylketonuria shall be promptly reported to the State department of health by the director of the laboratory performing such test.

The State department of health, in cooperation with other State departments and agencies, and with attending physicians is authorized to provide medical, dietary and related assistance to children determined to be afflicted with phenylketonuria. (1965, c. 136; 1966, c. 36)

Sec. 16-22-4. Penalties for violation of provisions of this article. Any person violating the provisions of this article shall be guilty of a misdemeanor, and, upon conviction, shall be fined not less than twenty-five nor more than fifty dollars. Violation of each such provision shall be considered a separate offense. (1965, c. 136)

Sec. 16-22-5. Severability. If any provision or item of this article or application thereof is held invalid, such invalidity shall not affect other provisions, items or applications of this article. (1965, c. 136)

Sec. 16-22-6. Effective date. The effective date of this article shall be July one, one thousand nine hundred sixty-five. (1965, c. 136)

WISCONSIN

Wisc. Stat. Ann. Sec. 146.02 (Supp. 1970)

Sec. 146.02. Tests for mental retardation.

(1) The attending physician shall cause every infant born in each hospital or maternity home, prior to its discharge therefrom, to be subjected to a test for phenylketonuria and such other causes of mental retardation under sub. (2) as the department of health directs.

(2) The tests to be performed shall be determined by the department of health and shall be performed in such regional laboratories as the department of health approves for this purpose, in accordance with rules prescribed by the department.

(3) This section shall not apply if the parents of the child object thereto on the grounds that the test conflicts with their religious tenets and practices. (L. 1965, c. 372, Sec 2 eff. Jan. 1, 1966, Subsecs. (1) and (2) amended by - L. 1969, c. 366, Sec. 117)

NOTE: Seven states were not listed in the State Laws Pertaining to Phenylketonuria as of November, 1970. They are Delaware, Mississippi, North Carolina, South Dakota, Vermont, Virginia, and Wyoming.

APPENDIX E

TESTS USED IN PHENYLKETONURIA

VARIOUS TESTS USED TO IDENTIFY PHENYLKETONURIA

	Test	Method	Use
1.	"Diaper test" of urine.	10% ferric chloride dropped on freshly saturated diaper. Green spot read as positive, indicating probably phenylketonuria.	Method cheap and effective. Useful in screening large population of infants. Not of value until baby is over six weeks of age.
2.	Phenistix test of urine.	Phenistix pressed against wet diaper, or dipped in urine. Green reaction indicates probability of phenylketonuria.	Method simple and effective. More accurate than diaper test, but slightly more expensive. Useful for screening large populations of infants, children, and adults. Useful after sixth week of age.
3.	Dintirophenlydydrazine test-tube test of urine.	One-half to 1 cc. of urine is placed in a test tube. Equal amount of DNPH solution is added. Immediate pale yellow-orange reaction is negative. A gradual change to opaque bright-yellow is positive and indicates possibility of PKU.	Test cheap and accurate. More complicated than diaper test or Phenistix. Confusion may arise if urine is cloudy to begin with. Test most useful in clinical setting to confirm diaper test or phenistix.
4.	Serum phenylalanine test: Guthrie	Test made from drops of blood placed on filter paper. Laboratory uses a bacterial inhibition assay method. Level above 8 mgs.% of phenylalanine considered diagnostic of PKU.	Test can be used to detect PKU in newborn period. Useful to monitor PKU diet. Has advantage that blood easily obtained by heel or finger puncture.

	Test	Method	Use
5.	Serum phenylalanine test: LaDu-Michael method.	Test made from 5 cc. of blood. Serum separated and tested for phenylalanine. Level above 8 mgs.% indicates phenylketonuria.	Test used for diagnosis and to monitor PKU diet. Test requires blood to be drawn from patients. Laboratory method difficult. Test not available in many laboratories.
6.	Serum phenylalanine test: fluorometric method of McCaman and Robins.	Test made from 5 cc. of blood. Serum separated and tested for Phenylalanine. Level above 8 mgs. % indicates phenylketonuria. In PKU patients on diet, level above 8 to 12 mgs.% indicates loss of dietary control.	Tests used for diagnosis and to monitor PKU diet. Laboratory procedures more simple than LaDu-Michael method. Test not available in many laboratories.

APPENDIX F

LOW-PHENYLALANINE DIET GUIDE

TABLE X

BASIC DAILY REQUIREMENTS OF THE LOW-PHENYLALANINE DIET AND SUGGESTED QUANTITIES OF LOFENALAC PER POUND OF BODY WEIGHT

Age	Phenylalanine* (mg)	Protein** (gm.)	K Calories	Lofenalac*** (tablespoons)
0-6 months	40-30	2.0	60	1 1/4-1
7-12 months	30-20	1.5	55	1-3/4
1-3 years	20-15	1.0	40-50	2/3
4-6 years	15-7	.75	35-40	1/2
7-9 years	7-5	.65	30-35	1/3-1/2
10-12 years	7-12	.50	25-30	1/2-1/3

*Mostly from milk and/or other foods added to the diet.

**Mostly from Lofenalac.

***Ranges wider than those shown are possible, depending on the amounts and kinds of supplementing foods used. Lofenalac alone in amounts listed will not supply the required phenylalanine for most children on the diet.

Note: Tables X and XIV are only general guides. The amount of phenylalanine needed to maintain a specific blood level and optimal growth and development varies considerably among children. Guided by frequent serum phenylalanine levels, an effort should be made to determine the maximum amount of phenylalanine the child can tolerate while keeping the level between 3 and 8 mg./ml.

TABLE XI

PHENYLALANINE, PROTEIN AND CALORIE CONTENT
OF "SERVINGS" IN TABLE X

List	Phenylalanine	Protein	Calories
	mg.	gm.	
Vegetables	15	0.5	10
Fruits			
Strained and Junior	15	0.6	150
Table and Juices	15	0.6	70
Breads and Cereals	30	0.6	30
Fats	5	0.1	60
Desserts*	30**	Varies	Varies
Free Foods	0	0	0
Lofenalac--2 Tbsp. powder	15	3.0	40

*Special recipes must be used.

**Averages from all dessert recipes.

TABLE XII

SERVING AMOUNTS FOR PHENYLALANINE-RESTRICTED DIET

VEGETABLES

Each Serving as Listed Contains 15 Milligrams Phenylalanine.

Strained and Junior Vegetables

Beets	6 tbsp.
Carrots	8 tbsp.
Creamed Spinach	2½ tbsp.
Green Beans	3 tbsp.
Squash	5 tbsp.
Lettuce, all	6 med. (1 sm.=
Mushrooms, cooked	2 gm.) (1 med.=
	3.5 gm., 1 lg. =
	5 gm).

Vegetables

Asparagus, cooked	1 stalk
Beans, green, cooked	5 tbsp.
Beans, yellow, cooked	5 tbsp.
Bean Sprouts, Mung, cooked	1½ tbsp.
Beets, cooked	8 tbsp.
Beet Greens, cooked	1 tbsp.
Broccoli, cooked	1 tbsp.
Brussels Sprouts, cooked	1 med.
Cabbage, raw, shredded	8 tbsp.
Cabbage, cooked	8 tbsp.
Carrots, raw	1/3 large
Carrots, cooked	5 tbsp.
Cauliflower, cooked	3 tbsp.
Celery, cooked, diced	4 tbsp.
Celery, raw	1 - 8" stalk
Chard Leaves, cooked	1½ tbsp.
Collards, cooked	1½ tbsp.
Cucumber Slices, raw	1 med. 6" long
	2" diam. Peeled
	(158 gm).
Eggplant, diced, raw	2 tbsp.
Eggplant, cooked	2½ tbsp.
Kale, cooked	1½ tbsp.
Mushrooms, fresh	4 large
Mustard Greens, cooked	2 tbsp.
Okra, cooked	2 3" pods
Onion, raw chopped	4 tbsp.
Onion, cooked	4 tbsp.
Onion, young, Scallion	3½ 5" long
Parsley, raw, chopped	3 tbsp.

Parsnips, cooked diced	3 tbsp.
Peppers, raw, chopped	½ med or 8 tbsp.
Pickles, Dill	1 large
Pickles, Sweet	1
Pickle, Sweet Relish	12 tbsp.
Pumpkin, cooked	¼ cup
Radishes	4 small
Sauerkraut	½ cup
Spinach, cooked	1½ tbsp.
Squash, Summer, cooked	5 tbsp.
Squash, Winter, cooked	2½ tbsp.
Tomato, raw	½ small
Tomato, cooked	3 tbsp.
Tomato Juice	¼ cup
Tomato Catsup	2 tbsp.
Tomato Puree	2 tbsp.
Turnip Greens, cooked	1½ tbsp.
Turnips, diced, cooked	½ cup

FRUITS

Strained and Junior Fruits

Applesauce	11 tbsp.
Applesauce, and Apricots	10 tbsp.
Applesauce and Cherries	14 tbsp.
Applesauce and Pineapple	10 tbsp.
Apricots and Tapioca	12½ tbsp.
Bananas and Pineapple	10 tbsp.
Bananas and Tapioca	14 tbsp.
Dutch Apple Dessert	16 tbsp.
Peaches	9½ tbsp.
Pears	14 tbsp.
Pears and Pineapple	14 tbsp.
Plums and Tapioca	11 tbsp.
Prunes and Tapioca	9½ tbsp.

Little or no Phenylalanine

Apples and Cranberries	16 tbsp.

Fruits

Apple, raw	2 med. 2½" diam.
Applesauce	1 cup
Apricots, raw	1 med.
Apricots, canned	2 med., 2 tbsp. syrup
Apricots, dried	2 halves
Avocado, cubed or mashed	5 tbsp.
Banana, raw, sliced	5 tbsp.
Blackberries, raw	5 tbsp.
Blackberries, canned in syrup	5 tbsp.
Blueberries, raw or frozen	12 tbsp.

Blueberries, canned in syrup.	10 tbsp.
Cantaloupe, diced	1/6 med.
Sour Cherries	8 tbsp.
Sweet Cherries, canned in syrup	8 tbsp.
Cranberries, raw	1 cup
Cranberries, sweetened, cooked	1 cup
Dates	2 tbsp.
Figs, raw	1 med.
Figs, canned in syrup	3 med., 2 tbsp. syrup
Figs, dried	1 small
Fruit Cocktail	12 tbsp.
Grapefruit, raw	½ med.
Grapes, Thompson, seedless.	½ cup
Guava	½ med.
Honeydew	¼ small, 5" melon
Mango	1 small
Nectarines, raw	1½ med.
Nectarines, cooked	1½ med.
Oranges, raw	1 med.
Papaya, raw	¼ med. or ½ cup
Peaches, raw	1½ med. or 3/4 cup
Peaches, canned in syrup	3 halves, syrup
Peaches, dried	3 halves
Pears, raw	1 3" x 2½"
Pears, canned in syrup	2 whole, syrup
Pears, dried	2 halves
Pineapple, raw	1 cup diced
Pineapple, canned in syrup	3/4 cup crushed
	2 lg. slices
Plums, raw	2 med.
Plums, canned in syrup	4 med.
Prunes, dried	2 med.
Raisins, dried seedless	2 tbsp.
Raspberries, raw	5 tbsp.
Raspberries, canned in syrup	6 tbsp.
Strawberries, raw	10 large
Strawberries, frozen	½ cup
Tangerines	3 small
Watermelon	¼ wedge, ½ cup cubes

Fruit Juices

Apricot Nectar	6 oz.
Cranberry Juice	12 oz.
Grape Juice	4 oz.
Grapefruit Juice	4 oz.
Orange Juice	6 oz.
Peach Nectar	5 oz.
Pineapple Juice	6 oz.
Prune Juice	4 oz.

BREADS AND CEREALS

Each Serving as Listed Contains 30 Milligrams of Phenylalanine.

Prepared Cereals

Alpha Bits	4 tbsp.
Apple Jacks	7 tbsp.
Cap'n Crunch	7 tbsp.
Cheerios	3 tbsp.
Corn Chex	7 tbsp.
Cornfetti	5 tbsp.
Cornflakes	5 tbsp.
Crispy Critters	4 tbsp.
Froot Loops	5 tbsp.
Kix	5 tbsp.
Lucky Charms	4 tbsp.
OK'S	3 tbsp.
Pep Wheat Flakes	5 tbsp.
Puffed Rice	10 tbsp.
Puffed Wheat	5 tbsp.
Rice Chex	7 tbsp.
Rice Flakes	5 tbsp.
Rice Honeys	4 tbsp.
Rice Krinkles	5 tbsp.
Rice Krispies	6 tbsp.
Quake	5 tbsp.
Quisp	7 tbsp.
Stars	7 tbsp.
Shredded Wheat	½ large biscuit
Sugar Frosted Flakes	6 tbsp.
Sugar Pops	10 tbsp.
Sugar Smacks	8 tbsp.
Trix	6 tbsp.
Wheaties	4 tbsp.
Wheat Chex	12 biscuits
Wheat Honey	4 tbsp.

Cooked Cereals

Cornmeal	¼ cup
Cream of Rice	2 tbsp.
Cream of Wheat	2½ tbsp.
Farina	2½ tbsp.
Malt-o-Meal	2½ tbsp.
Oatmeal	2 tbsp.
Pettijohns	2 tbsp.
Ralston	2 tbsp.
Rice, brown or white	4 tbsp.
Wheatena	2½ tbsp.
Wheat Hearts	2½ tbsp.

Junior Breads and Cereals

Barley Cereal	3 tbsp.
Creamed Corn	8 tbsp.
Mixed Cereal	3 tbsp.
Oatmeal	2 tbsp.
Rice Cereal	5 tbsp.
Wheat Cereal*	2 tbsp.
Sweet Potatoes	8 tbsp.

*Phenylalanine calculated as 4.4% of Protein.

Crackers

Animal Crackers	5
Arrowroot Cookies	1½
Graham Crackers	1
Ritz Crackers	2
Saltines	2
Tortilla, Corn	½ (6" diam.)
Wheat Thins	5

Miscellaneous

Corn, cooked	1½ tbsp.
Hominy	4 tbsp.
Macaroni, cooked	1½ tbsp.
Noodles, cooked	1½ tbsp.
Potato Chips	6 (2" diam.)
Potatoes, Irish, cooked	3 tbsp.
Potatoes, French Fried	3 (½ x ½ x 2")
Instant Potatoes (dry) without milk.	2½ teas.
Popcorn, popped	6 tbsp.
Spaghetti, cooked	2 tbsp.
Sweet Potatoes, cooked	2½ tbsp.
Instant Sweet Potatoes, dry without milk	1 tbsp.

DESSERTS

Each Serving as Listed Contains 30 Milligrams Phenylalanine.

Cake*	1/12 of cake
Cookies, Rice Flour*	2
Cookies, Corn starch*	2
Cookies, Arrowroot	1½
Ice-Cream, chocolate*	2/3 cup
Ice-Cream, strawberry*	2/3 cup
Jello	1/3 cup
Puddings*	½ cup
Sauce, Hershey	2 tbsp.
Wafers, sugar, Nabisco	5

FATS

Each Serving as Listed Contains 5 Milligrams Phenylalanine.

Butter	1 tbsp.
French Dressing, Commercial	2 tbsp.
Margarine	1 tbsp.
Mayonnaise	½ tbsp.
Miracle Whip	½ tbsp.
Olives, green or ripe	1 med.

FREE FOODS

These Foods Contain Little or no Phenylalanine. May be Used as Desired.

Apple Juice
Candies:
  Butterscotch
  Cream Mints
  Fondant, patties or mints
  Gym Drops
  Hard Candy
  Jelly Beans
  Lollipops
Carbonated Beverages
Corn Syrup
Cornstarch
  Danish D ssert*
Diet Margarine
Fruit Butter
Fruit Ices
Jell Quick
Jellies
Kool Aid
Lemonade
Maple Syrup
Molasses
Popsicle
Rich's Topping
Shortening
Start Liquid
Sugar, Brown
Sugar, Granulated
Sugar, White, Powdered
Tang Liquid

---

*Recipes from "Phenylalanine-Restricted Diet Recipe Book," by Phyllis B. Acosta and Ardis Beckner, California State Department of Public Health, 1966.

MISCELLANEOUS

Food	Amount	Phenylalanine (mg.)	Protein (gm.)	Calories
Cake Flour	1 tbsp.	30	.6	26
Tapioca, Granulated	1 tbsp.	5	.1	36
Wheat Starch	1 tbsp.	1.2	.02	35
Non-Dairy Creams				
Bonus	1 tbsp.	2	.1	20
Coffee Rich	1 tbsp.	2	.04	22
Cool Whip	1 tbsp.	2	.1	48
Dzert Whip, Liquid	1 tbsp.	9	.2	44

Specialty Products

Jolly Joan Low-Protein Bread Mix

Lo Pro Pasta (Cellu)

Resource Baking Mix (D.M. Doyle Pharmaceutical Co.)

TABLE XIII

REFERENCE TABLE OF BABY FOODS

Food	Amount	Phenylalanine (mg.)	Protein (gm.)	Calories
Vegetables				
Beets	1 tbsp.	2.5	.16	5
Carrots	1 tbsp.	2.0	.1	4
Creamed Spinach	1 tbsp.	6.4	.4	6
Green Beans	1 tbsp.	5.0	.2	3
Squash	1 tbsp.	3.2	.1	3
Mixed Vegetables	1 tbsp.	5.0	.2	6
Fruits				
Applesauce	1 tbsp.	1.4	.03	12.4
Applesauce and Apricots	1 tbsp.	1.5	.04	13
Applesauce and Pineapple	1 tbsp.	1.5	.03	11
Apricots	1 tbsp.	1.2	.04	12
Bananas	1 tbsp.	1.0	.07	12
Bananas and Pineapple	1 tbsp.	1.4	.04	12
Peaches	1 tbsp.	1.4	.07	12
Pears	1 tbsp.	1.0	.04	10
Pears and Pineapple	1 tbsp.	1.2	.05	9
Plums	1 tbsp.	1.4	.04	14
Prunes	1 tbsp.	1.2	.04	13
Desserts				
Dutch Apple	1 tbsp.	.8	.09	15
Fruit Dessert	1 tbsp.	1.5	.04	13
Raspberry Cobbler	1 tbsp.	.7	.03	12
Blueberry Buckle	1 tbsp.	.6	.02	12
Apple Gel	1 tbsp.	.3	.01	10
Cherry Gel	1 tbsp.	1.3	.05	15
Orange Gel	1 tbsp.	.6	.05	10
Pineapple Gel	1 tbsp.	.7	.02	13
Peach Cobbler	1 tbsp.	2.2	.08	14
Cereals				
Barley	1 tbsp.	10.6	.4	9
Oatmeal	1 tbsp.	17.5	.4	9
Rice	1 tbsp.	6.2	.1	9
Wheat	1 tbsp.	14.1	.3	8.4
Mixed*	1 tbsp.	11.2	.3	9
Hi Protein	1 tbsp.	40.0	.8	9
Creamed Corn	1 tbsp.	4.0	.2	9
Sweet Potatoes	1 tbsp.	3.6	.2	9

Food	Amount	Phenylalanine (mg.)	Protein (gm.)	Calories
Cereals (Continued)				
Peas	Not Available			
Garden Vegetables	1 tbsp.	9.5	.3	5

*Phenylalanine calculated as 4.4% of protein.

TABLE XIV

EXAMPLES OF LOW-PHENYLALANINE MENUS

Age and weight	Formula	Breakfast	Mid-morning	Dinner	Mid-afternoon	Supper	Bedtime
2 months (10 lbs)	11 tbsp. Lofenalac 4½ oz. milk Water to make 25-30 oz.	Five or six 5-6 oz. feedings of formula.					
8 months (18 lbs)	15 tbsp. Lofenlac 3 oz. milk Water to make 28 oz.	5 tbsp. rice cereal* 7 oz. formula		½ cup chopped carrots 7 oz. formula		14 tbsp. mashed banana 7 oz. formula	2 tbsp. str. oatmeal 7 oz. formula
2 years (26 lbs)	16-18 tbsp. Lofenalac 2 oz. milk Water to make 24 oz.	2 tbsp. cooked oatmeal 2 canned apricots 6 oz. formula		3 tbsp. mashed potato-no milk 5 tbsp. cooked carrots 1 cup applesauce 6 oz. formula	2 animal cookies 6 oz. formula	2 tbsp. cooked rice 5 tbsp. cooked green beans 5 tbsp. fresh sl. banana 6 oz. formula	
4 years (36 lbs)	24 tbsp. Lofenalac Water to make 24 oz.	2 tbsp. cooked oatmeal 6 oz. formula		3 tbsp. mashed potato (use protein-free margarine, no milk) 5 tbsp. cooked carrots 1 cup applesauce 6 oz. formula	2 animal cookies 6 oz. formula	2 tbsp. cooked rice 5 tbsp. cooked green beans 5 tbsp. fresh sliced bananas 6 oz. formula	

16 tablespoons = 1 cup

*Do not use any "protein-fortified" cereals

APPENDIX G

PUBLIC HEALTH SERVICES FOR CHILDREN IN OKLAHOMA--

FIFTEEN SELECTED INSTITUTIONS AND AGENCIES

PUBLIC HEALTH SERVICES FOR CHILDREN IN OKLAHOMA

FIFTEEN SELECTED INSTITUTIONS AND AGENCIES

ALTUS-JACKSON COUNTY GUIDANCE CENTER
201 South Lee Street
Altus, Oklahoma 73521 Phone: 405 482-7308

Robert Warner, Chief Administrator

Contact Person: Audra Oldroyd, Secretary

SPONSOR: Altus and Jackson Counties, Oklahoma State Department of Health

ESTABLISHED: 1965

PROGRAM: Outpatient care only. Evaluation, diagnostic and counseling services for all children ages 2 years through 18 years.

Educational Facilities

Classes for Educable Mentally Retarded, Trainable Mentally Retarded in Altus Elementary School.
Classes for Educable Mentally Retarded in Junior and Senior High.

Special Services Available in Community

Speech and Hearing - Altus Public Schools
Altus-Jackson County Guidance Clinic
Reading Clinic in Altus Public Schools

Other Services Provided

Parental counseling
Aftercare services

Other Agencies Utilized

Child Welfare
CMH - Oklahoma City
Speech Clinic - Lawton Guidance Center

Altus-Jackson County Guidance Clinic (Continued)

ADMISSION REQUIREMENTS: Standard application forms for State Health Department Guidance Centers.

Geographic Area Served: Altus and Jackson Counties

FEE: None

ATOKA COUNTY GUIDANCE CENTER
Bo Box 128
Atoka, Oklahoma

Phone: 405 889-2116 or
405 332-0085

Dr. R. C. Dean, Medical Director

Contact Person: Dr. Sidney Pepper, Coordinator

LOCATION: 102 Virginia Street, Atoka

SPONSOR: Oklahoma State Health Department

PROGRAM: Outpatients only. No upper age limit for admission.

Facilities and staff supervision to serve Mentally Retarded, Emotionally Disturbed, Educationally Handicapped, testing for Vocational Training needs, psychological testing, referral counseling, school consultation perceptual training.

Educational Facilities

Community Schools: 2 elementary, 1 junior high, 1 senior high. One Special Education class for Educable Mentally Retarded in elementary.

Special Services Available in Community

Guidance Clinic

Other Services Provided

Parental counseling

BAPTIST MEMORIAL HOSPITAL
5800 N.W. Grand Blvd.
Oklahoma City, Oklahoma 73112 Phone: 405-946-6411

Mr. James Henry

Contact Person: Appropriate physician who is a member of the staff.

SPONSOR: Baptist Memorial Hospital

ESTABLISHED: May, 1960

PROGRAM: Any age. Facilities and staff supervision to serve mentally retarded, emotionally disturbed, educationally handicapped, vocational training needs, speech problems, hearing problems.

Special Services Available in Community

Speech and Hearing
Guidance Clinic
Reading Clinic

Other Services Offered

Parental counseling may be supplied by Social Service Department, or Department of Pastoral Care and Counseling. Aftercare Services are provided as an outpatient service.

Other Agencies Utilized

Social agencies in the community such as Community Guidance Center, Family and Child Service, Etc.

ADMISSION REQUIREMENTS:

Application:	Medical or physical problem and be admitted by M.D. only.
Placement Authority:	M.D.
Geographic Area Served:	No limits

FEE: According to service obtained.

LICENSURE: Approved by Hospital Association and other medical standard-setting organizations.

ACCREDITATION: Hospital Association and other authorized accredited agencies.

BETHANY GUIDANCE CENTER
6901 N. W. 23rd
Bethany, Oklahoma 73008 Phone: 405-789-9066

J. Ronald Cruse, PhD., Psychologist-Coordinator

SPONSOR: Oklahoma City-County Health Department and Oklahoma State Department of Health

ESTABLISHED: 1964

PROGRAM: Outpatient facilities and staff supervision to serve mentally retarded, emotionally disturbed, educationally handicapped, vocational training needs, speech problems and hearing problems. Services available to all children ages birth to 21 years.

Medical Services Available

Referral to City-County Health Department, Child Study Center of Oklahoma University Medical School, psychiatric consultation and referral to provate physicians.

Other Services Available

Parental counseling

ADMISSION REQUIREMENTS:

Placement Authority:	Application: Obtain application from Center.
Geographic Area Served:	Northwest Oklahoma City, children in Bethany and Putnam City school systems.

FEE: Sliding scale based upon family income and number of children.

CHEROKEE COUNTY GUIDANCE CENTER
2nd and College
Cherokee County Health Department
Tahlequah, Oklahoma 74464 Phone: 918-456-8828

J. T. Reese, Psychologist-Coordinator

Contact Person: Tim O'Connor, Psychologist

ESTABLISHED: 1968

PROGRAM: Out-patient services (no age limit) with facilities and staff supervision to serve mentally retarded, emotionally disturbed, educationally handicapped.

Educational Facilities

Community schools, elementary through senior high.

Special Services Available in Community

Two Educable Mentally Retarded classes, one Trainable Mentally Retarded class, one Learning Disabilities Learning Laboratory. Speech and Hearing Clinic available through Northeastern State College. Guidance Clinic offering diagnostic services, individual and group therapy. Reading Clinic at Northeastern State College.

Other Services Provided

Parental Counseling
Aftercare Services

Other Agencies Utilized

BIA, Vocational Rehabilitation, Child Study Centers, Department of Public Welfare.

ADMISSION REQUIREMENTS: No requirements.

Geographic Area Served: Cherokee, Adair and Sequoyah Counties.

FEE: Sliding scale based on annual income and number of children in family. No person denied services because of inability to pay.

MEMBERSHIPS: ACLD (local, state, and national), SWPA, OPHA, OSPA Associate Member, APA Associate Member.

CHICKASHA CEREBRAL PALSY DAY-CARE CENTER
9th and Choctaw
Chickasha, Oklahoma

Contact Person: Mrs. Cyril Novatny, R.R. 1, Amber, Oklahoma

SPONSOR: Grady County Cerebral Palsy Service Committee

ESTABLISHED: September, 1963

PROGRAM: Open Tuesday and Thursday afternoons to all physically or mentally handicapped, to give child the opportunity for social and emotional development, to expose the child to realistic life situations, to expose the child to group experiences, to help him develop his personality, and to receive training in other activities of daily living.

Open to all physically or mentally handicapped children in Grady County who have NO other program, age 4 and up.

FEE: None.

CHILD STUDY CENTER - UNIVERSITY OF OKLAHOMA MEDICAL CENTER
601 N.E. 18th Street
Oklahoma City, Oklahoma 73105 Phone: 405-524-4449

Ellidee D. Thomas, M.D., Director

Contact Person: Mrs. Dorothea Neal, Adm. Secretary

PROGRAM: Primarily a diagnostic and evaluative center for children with neurological problems including learning disabilities, seizure disorders, developmental and mental retardation.

Educational Facilities

Limited tutorial services on an individual basis for children with learning disabilities. Pre-school for deaf-blind children.

Medical Services Available

All facilities of the University of Oklahoma Medical Center.

Other Services Offered

Parental Counseling
Aftercare Services

Other Agencies Utilized

Guidance Centers
Sunbeam Home and Family Service

ADMISSION REQUIREMENTS:

Application: Physician referred. Direct referrals are accepted from Guidance Centers, Social and Rehabilitive Service, Children's Court.

Geographic Area Served: No limit.

FEE: Average diagnostic work-up about $200.00. Adjustment in charges may be made in certain cases where full payment would be a real hardship for the family.

CHILD STUDY CLINIC FOR THE MENTALLY AND PHYSICALLY HANDICAPPED
P.O. Box 7352
Tulsa, Oklahoma 74105 Phone: 918-749-2281

James G. Coldwell, M.D., Director

Contact Person: Central Intake

LOCATION: Children's Medical Center, 4818 South Lewis, Tulsa

SPONSOR: Division of Maternal and Child Health of the Oklahoma State Department of Health

ESTABLISHED: 1957

PROGRAM: Diagnostic-evaluation clinic for multiple handicapped and mentally retarded children from birth to nine years of age.

Educational Facilities

Diagnostic Nursery and Sunny Side School - Children's Medical Center.
Kindergarten classes of Tulsa Public Schools located in Children's Medical Center.
Special Education - Classes available in Tulsa Public Schools for Educable Mentally Handicapped, Trainable Mentally Handicapped, visually impaired, feaf or hard-of-hearing, learning disabilities, orthopedic or physically handicapped, and speech correction.
Town and Country School - Tulsa
Tender Loving Care School - Tulsa

Special Services Available in Community

Speech and Hearing - Mary K. Chapman Communicative Disorder Center, University of Tulsa; Children's Medical Center; Tulsa Public Schools; private speech therapists; State Department of Health Guidance Centers and Health Departments.
Psychiatric Clinic - Children's Medical Center.
Guidance Clinic - State Health Department Guidance Centers.
Reading Clinics - Tulsa Public Schools; Mabee Reading Clinic, University of Tulsa.
Sheltered Workshop - Handicapped Opportunity Workshop, Tulsa.
Vocational Training Center - Children's Medical Center.

Other Services Provided

Parental Counseling
Aftercare Services

Child Study Clinic for the Mentally and Physically Handicapped (Cont.)

Other Agencies Utilized

Children's Medical Center
Public and Private Schools
Oklahoma State Department of Health
Department of Public Welfare
Family and Children's Services
Tulsa Psychiatric Foundation
Day Care Services
Private Physicians
Hissom Memorial Center

ADMISSION REQUIREMENTS:

Application:	Any agency may refer patients, or parents may request services irrespective of income or place of residence.
Geographic Area Served:	No restriction - primarily service to residents of north-eastern Oklahoma.

FEE: No fee charged for services. Nominal fees for laboratory tests. Contributions are accepted.

CHILDREN'S CONVALESCENT HOSPITAL
P. O. Box 888
Bethany, Oklahoma 73008 Phone: 405-789-6711

Leonard Platt, Administrator

Contact Person: Mrs. Patricia Bodkin, Assistant Administrator

LOCATION: N.W. 39th and Mueller, Bethany

ESTABLISHED: 1940

LIVING ACCOMMODATION: Wards

Capacity

Boys - 35
Girls - 35

Upper age limit - 21 years

PROGRAM: Facilities and staff supervision to serve mentally retarded, educationally handicapped, speech problems, hearing problems.

Educational Facilities

Community schools grades 1 through 12.
Special Education School Program part of Bethany School District.

Special Services Available

Speech and Hearing
Guidance Clinic
Reading Clinic
Sheltered Workshop - Oklahoma City

Medical Services Available

Medical supervision by a Medical Director and affiliated with the University of Oklahoma Medical Center.

Other Services Provided

Parental counseling.
Follow-up care usually arranged at University of Oklahoma Medical Center, although out-patient occupational therapy, physical therapy and speech available at Children's Convalescent Hospital.

Children's Convalescent Hospital (Continued)

Other Agencies Utilized

Guidance Center
Department of Public Welfare
County Health Departments
Private Social Agencies in community.

ADMISSION REQUIREMENTS: Referral made by the patient's physician.

Placement Authority: Admissions approved by Medical Director

Geographic Area Served: State of Oklahoma

LICENSURE: State Department of Health

ACCREDITATION: American Hospital Association

MEMBERSHIPS: Oklahoma Hospital Association
National Association of Children's Hospitals and Related Institutions

CHILDREN'S MEDICAL CENTER
P. O. Box 7352
Tulsa, Oklahoma 74105 Phone: 918 749-2281

John L. Byrne, Administrator

Contact Person: Mrs. Phyllis Toon, Admissions Officer - Ext. 324

LOCATION: 4818 South Lewis Avenue

ESTABLISHED: 1926

PROGRAM: Facilities and staff supervision to serve Mentally Retarded. Emotionally Disturbed, Educationally Handicapped, Vocational Training Needs, Speech & Hearing Problems, Physically Handicapped.

Capacity

Day Care School for children with developmental delays - 68 children, ages 2-9 years.
Vocational Training Center - 60 trainees (Handicapped), ages 16-24 years.
Hospital - 23 Boys and 23 Girls, infant through 17½ yrs.

Educational Facilities

Tulsa Public School classes conducted on site, Elementary through Senior High.
Vocational Training Center teaches handicapped trainees skills fitted to the capability of each.
Day Care School for Children with Developmental Delays accepts students from age of 2 years through 9 years for an eleven-month yearly program. Each is taught to the limit of his capability.

Special Services Available in Community

Speech and Hearing - Mabee Clinic, and Children's Medical Center
Guidance Clinic - Children's Medical Center
Reading Clinic - Children's Medical Center

Medical Services Available

Hospital services at CMC for pediatric patients whether general psychiatric, pediatric with genetic defects, muscle disease or neurological.
Complete in-patient and out-patient services as well as orthopedic services for out-patients in addition to above.
Emergency services, research, training, rehabilitation, outreach.
Off-campus - complete pediatric general services in the hospitals of Tulsa.

Children's Medical Center (Continued)

Other Services Provided

Parental Counseling
Aftercare Services

Other Agencies Utilized

Tulsa Boys' Home, St. John Vianney Girls' Home, Tulsa Psychiatric Center, other Tulsa hospitals, Eastern State Oklahoma Mental Hospital, Oklahoma DPW, Oklahoma Department of Health, Tulsa County Department of Health, Juvenile Court.

ADMISSION REQUIREMENTS: Application - a patient must be within the age limits for admission; our admission forms must be used; no other restrictions.

Placement Authority: Physicians' referrals; "walk-in" patients.

Geographic Area Served: No limitations.

FEE: Charges for specific services.

LICENSURE: Oklahoma State Department of Health

ACCREDITATION: Joint Committee for Accreditation of Hospitals
American Association for Psychiatric Services to Children
American Medical Association (teaching program)

MEMBERSHIPS: American Hospital Association
National Assn. of Children's Hospitals and Related Institutions
Oklahoma Hospital Association
Tulsa Hospital Council
National Assn. of Sheltered Workshops & Homebound Programs
Oklahoma Assn. for Children's Institutions and Agencies, Inc.

CLEVELAND COUNTY GUIDANCE CENTER
641 East Robinson
Norman, Oklahoma 73069 Phone: 405 321-4048

Wes Whittlesey, M.D., M.P.H., Director

Contact Person: J. David Bennett, Ph.D., Coordinator

ESTABLISHED: 1961

PROGRAM: Out-patient facilities and staff supervision to serve mentally retarded, emotionally disturbed, educationally handicapped, speech and hearing problems for children ages 1 through 14 years of age.

Educational Facilities

Community Schools - I.D. Classes, Educable classes, Trainable classes for Mentally Handicapped on elementary level; Learning Disability class, Remedial and Educable classes on Junior High level.

On-campus Educable classes in pre-school (Day Care Center) and elementary levels.

Special Services Available

University of Oklahoma Speech and Hearing Clinic
University of Oklahoma Reading Clinic
Children's Shelter, Central State Hospital, Norman

Other Services Provided

Parental Counseling.

Other Agencies Utilized

OU Medical Center
Child Study Center
Community Mental Health Center
Day Care Centers
Welfare Department

ADMISSION REQUIREMENTS: Geographic Area Served: Cleveland County

COMANCHE COUNTY SCHOOL FOR HANDICAPPED CHILDREN
P. O. Box 45
Lawton, Oklahoma 73501 Phone: 405 355-5834

Robert E. Greiner, Ltc. USA Ret., Executive Director

LOCATION: 10 East B Avenue, Lawton

SPONSOR: Comanche County United Cerebral Palsy Affiliate, Inc.

ESTABLISHED: 1962

PROGRAM: Facilities and staff supervision to serve any child age 18 months through 27 years who is Mentally Retarded, Emotionally Disturbed, Educationally Handicapped, Speech Problems.

Curriculum:
Pre-School Training
Kindergarten
Special Education, Educable
Special Education, Trainable
Physical Therapy
Speech Therapy
Crafts and Art

ADMISSION REQUIREMENTS: We take any child not acceptable to the public school system.

Geographic Area Served: Comanche County

FEE: $20.00 per month, based on ability of parent to pay.

COMMUNITY MENTAL HEALTH CLINIC
Box 625
McAlester, Oklahoma Phone: 918 423-7477

Hayden H. Donahue, M.D., Director

Contact Person: Maurine Van Cleave, Psychiatric Social Worker

LOCATION: 508 South Third

SPONSOR: State Department of Mental Health

Special Education Classes are available in community for all grades and pre-school.

Special Services Available in Community

Speech and Hearing at the Guidance Center
Guidance Clinic

Other Services Provided

Parental Counseling
Aftercare services for Ex-Mental patients from state institutions.

MEMBERSHIPS: OHWA
NASW

GARFIELD COUNTY GUIDANCE CENTER
P. O. Box 3266
Enid, Oklahoma 73701 Phone: 405-233-0650
405-234-4738
Cecil R. Reinstein, M.D., Medical Director

Contact Person: Michael B. Blazi, M.S., Psychologist-Coordinator

LOCATION: 2109 Lahoma Road, Enid, Oklahoma

SPONSOR: State and local Health Department

ESTABLISHED: 1968

PROGRAM: Facilities and staff supervision to serve mentally retarded, emotionally disturbed, educationally handicapped, speech and hearing problems. Available for ages three years thru adult. Under age three can refer and pay for evaluations.

Educational Facilities

Elementary classes for emotionally disturbed, educable mentally retarded, learning disabilities and deaf available in community schools.

Educable mentally retarded, learning disabilities classes available in community schools on the junior high level. Educable mentally retarded classes available in community high schools.

O. T. Autry Vocational-Technical School.

Special Services Available in Community

Speech and Hearing - Enid Community Speech and Hearing Clinic.
Garfield County Guidance Clinic.
Reading Clinic - a function of Community Speech and Hearing.
School Psychological Center.

Medical Services Available

In-clinic immunization and hearing screening. Consultants available in speech and hearing, pediatric neurology, psychiatry, psychology.

Other Services Available

Parental Counseling
Aftercare Services

Garfield County Guidance Center (Continued)

Other Agencies Utilized

Vocational Rehabilitation
Welfare,
Salvation Army
YMCA
YWCA

ADMISSION REQUIREMENTS: No restrictions as to age, sex, race. Parental consent for anyone under age 18.

Geographic Area Served: Garfield County

FEE: Sliding scale contingent family size and income.

ACCREDITATION: Oklahoma State Health Department

VITA

Louise Farha Roberds

Candidate for the Degree of

Doctor of Education

Thesis: PHENYLKETONURIA: RECOMMENDATIONS FOR PARENTS AND TEACHERS

Major Field: Elementary Education

Biographical:

Personal Data: Born in Shamrock, Oklahoma, the daughter of Ellis L. and Mahaba Barkett Farha.

Education: Attended grade school in Bristow, Oklahoma; graduated from Bristow High School in 1934; graduated from Bristow Junior College, 1936; received the Bachelor of Science degree from Oklahoma Agricultural and Mechanical College in May, May, 1938, the Master of Science degree from Oklahoma Agricultural and Mechanical College with a major in Elementary Education, in August, 1941; completed requirements for the Education Specialist degree in May, 1965, and completed requirements for the Doctor of Education degree in Elementary Education from Oklahoma State University at Stillwater, Oklahoma, in July, 1974.

Professional Experience: Taught in the elementary school in Guymon, Oklahoma, 1941-42; taught in the Bristow schools from 1942 to 1963 as classroom teacher, Dean of Girls in Junior High School, Junior High Librarian, History teacher, and curriculum coordinator and supervisor of elementary grades; associate professor of elementary education at Phillips University, Enid, Oklahoma, 1963-present.

Professional Assocaitions: International Reading Association, National Council of Teachers of English; National Education Association; Oklahoma Education Association; Southern Association on Children Under Six; Elementary-Kindergarten-Nursery Educators; Kappa Delta Pi; Delta Kappa Gamma Society; Kappa Kappa Iota Sorority.