REDEFINING LEGAL BLINDNESS

BY

ELIZABETH HOPPE

O.D., B.S. FERRIS STATE UNIVERSITY 1988

AN ESSAY PRESENTED TO

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June 26th, 1990

Date

ABSTRACT

The major causes of visual impairment in the U.S. are diabetic retinopathy, glaucoma, cataract, and age related macular degeneration. Because these conditions are closely linked with aging, as the population gets older, an increase in visual impairment can be expected. Public Health professionals will be faced with challenges in studying the epidemiology of blindness, program planning, and administration of federal and state funds.

In order to meet these challenges it must be determined what level of vision constitutes legal blindness. The legal definition of blindness was developed in 1935 as part of the Social Security Act. Although advances have been made in the treatment of eye disease, and in the measurement of visual performance, this definition has not been changed in 55 years. It is no longer adequate for purposes of certification of blindness or for epidemiologic studies. The law describing legal blindness needs to be evaluated and areas of potential variability need to be eliminated in order to ensure uniform standards.

I would like to acknowledge the contributions of the following individuals:

Thank you to Dr. James Jekel for acting as advisor and first reader of this paper.

Thank you to Dr. Lisa Berkman for serving as second reader.

Thank you to the late Dr. James Holman for introducing me to my first low vision evaluation. His enthusiasm and expertise made caring for the blind very special.

Thank you to the faculty at Ferris State University, especially Drs. C. Allyn Uniacke and Walter Betts who served as supervising clinical professors in Low Vision, for providing a quality education.

Thank you to the staff of the Eastern Blind Rehabilitation Center, especially Dr. Robert Perlin, without whom I would not have had the insight or clinical experience to evaluate this topic.

Thank you to my parents William and Shirley Hoppe for their support in everything.

TABLE OF CONTENTS

TABLE OF APPENDICES

CHAPTER ONE: Blindness as a Public Health Problem

Prevalence of Blindness

In a study of chronic conditions and impairments among the civilian, non-institutionalized U. S. population, visual impairment ranked ninth over all. Among nursing home residents, visual impairment had the eleventh highest prevalence of any condition.(U.S.D.H.H.S. 1986) The care and rehabilitation of the visually impaired is now a public health problem of great importance, and will become even more of an urgent demand on public health professionals in the future, as the structure of the population changes.

In the United States, four conditions, cataract, diabetic retinopathy, age-related maculopathy, and glaucoma, cause the majority of cases of blindness. Although progress has been made with laser photocoagulation and other surgical interventions, diabetes is still the number one cause of blindness in the United States.

The disease process of diabetes causes impaired circulation among the blood vessels supplying nutrients to the retinal tissue. As a consequence, new blood vessels grow on the surface of the retina. These blood vessels are abnormally fragile and tortuous, and break and bleed easily. This causes massive hemorrhaging and scarring, and may lead to retinal detachment.

Diabetes affects approximately 5.5 million Americans at any one time. This results in a prevalence of 50,000 cases of blindness due to diabetes, with an additional 5,800 new cases each year.(Mazze 1985) A study in Denmark among insulin dependent diabetics with age of onset less than 30 years, found an incidence rate of blindness of 1.0 per 100 person-years. This population had a 50 to 80 times higher risk of blindness than the background population.(Sjlie 1987) The Framingham Eye Study showed a prevalence of 3.1% positive for diabetic retinopathy in one or both eyes among the survivors of the Framingham Heart Study.(Kahn 1977)

Glaucoma is the second leading cause of new cases of blindness in the United States. It affects over 1.4 million Americans and accounts for over three million visits to eye care providers each year. Studies suggest that over the course of twenty years blindness develops in as many as 75% of the persons with severe disease.(U.S. Preventive Services Task Force). The Framingham Eye Study concluded that the prevalence of glaucoma in the population studied was 3.3%.(Kahn 1977)

Most cases of glaucoma have an unknown underlying etiology, and are referred to as either primary or chronic open angle glaucoma. Pressure within the eye builds up causing damage to the optic nerve. If uncontrolled, the nerve cells start to die, resulting in a loss of vision. As nerve damage progresses, more and more spots of vision start to disappear, leading to tunnel vision, or eventually a complete loss of all light perception.

Cataracts develop when the crystalline lens of the eye becomes clouded or opaque. The lens then loses its ability to transmit light and focus images clearly on the retina of the eye. The majority of cataracts in the U.S. are related to aging changes, although some may develop due to trauma, or may be congenital in nature. Factors that contribute to the development of cataracts are ultra-violet radiation, normal aging changes, diabetes, or congenital disease.

Although cataract extraction, and replacement of the crystalline lens with an intra-ocular lens implant in most cases, has become a safe and routinely performed procedure, at any given time there are a number of individuals who may be blind due to cataracts. The Framingham Eye Study found a prevalence of 15.5% of cataracts in one or both eyes.(Kahn 1977) A study of the birth cohort of 1970 showed congenital cataract to be the leading cause of blindness before age 30.(Stewart-Brown 1988) The National Health Survey conducted in 1971 showed cataracts to be responsible for 33,538,000 disability days, or a reported 8.5 days per condition.(U.S.D.H.H.S. 1986)

Age related macular degeneration (ARMD), which was formerly known as senile macular degeneration (or SMD) causes a loss of central visual acuity. For some unknown reason, the membrane separating the avascular macular area from the underlying blood vessels ruptures, allowing new blood vessels to grow up into the retina. As in diabetic retinopathy, these blood vessels are easily broken resulting in edema, scarring, and damage to the macular area of the retina. This area is responsible for the finest detail of vision, and once scarred, the eye rapidly loses acuity. The Framingham Eye Study found a prevalence of 8.8% positive for macular degeneration in one or both eyes.(Kahn 1977)

Increasing Prevalence and Incidence of Blindness

As in most developed countries, these chronic diseases have become a greater health problem than infectious conditions, such as trachoma. Because these chronic conditions are closely associated with age, as the population gets older, the prevalence and incidence rates of the adventitiously blinded will increase.

According to the American Foundation for the Blind, in 1978, about 65% of the 1.7 million people who were registered as legally blind in the United States were over the age of 60. A needs assessment study of the registered legally blind in Massachusetts revealed that of the 13,564 registered blind clients, 2,125, or 15.7%, were between the ages 65 to 74, and 5,859, or 43.2%, were 75 or older. Therefore, the total percentage of registered blind clients who were 65 years or older was 59.9% Registrants ages 45 to 64 totalled 2,750, contributing 20.3%. Nationwide, the number of elderly, and those approaching older age, who have severe visual problems and are not classified as legally blind, may be as high as 5.8 million.(Wineburg 1984)

The Framingham Eye Study showed a high correlation between the rates of disease and age. The percentage of eyes with a diagnosis of one or more of the four diseases studied (glaucoma, cataracts, diabetic retinopathy, or ARMD) increased more than eight times, from 4.3% in eyes of persons less than 65, to 37.9% in eyes of persons age 75 or older. The age trend was very strong for cataract and ARMD, but less strong for diabetic retinopathy and open angle glaucoma. Among the people ages 65 or less, 14.2% of the diseased eyes had more than one disease, compared to 40.3% of those studied ages 75 or older.(Liebowitz 1980) It has been found that the prevalence of glaucoma in those over age 75 increases to 2-4%.(U.S. Preventive Services Task Force)

Stroke victims often suffer visual impairment due to constriction of the field of vision. The visual pathways in the brain may be damaged by the stroke, resulting in a loss of areas of vision. Quite commonly, one half of the visual field may be obliterated, producing what is known as a hemianopic visual field loss. As the incidence of stroke is highly correlated with age, and as those who survive a stroke are increasing, more people suffering from visual impairment may be expected.

Most newly blind are elderly, poor women over age 70. They often suffer from more than one noticeable ailment, and they are not usually recognized as blind because they have some remaining vision.(Wineburg 1984)

Based on the demographics, it can be expected that as the population ages, a concomitant rise in blindness will occur. This represents a dramatic challenge to the public health system. Increases in the numbers of blind individuals will not only result from the geriatric population, but also from infants. As the survival of low birth weight babies increases, congenital blindness will increase.

The decrease in the infant mortality rates of the past 20 years has been largely due to the increase in survival of very small babies. In 1971 7.6% of the infants born in the U.S. were considered to be low birth weight infants. The rate has changed very little, to the current incidence of 6.8% of those born in the U.S. being very low birth weight. Because of the increase in survival, more of these infants will have the chance of becoming blind.(Wallace 1988)

Low birth weight babies are likely to suffer from retinopathy of prematurity. The fetal retina vascularizes from the optic nerve to the periphery, and until vascularization is complete, the retinal arteries are susceptible to the high oxygen concentrations in the retina, that result from the ventilation procedures used to help the infants survive. Immature vessels are sensitive, and initially become vasoconstricted and subsequently obliterated. This is followed by a ridge of neovascular budding along the line of retinal ischemia, which penetrates the surface of the retina, and projects into the vitreous gel. Vitreous hemorrhage, fibrosis, and retinal traction follow, leading to retinal detachment, and blindness.(Spalton 1984)

A study has been done which suggests that a new epidemic of retinopathy of prematurity is developing. Annual population-level incidences of retinopathy in British Columbia were evaluated from 1952 to 1983. Standardized incidence ratio analyses revealed a significant increase in the overall incidence of retinopathy of prematurity-induced blindness in the later, compared with the earlier period. It was found that infants weighing 750 to 999 grams at birth had a significantly increased standardized incidence ratio of 3.07.(Gibson 1989)

Another study in British Columbia showed that the birth prevalence rate of congenital blindness of 8/10,000 live births in the late 1940's decreased to 3/10,000 in 1984. Retinopathy of prematurity was found to decrease over all, but was beginning to reemerge toward the end of the time period studied. Genetic ocular disorders represented the leading cause of blindness, with a significant increase in the number of births with optic nerve head lesions during the past 15 years.(Robinson 1987)

Another cause of congenital blindness is the infection of the fetus with syphilis. The United States is now facing an epidemic of congenital syphilis, closely related to the practice of substance abuse. An infant with congenital syphilis is at risk of developing congenital cataracts and retinal lesions. As the child grows, they may experience an acute episode of interstitial keratitis, or inflammation of the cornea. This causes growth of new blood vessels within the normally clear cornea, leading to scarring and vision loss. The combination of cataract, retinal problems, and corneal scarring often lead to severe visual impairment or blindness.(Spalton 1984)

Rates of congenital syphilis have risen dramatically in recent years. From 1978 to 1985, reported cases of congenital syphilis rose 148%, to an incidence rate of 1/100,000 live births. In 1986, more cases of congenital syphilis were reported to the Centers for Disease Control than in any of the preceding 15 years, at a rate of 10/100,000 live births.(Zaidi 1989) In the face of this epidemic, cases of blindness due to congenital syphilis can be expected to show a concomitant rise.

Another disease that may result in blindness is congenital rubella. The consequences of rubella are similar to that of syphilis, with the child showing signs of congenital cataract and retinal lesions. In addition, a child born with congenital rubella may suffer from malformation of the eye ball such as micro-ophthalmos (a small, non-seeing eye) or anophthalmos (complete lack of the eye). By far the most common cause of congenital cataracts is maternal rubella occurring during the first trimester of pregnancy.(Spalton 1984)

Concern over the numbers of women of child bearing age in the United States who have not been fully immunized is growing. A study done in Jamaica, where immunization programs have not been successful, show what consequences may develop. Of 108 blind children in residential care, 22% were blind as a result of congenital rubella syndrome. This was shown to be the leading preventable cause of childhood blindness in Jamaica.(Moriarity 1988)

In the United States, a nationally representative sample of 15,000 ten year old children revealed a prevalence of blindness of 3.4 to 4.0/10,00. Those who were designated as having partial sight represented a prevalence of 5.4 to 8.7/10,000. The most common cause was found to be congenital cataract, followed by congenital nystagmus.(Stewart-Brown 1988)

Another potential source of future cases of blindness comes from the population testing positive for the HIV. Patients suffering from AIDS can develop retinal vascular problems, and may become blinded as a result. The most common ocular manifestations of AIDS include retinal cotton wool spots, vasculopathies, cytomegalovirus retinitis and conjunctival Kaposi's sarcoma. Other less common manifestations are Toxoplasmosis retinitis, Varicella zoster ophthalmicus, cryptococcus and Herpes simplex retintis.(Petito 1990) Many of these can lead to scarring of the retina, and visual impairment.

As all of these indicators predict, more and more cases of blindness will likely develop as we enter into the 90's and the twenty-first century. The public health programs in the United States, and the world will find it necessary to re-evaluate and restructure the existing services for this population.

Challenges to Public Health

The area of public health will be faced with three specific challenges. First, the epidemiology of blindness must be studied. Statistical information on the prevalence and incidence of blindness must be developed and maintained to describe the problem accurately. Causes of blindness must be determined and evaluated, and potential risk factors for blindness must be analyzed.

Secondly, public health professionals will be faced with dilemmas in program planning. The service system for the blind already has problems accommodating the 1.7 million individuals who are recognized as blind. Given the obstacles facing them, it is unthinkable that this system could accommodate the increased numbers of those anticipated to become blind. The service system for the blind was developed in the 1930's to meet the needs of young, potentially employable adults. To serve today's population of blind individuals, the entire system will have to be re-evaluated.(Wineburg 1984)

Wineburg says further that no campaign for the prevention of blindness among the elderly can be successfully mounted without an appraisal of the present problem, its genesis, and its implications.(Wineburg 1984) Much work will have to be done to ensure equity of care for blind individuals, access to high quality of care, and accountability among the government services, and private providers of care for the blind.

The third challenge facing public health care is the distribution of federal and state funds. Under the Social Security Act of 1935 (SSA), blind individuals are entitled to supplemental security income. Titles XVII, XIX, and XX of the SSA establish further state and federal supplementation programs for the blind. The 1972 amendments to the Social Security Act (Public Law 92-603) created the Supplemental Security Income (SSI) program to replace the Federal Grants-in-Aid programs for the needy aged, blind, and disabled persons with inadequate income or means of support. In order to receive payments under the SSI program, an aged, blind, or disabled person's countable resources must fall below specified limits. The current limits are $2,000 for an individual, or $3,000 for a couple.

It has been found that the resources of most recipients fall well below these limits. The majority of SSI recipients had less than $100 in countable resources, and only 12% had more than $1,000.(Scott 1989)

Among all federally administered payments, the number of adult blind totalled 72,028. Blind children were found to number 6,595. Among the federally administered state supplementation only programs, there were 8,923 adult enrollees, and 107 blind children.

The median age of the blind among all federally administered payments was 53. Eighteen percent of those receiving funds were ages 29 or younger. The largest percentage was represented by the age range of 30 to 64, at 46.8%, followed by 34.1% ages 65 and over.

Those with federally administered supplementation only had a median age of 70. The largest portion of this population was among those aged 65 and over, representing 60.8% of the total.(Hawkins 1983)

From December 1979 to December of 1981, the number of persons receiving state supplementary payments under the Supplemental Security Income Program for the aged, blind, and disabled who were eligible because of blindness rose a modest 1%. The total number increased from 41,000 to 42,000 individuals. Expenditures for state supplementary payments continued to increase during this time period, as they have since the inception of the program.(Hawkins, 1983) A study of those receiving SSI in July of 1981 whose only payment was a federally administered state supplement shows that 61% of the blind were age 65 or older. Children represented 2% of the blind. Among the total SSI group, 34% were receiving benefits due to blindness. As described previously, this program can also expect to see an increase in utilization, particularly among the elderly. State and Federal agencies for the administration of funds must be prepared to meet the demand.

The Need to Evaluate the Definition of Legal Blindness

In every area, the epidemiology of the problem, program planning to meet the needs of the population, and the administration of funds, the definition of legal blindness must be considered. This paper proposes to evaluate the existing definition, discuss its weaknesses, describe how the statistics on visual impairment have been derived, and illustrate the need for a standardized definition of legal blindness. Conclusions and recommendations to redefine legal blindness will be offered.

CHAPTER TWO: Defining Legal Blindness

United States Early Laws

In the early part of the twentieth century legislation for developing programs to financially aid the blind began to be introduced at the state level. These laws were often incorporated into the "poor laws" or into laws for aid to the disabled. Society began to feel the need to care for those who were not capable of earning their own living. By 1928 twenty states had laws for aid to the blind (see table one).

Table One: States with Laws for Aid to the Blind

State	Year Introduced
California	1917
Colorado	1913
Connecticut	1921
Idaho	1917
Illinois	1903
Iowa	1915
Kansas	1911
Kentucky	1922
Louisiana	1928
Maine	1916
Massachusetts	1920
Minnesota	1923
Missouri	1923
Nebraska	1917
Nevada	1925
New Hampshire	1925
New Jersey	1921
New York	1922
Ohio	1921
Wisconsin	1917

(Source: Irwin 1928)

Several definitions of blindness were used in developing these blind relief laws. In Missouri blindness was defined as "vision not greater than light perception". Nebraska defined a blind person as one "who is destitute of useful vision so as to be incapacitated for the performance of labor, rendering such person incapable of earning support". New Hampshire, Nevada, California, and Idaho defined a blind person as "one who has a defect of vision incapacitating him to earn the necessities of life". Ohio defined a blind person as "any person of either sex who by reason of loss of eyesight is unable to provide himself with the necessities of life". Several states called for a physician to certify the individual in question as "blind or not" and left the definition of blindness at that.(Irwin 1928)

Irwin supported this lack of a clear cut definition as it left some room for interpretation. He states:

> Anyone familiar with a large number of blind people will testify that a certain defect of vision handicaps one person much more than it does another. This degree of handicap is the real measure of blindness when dependency is under consideration.(Irwin 1928)

The original draft of the Maine law contained no definition of legal blindness. Because of the resulting confusion, an amendment was added which defined blindness as "less than one-tenth vision". Irwin comments:

> The definition "less than one-tenth vision" has not been entirely satisfactory in Maine. The certificate of blindness is made by a general practitioner, to whom "one-tenth vision" has frequently but a vague significance. Perhaps, however, this vagueness in the one-tenth vision clause has given it its saving flexibility. The chief value of the clause is that it suggests to the examiner that something short of total blindness may make one eligible for this relief. (Irwin 1928)

Examples of this "saving flexibility" may be found in the notes copied from the examining physician's records:

> 6/1916 "...sees to get around on the land without assistance. Reads large figures on calendar - 3/4 inch size - at close range."
>
> 1916 "...was born suffering an extreme case of strabismus of both eyes. The right eye is absolutely blind, the left is 1/4 good. Not totally blind, but cannot see 5 inches in front of her."
>
> 1919 "She has only one eye that she can see very little with to find her way in daytime. I should say that the eyesight is about one-twentieth. Other eye is totally blind. She was born crooked eyes - now she is about blind."
>
> 12/1916 "He had a cataract on right eye - it was operated on two years last Nov. and taken out. He also had glaucoma of both eyes. He can see now with left eye only an object in front of him - can't distinguish anything - sight in left eye is nine-tenths gone."
>
> 12/1916 "...one eye gone - enucleated - and other 3/4 blind at least - perhaps more if put to a test. This man is very indigent and nearly helpless - sooner or later will have to be a town charge."
>
> 1915 "This man has been practically blind since childhood. When of school age he was dismissed by 3 o'clock in the afternoon as he could then see only in a strong light."
>
> 1918 "Nerve of eyes injured at time of birth by obstetrical instruments. Practically blind at night - a very bright day without assistance - hard to estimate degree of blindness but he is blind enough to prevent him from earning a livelihood. Deserves this pension." (Irwin 1928)

In addition to the requirements of blindness, need, and proper residential qualifications, those hoping to receive financial aid were also required to meet moral standards in many states. It was felt that persons with "vicious habits" and beggars should be disqualified for aid. It was also generally accepted that any financial benefits received should be kept low enough to discourage two blind individuals from marrying. It was society's idea that if a blind individual could support themself, they could marry whomever they wished. However, if two blind people were already receiving aid, they should not burden the state further by the possibility of having blind children.

New Jersey imposed the following restrictions on those receiving state aid:

> No person shall be eligible to this relief while publicly soliciting alms in any part of the state. The term "publicly soliciting" shall be construed to mean the wearing, carrying or exhibiting of signs denoting blindness, or the carrying of receptacles for the reception of alms, or the doing of the same by proxy, or by begging from house to house.
>
> No person shall be eligible to the relief granted by this act who is suffering from mental or physical infirmity, which in itself, would make him or her a charge upon any other institution or agency of this state, and which has so incapacitated him or her prior to the loss of sight, that such person was a public charge prior thereto. (Irwin 1928)

In the 1920's organizations for the blind were pushing for nationalization of aid to the blind. Despite their efforts, national legislation was not introduced until 1935, under the Social Security Amendment.

United States Social Security Act

The definition of legal blindness first came into national importance in the Social Security of 1935. To administer funding for those deemed in need of financial aid, the adoption of one definition of legal blindness was critical.

Several parts of the Social Security Act deal with funds for the blind. Title X specifies grants to the states for aid to the blind as follows:

> For the purpose of enabling each state to furnish financial assistance, as far as practicable under the conditions in such state, to needy individuals who are blind, there is hereby authorized to be appropriated for each fiscal year a sum sufficient to carry out the purpose of this title.

Title XVI authorizes grants to states for aid to the aged, blind, or disabled. This section is as follows:

> For the purpose of enabling each state, as far as practicable under the conditions in such state, to furnish financial assistance to needy individuals who are 65 years of age or over, are blind, or are 18 years of age or over, and are permanently and totally disabled there is hereby authorized a to be appropriated for each fiscal year a sum sufficient to carry out the purpose of this title.

Title XVI of the original Social Security Act establishes supplemental security income for the aged, blind, and disabled. This section is worded as such:

> For the purpose of establishing a national program to provide supplemental security income to individuals who have attained age 65 or over or are blind or disabled, there are authorized to be appropriated sums sufficient to carry out this title.

It is interesting to note that blindness was not considered under the same heading as a disability. Title II of the Act, entitled Federal Old-Age, Survivors, and Disability Insurance Benefits makes no mention of blindness at all.

To implement this law, a national definition of blindness had to be determined. At the time the Social Security Act was written, the states had still maintained their own individual defintions of blindness. Several states had made amendments to their original laws making them less subjective in nature. By 1935 eighteen states had incorporated a visual acuity of 20/200 into their definition of blindness. Out of these eighteen states, all but five also specified that blindness could result from a defect in the visual field. The Social Security Act defined blindness as the following:

> An individual shall be considered to be blind for the purposes of this title if he has central visual acuity of 20/200 or less in the better eye with the use of a correcting lens. An eye which is accompanied by a limitation in the fields of vision such that the widest diameter of the visual field subtends an angle of no more than 20 degrees shall be considered for purposes of the first sentence of this subsection as having a central visual acuity of 20/200 or less.

An amendment to this section was added in 1973. This amendment is important because it specifies that the individual must remain continuously blind. However, the determination of what constitutes being continuously blind, and how this is to be determined is not described. This amendment also opens the law up to consider other definitions of legal blindness, as determined under state plans. The amendment is as follows:

> An individual shall also be considered blind for purposes of this title if he is blind as defined under a state plan approved under title X or XVI as in effect for October 1972 and received aid under such plan (on the basis of blindness) for December 1973, so long as he is continuously blind as so defined.

This legislation was part of the sweeping social reform that took place during the Great Depression. It was designed to give aid to those who were felt to be "deserving" poor. Blind rehabilitation at that time was designed for young, otherwise healthy individuals. They were given job training in such areas as chair caning and typing, and they were encouraged to work in the home, or sheltered work shops. No moral restrictions, or other qualifications were defined in the law.

U.S. Internal Revenue Code

Following World War II, legislation was introduced to allow blind individuals to qualify for special exemptions for federal income tax. This legislation was sparked by the numbers of war veterans who had become blind due to trauma. This legislation also enabled blind agencies and blind rehabilitation programs to achieve tax exempt status. The

U.S. Internal Revenue Code Title 26 - 151 defines legal blindness similarly to the original law written in 1935:

> For purposes of this subsection, an individual is blind only if his central visual acuity does not exceed 20/200 in the better eye with correcting lenses, or if his visual acuity is greater than 20/200 but is accompanied by a limitation in the fields of vision such that the widest diameter of the visual field subtends an angle of no greater than 20 degrees.

This definition recognizes visual field loss as being a significant factor in visual impairment in its own right, and does not attempt to equate the loss in visual field with a measurement of visual acuity. However, lacking in this definition is any provision regarding the continuity of blindness. Some of the early state laws made provision such that if it were determined that the condition of blindness could be reversed through surgery or medical intervention, the blind individual could send a written statement of such to the board determining benefits. The board, at its discretion, could allow funds to be used to implement this medical correction. Subsequently, the formerly blind individual would be removed from any further benefits.

Also lacking in this definition is a designation of who is to determine the status of vision. Some state laws had specified that certification had to be made by a county physician. Other states called for the individual to be examined by an eye specialist, or "oculist". Some states contracted with one or two doctors to provide such services, thus decreasing the chances of bribery or financial gain through false certification.

Titles XVIII and XIX of the Social Security Act were passed under the Johnson Administration in the 1960's. These titles allowed for blind individuals receiving Social Security Income benefits to qualify for Medicare and Medicaid. They relied on the original definition of legal blindness from 1935.

United Kingdom

The United Kingdom enacted similar social legislation as a part of the 1948 National Assistance Act. The statutory definition of blindness is that the person is "so blind as to be unable to perform any work for which eyesight is essential".(Aclimandos 1988) No numerical quantification of this level is specified, and no guidelines in testing procedures are given.

Although no statutory definition of "partial sight" was included in the 1948 act, the Ministry of Health subsequently advised that a person who is not blind within the meaning of the act but who is "substantially and permanently handicapped by congenitally defective vision or from illness or injury causing defective vision" would be eligible to be registered as partially sighted.(Gibson 1986) Persons who were registered as partially sighted could receive the same welfare services as are provided by the local authorities for the blind, but are not eligible to receive other blind benefits specifically enjoyed by the blind, such as income tax concessions, and supplementary benefits.(Gibson 1986)

In the United Kingdom, statistical information concerning visual impairment is collected by consultant ophthalmologists who are required to complete special registration forms for the blind. The procedure is entirely subjective, and depends on the assessment of the consultant as well as the willingness of the patients to be registered. Registration is not legally required but is performed on a voluntary basis.(Aclimandos 1988)

The blind registration forms are processed on the local level, usually by the Social Services Department in order that the patients who qualify can be placed on their list. Copies of blind registries are sent to the Department of Health and Social Security for computer analysis. The names are erased for confidentiality.(Aclimandos 1988) On the registration forms, visual acuity can be classified as no light perception, hand motion, count fingers, 6/60 (this corresponds to the level of 20/200, but is specified with a testing distance of 6 meters, rather than 20 feet, as is custom in the U.S.), 6/36, 6/24, 6/18, 6/12, 6/9, or 6/6. Although the guidelines suggest that a category of 3/60 (equivalent to 20/400) should be included, it has rarely been used by the registering physicians.(Grey 1989)

Visual field loss was broken down into the following levels: nil, less than 10 degrees, contracted, central scotoma, hemianopia, or good. Any combination of contracted, central scotoma, or hemianopia are categorized together as equivalent to less than 10 degrees.(Grey 1989)

If the visual acuity is measured to be less than 6/60 (20/200), the individual is considered to be blind, regardless of the visual field. If the visual field is measured to be less than 10% the individual is considered to be blind, regardless of the visual acuity. If the individual has a visual acuity better than or equal to 6/60, but has an accompanying visual field loss classified as contracted, central scotoma, or hemianopia, they are classified as legally blind. Any other combinations of levels would be considered to qualify for registration as partially sighted.(Grey 1989) It must be remembered, that these guidelines are voluntary, and are not specifically indicated by the letter of the law.

As a result of the definition employed in the United Kingdom, the voluntary registration, and the system used, there has been considerable under reporting of cases of blindness. A study of the registrants carried out in Melton Mowbray found that the registry underestimated the prevalence of blindness by 10%. The registry of the partially sighted was found to have a high specificity, but a sensitivity of only 50%. The prevalence of partially sighted was determined to be underestimated by a factor of 1.5. Twenty-one percent of the registerable visually impaired had not been identified to the system.(Gibson 1986)

The World Health Organization

The World Health Organization recognizes the need for a generally acceptable definition of blindness and visual impairment. The World Health Assembly resolution WHA25.55 calls for the development of this definition, and implementation into programs designed to prevent blindness.

A study group assigned to deal with this task felt that it was necessary to define categories of visual impairment as a first step to obtaining comparable data world wide. The group notes that while visual loss is defined primarily in terms of distant visual acuity, account should also be taken where possible of visual field and near vision.

The World Health Assembly specifies that each country must define blindness in relation to its own social and economic conditions, but there is need for an internationally accepted definition of blindness for the purposes of compiling international statistical data. Until this is done, it is suggested that countries using a different definition might submit their national statistics for the level of vision laid down by their authorities, with adjustments where possible to conform to the international classifications, as follows:

Table Two W.H.O.

CATEGORIES OF VISUAL IMPAIRMENT AND BLINDNESS

Category of visual impairment	Visual Acuity with both eyes using best correction	
	maximum less than	minimum equal to or better than
1	6/18 3/10 (0.3) 20/70	6/60 1/10 (0.1) 20/200
2	6/60 1/10 (0.1) 20/200	3/60 1/20(0.05) 20/400
3	3/60 1/20 (0.05) 20/400	1/60 1/50(0.02) 20/1200
4	1/60 1/50 (0.02) 20/1200	light perception
5	No light perception	
9	Undetermined or unspecified	

(Source: World Health Organization 1973)

It is noted that if the extent of the visual field is to be considered, patients with a field of less than 10 degrees, but more than five degrees around central fixation should be placed in category four, even if the central acuity is not impaired. The study group recommended that the definition of blindness should include categories 3, 4, and 5.

Interpreting the Laws

When initially reading these laws, they seem relatively clear cut and easily interpreted. However, in clinical practice, and in epidemiologic studies, it soon becomes apparent that these laws are inadequate. The specifications of the measurements, testing conditions, and interpretations of the results are not in enough depth, and leave too much open to interpretation, and variability between practitioners.

Wineburg states that the federal and state aid programs instituted during the Great Depression needed an objective scheme to authenticate the claims of those who maintained they could not work because of loss of sight. From this administrative necessity came the use of a numerical standard by which to measure an individual's ability to see, and the term "legal blindness". Although based on numerical classification, the term actually encompasses a wide range of visual capabilities and performances -- a confusing point in trying to understand blindness and a given individual's ability to see enough to function.(Wineburg 1984)

Changes in Technology

Since the law was written in 1935, the advancements in the treatment of ocular disease have been enormous. In 1935, cataract extraction was still experimental. Intra-ocular lens implants following the extraction were unheard of. Rather than being a twenty-minute out-patient procedure, cataract removal was performed under general anesthesia, and required weeks of bed rest with the head of the patient immobilized by sand bags.

The use of laser photocoagulation for the treatment of diabetic retinopathy or macular degeneration might have seemed like science fiction to a physician in 1935. Glaucoma was still largely untreatable, and often was not even detected at the early stage it is today.

Because of these advancements in medical technology, patients who once might have become totally blinded, with no light perception, are left with varying degrees of residual vision. The once black and white issue of blind or not blind, is now evaluated in varying shades of gray, corresponding to the varying levels of visual impairment.

The technologies of diagnosis and visual testing have also seen dramatic changes since 1935. New methods of visual acuity testing, such as preferential looking technique, and contrast sensitivity have been developed. The development of new types of visual acuity charts have replaced the cardboard wall chart of letters from the thirties. Most visual field measurement is now done with computerized automated visual field testers. These instruments give very different results from the tangent screen tests done by hand.

Because of the changes in the treatment of eye disease, and the changes in the technology of the measurement of the visual system, the definition of legal blindness has become inadequate. It has not kept up with the practice of eye care, and it is too ambiguous to be meaningful for epidemiologic purposes. Areas of potential variation need to be evaluated and eliminated as much as possible.

CHAPTER THREE: Factors Affecting the Measurement of Visual Acuity

Visual Acuity Specified in the Law

The law defining legal blindness is broken down into two parts: that concerning the level of visual acuity, and that concerning the level of visual field. The standard measurement of visual acuity in the United States is to specify the ratio of a letter of overall size of 5 minutes of arc, with detail one minute of arc, at a distance of twenty feet to be equivalent to 20/20 visual acuity.

A simple way to interpret this is as the relationship of what a "normal" eye can see at the testing distance of twenty feet. For example, a visual acuity measurement of 20/20 implies that a person can see what is expected at twenty feet. By contrast, a visual acuity measurement of 20/200 implies that for an individual with this visual acuity to distinguish letters at twenty feet, they would have to be ten times (or 200 divided by 20) as large as normally expected. Or, for a person with visual acuity of

20/200, they would have to be at one tenth of the distance to an object to see it as a person with 20/20 vision could. This is a very simplified explanation, and does not truly explain what a person with visual impairment would observe.

When it comes to interpreting the visual acuity specified as blindness, one finds the law to be very vague. No specific type of testing chart is mentioned. No specific testing distance is mentioned. There is no specification of the luminance levels. No criteria for grading the visual acuity are given. There is no consideration made for levels of vision that may be better than 20/200, yet are still impaired. These areas of ambiguity invite differing interpretations, and as such, differing results.

Ederer makes a case for the standardization of visual acuity measurement for epidemiologic purposes. He states:

> Measurement of central visual acuity is necessary for epidemiologic studies of the many diseases that cause visual impairment. The test is commonly performed by having the subject read letters on a chart from a distance of 10 to 20 feet. This test is subjective and depends on the subject's cooperation, alertness, and ability to follow instructions. To some extent, the visual acuity test may be a test of intelligence in that intelligent subjects may more easily be able to guess correctly letters they cannot clearly discern.
>
> Possible patient malingering can be dissuaded by having the examiner urge, cajole, and encourage the patient to a maximum effort to read or guess, and to continue testing until the patient makes, say, two or more mistakes on a line of five letters.
>
> In addition to possible personal biases, the visual acuity measurement is influenced by physical variables such as: 1) the location of light for the eye chart front, rear, through glass, or projected image. 2) the amount of chart illumination 3) the amount of room illumination 4) the distance of the

> patient from the chart 5) the degree of black and white contrast between the letters and background 6) the degree of reading difficulty of letters, some letters are more difficult than others, and 7) the printing style of the letters. Because variation in any of these factors can influence outcome, both equipment and procedures should be standardized, not only in multi-center studies, where the need is obvious, but also in single-center studies to obtain comparability between examiners within a study and between outcomes of similar studies in different centers.(Ederer 1983)

A.O. Project-O-Chart

The first area to be considered is the type of testing chart used to measure the vision. Most commonly used today is the A.O. project-o-chart. This chart was not in use in 1935. The A.O. project-o-chart system consists of a projector with a bulb that projects letters printed on a glass slide onto a surface. The test is calibrated to be equivalent to twenty feet, which is considered to be optical infinity. Mirrors or silvered reflecting surfaces may be used to achieve an appropriate distance in a shortened room. Different glass slides may be obtained to project Snellen letters, a Tumbling E chart, Allen figures, or Snellen numbers.

Using the projected Snellen letters, the chart consists of acuity levels of 20/400, 20/200, 20/100, 20/80, 20/70, 20/60, 20/50, 20/40, 20/30, 20/25, 20/20, 20/15, and in some cases 20/10. Because the chart is not moveable to different distances, these levels remain constant. (See appendix A, figure 1)

When evaluating a person for potential qualification for legal blindness, the two lines of 20/200 and 20/100 are the lines most critical. If the person can distinguish the characters on the 20/100 line, they are not considered to be legally blind. If they cannot read the characters on the 20/100 line, the vision is assumed to be 20/200 or worse, and therefore the individual will qualify for registration as legally blind.

Several factors are potential problems in this testing situation. First, the clarity of the projected letters is dependent on the quality of the glass slide, the surface on which the letters are projected, the testing distance calibrated, and the ambient room illumination. As the glass slide ages, and is subjected to repeated use under the hot bulb of the projector, the black letters start to fade. As they fade, the contrast of the projected image will decrease, and may yield falsely low visual acuity measurements.

If the surface on which the letters are projected is dusty, irregular, or if the silvering has become aged, the letters will further lose contrast resulting in even more reduced acuity. When mirrors are used to approximate a twenty foot distance in a shorter room, each reflection loses some of the light intensity. If the mirror is altered in position, is not cleaned properly, or maintained properly, the calibration of the system will be off.

Potentially, this differing calibration could either increase or decrease the acuity measured.

In a projected system, the illumination levels are critical to contrast. Contrast is calculated as:

$$\frac{\text{(Luminance of the background)} - \text{(Luminance of the letters)}}{\text{(Luminance of the background)}}$$

In the standards for the assessment of visual acuity put forth by the Assembly of Behavioral and Social Sciences, the issue of contrast is discussed as follows:

> In the case of projected charts, the image quality must be good enough so that when the projector is precisely focused it does not produce an appreciable loss in contrast. The walls, floor, and ceiling of the test room must be left in darkness or may be illuminated to produce a surround luminance of the chart. The general illumination should not be allowed to reduce the contrast of the letters below 0.85 as a result of the ambient or veiling luminance, and provision should be made for controlling the general room illumination independently of the localizing light of the chart. The luminance of the surround is important because it controls the pupil size and the amount of stray light in the eye. Stray light is an important factor in measuring acuity when the media [of the eye] are translucent.(Assembly of Behavioral and Social Sciences 1980)

As discussed by Ederer, guessing can play an important part in the measurement of visual acuity. When using letters to measure the vision, each letter represents an odds of one in twenty-five for guessing correctly. Some project-o-chart slides feature numbers mixed in with the letters, such as on the 20/80 acuity line which reads: C A V 8. In this case, the odds for guessing now become one out of thirty-four. This represents the lowest chance for guessing among all of the visual acuity measurements which will be discussed in this paper.

Some letters are more easily confused, such as the letters O, C, Q, and G. Other letters commonly mistaken are V and Y, F and E, and M, N, and H. In a line of five or six letters, as shown on the higher acuity levels, one or two substitution errors of this nature may be factored out. However, using the projected Snellen letters, the visual acuity line corresponding to vision of 20/200 has only one letter: E (oriented in one of four positions, depending on the slide used). The visual acuity line corresponding to vision of 20/100 has two letters, either S and L or H and B, dependent on which slide is used.

The Assembly of Behavioral and Social Sciences recommends that when recording the visual acuity level obtained:

> specify the smallest size at which one or more of the optotypes are missed, and also specify the number of optotypes missed. For example VA=4/8 -2.
>
> Another alternative method is to specify the last size with a perfect score, and the number of optotypes identified at the next smaller size. For example:VA=4/8+3.

(Assembly of Behavioral and Social Sciences 1980)

Using this scheme with the projected Snellen letters, in attempting to record visual levels that are on the border of legal blindness, one runs into unanticipated problems. For example, should an acuity level be recorded as 20/200 +1 when an individual reads one out of two of the letters on the 20/100 line correctly? Is this individual legally blind? Another tester might record the same performance as an acuity level of 20/100 -1. Is this individual legally blind?

Another circumstance frequently arises when the chart used for testing features the letter E oriented on its back, with the three prongs pointed vertically. The patient may incorrectly identify this letter as a W. In the strictest sense, they have not discerned this character properly, yet they may be able to correctly identify the characters on the next line. Would this acuity be recorded as 20/200 -1 +2 or 20/100 ? Would this individual be considered legally blind? When dealing with large numbers of people with impaired vision, these examples become frequent problems, and left totally to subjective interpretation.

In the design of this chart, the visual acuity measurement goes directly from 20/200 to 20/100, a jump that requires vision that is twice as good. Quite frequently, an individual may have a true visual acuity that is somewhere in between the two levels, such as 20/180 or 20/120. Using this test design, acuities of these intermediate levels will be lost, and recorded as falsely low.

General Physician Wall Charts

In the offices of most general practitioners, a cardboard wall chart for measuring visual acuity may be found. This can play an important factor in the certification of legal blindness, especially among the elderly. Often times, the family doctor plays a crucial role in the life of an older person. They may have multiple illnesses, requiring frequent visits to the doctor's office. He or she becomes a trusted confidant, and many people will seek a second opinion about legal blindness from their general physician. Or sometimes, all too frequently, these visits to the family doctor may be all of the health care received.

The typical chart used is designed to be hung on the wall at approximately eye level, twenty feet away from the individual being tested. It employs black Snellen letters on a white background. The lines of acuity important in the certification of legal blindness using this chart are 20/200, 20/100, 20/70, and 20/50. (See appendix A figure 2)

Similar problems may develop as in the case of the projected charts. Room illumination can affect the level of vision. Quite frequently, a doctor's office or a hospital setting will be brightly lit with fluorescent lights, and may have a well polished tile floor. These lights, and the reflections form the floor may act as sources of veiling glare, causing a decrease in the level of vision.

Because letters are used, the odds for correct guessing are again one out of twenty-five. This chart begins with the level of 20/200, and it only presents one letter: E. Many people have become attuned to the fact that most eye charts start with "the big E". It is not uncommon to hear a patient say,"I know it's an E because it's the biggest one". This presents a definite bias in acuity measurement.

As in the projected chart discussed previously, the acuity level of 20/100 presents only two letters, this time F and P. In the Snellen style of letter, these two shapes are very similar, and might easily be confused. The same problems of recording the levels of borderline vision occur when using this chart for testing.

Because the testing is presumed to be in the general physician's office, there is little guarantee that the testing will be performed when utilizing the best optical correction. A general physician can not be expected to be practiced in the techniques of refraction, and is not likely to have the appropriate equipment to do so. It may be likely that a change in spectacles could change the visual performance, making the patient no longer qualify as legally blind.

One way to avoid the problem of refractive error is to employ the use of a pinhole. Optically, the pinhole acts to reduce the size of the blur circles forming the image on the retina. This allows for a partial correction of refractive errors, but will not affect vision decreased by pathological conditions. The effectiveness of using a pinhole for visual screening was studied in the homes of an adult population. A pinhole disk was utilized to retest subjects who initially failed the acuity screening at the level of 20/40. Use of the pinholes reduced the failure rate from 14.4% to 6.9%. The pinhole test was found to have a false positive rate of 26%, and a false negative rate of 1.5%.(Loewenstein 1985) The use of a pinhole might help avoid unnecessary certification in the case of uncorrected refractive error.

The type of testing chart used in general practitioner's offices is also subject to another potential biasing factor that does not affect the project-o-chart system. Because it is easily portable, the cardboard chart is subject to variations in testing distances. In fact, it might be rather rare to encounter a physician's office with an entire twenty feet of unused space to be devoted to visual acuity testing. The problems of differing test distances will be discussed further in following sections.

Sloan Letters

Sloan letters were developed by Louise Sloan, Ph.D., Johns Hopkins University. These letters differ from the Snellen letters in several ways. Rather than using all of the letters of the alphabet, the Sloan letters consist only of ten letters: C, D, H, K, N, O, R, J, V, and Z. When the patient is informed of the possible choices, any test employing Sloan letters would have guessing odds of one out of nine, rather than one out of twenty-five, as in the other letter charts.

The Sloan letters are simpler in style than the Snellen letters, and do not employ as much detail. End tabs and extensions are not used, as they are in the more stylized Snellen letter. The Sloan letter is based on a square system, 5 units high by 5 units wide. The strokes of the letters are bounded by curves and straight lines. The details of the letters are 1 unit in the case of the opening of the letter C and the lines of letters V, N, and Z. The letter S has detail of 1.5 units. (See appendix A figure 4)

Sloan letters have been used in the development of vision charts designed by Goodlite, and by Bailey and Lovie. The Assembly of Behavioral and Social Sciences has deemed that the Sloan letters are equivalent to the standard Landolt rings (to be discussed later), an as such are suitable for use in designing test charts, see appendix A figure 3.(The Assembly of Behavioral and Social Sciences 1980)

Goodlite Chart

The Goodlite Low Vision Chart was designed for use at 6 meters. It is made of a 10 inch by 18 inch sheet of plastic with a matte surface to avoid reflections. The letters are of good contrast, black on a white background. Two different charts are available to avoid problems with patient memorization.

Both sides of the chart are utilized. On one side, acuity levels of 20/200, 20/160, 20/125, and 20/100 are presented. The first three lines have 2 letters each, and the 20/100 line presents 3 letters. On the other side, acuity levels of 20/100, 20/80, 20/60, 20/50, 20/40, 20/30, 20/25, and 20/20 are presented. The levels of 20/100 and 20/80 both have 3 letters. The 20/60 line has 4 letters, the 20/50 line has 5 letters, and the 20/40 line has 6 letters. The three smallest acuity lines each have 8 letters presented. The 20/30 line has all of the 8 letters spaced together across the page. The 20/25 and 20/20 lines have two sets of 4 letters grouped together, with a space in the middle.(See appendix A figure 5)

Because this chart offers different numbers of letters for different acuity levels, the comparisons between visual performance at different levels does remain constant. By only offering 2 letters at each of the 20/200, 20/160, and 20/125 lines, measurement of vision at these levels will be less accurate. This is important, because these are the levels that will come into play in the certification of legal blindness. By introducing the levels of vision between 20/200 and 20/100, the testing will show better acuities in comparison with either the A.O. Project-o-scope or the common wall chart.

Bailey-Lovie Chart

The Bailey-Lovie chart was developed on the theory that the visually impaired suffer from contour interaction effects. This theory proposes that the proximity of the other testing letters interferes with the patient's ability to discern the letter they are concentrating on. Patients who have problems with contour interaction commonly complain that the letters all run together, or become jumbled up. As a consequence, visual acuities measured are falsely low.

This chart proposes to deal with the problem by standardizing the space between the letters and rows of letters in relation to letter size. Spaces on the chart are kept proportional at each acuity level. Each row presents 5 Sloan letters, with proportional distances between the letters. As a result, the chart takes on an over-all inverted triangle appearance. Acuity levels presented are 20/200, 20/160, 20/125, 20/100, 20/80, 20/63, 20/50, 20/40, 20/32, 20/25, and 20/25. (See appendix A figure 6). This chart assumes to present essentially the same visual task at each acuity level.(Lovie-Kitchin 1986)

Because of the equal number of letters on each line, the odds will remain constant at each level. This is the only chart to do so. Because of the acuity levels presented between 20/200 and 20/100, higher acuities will be obtained, as in the case of the Goodlite chart.

One of the other major differences in this chart is that it is based on a logarithmic progression. Because of this, the acuity levels of 20/60 and 20/30 which are normally seen on other visual acuity charts become 20/63 and 20/32. These odd fractions raise potential problems if the testing distance is changed. This chart is the largest of any discussed in this paper, and it is quite cumbersome. Even so, it might not be maintained at a fixed distance. The implications of this will be discussed later.

Feinbloom Chart

A testing chart for use specifically with the visually impaired was developed by William Feinbloom, O.D., Ph.D., for Designs for Vision, Inc. This Distance Test Chart for the Partially Sighted differs in several important ways from the other charts described previously.

The chart is designed for use at ten feet, rather than the typical twenty foot testing distance. As such, any acuities measured with this chart are to be recorded as having a numerator of 10. For example, a distance acuity of 20/40 would be equivalent to 10/20, and so forth.

Numbers are used rather than letters. This brings the odds of guessing correctly to one out of nine. However, the level of difficulty in identifying numbers varies, as it does in identifying letters. The easiest number for most people to identify is 7. The distinctive diagonal line makes it stand out from other numbers exactly the same size, if presented in a row. Other numbers are more difficult to determine; 6,8, and 9 are commonly confused. The number 2 is sometimes confused with the number 5, depending on the style of print used. If the person being tested is not given proper instruction, they may try to interpret the numbers as letters, substituting I for 1, S for 5, or Z for 2. This will bring the odds of guessing correctly down further.

The print used for the numbers consists of very dark, and very wide black lines against a white background. The paper used has a special matte finish to avoid any problems with reflections causing veiling glare. The numbers are spaced widely to avoid any confusion. (See appendix A figures 7 and 8)

Because this chart was designed for the partially sighted, it contains a wider range of acuity levels. The chart begins with the acuity level of 10/700, or 20/1400. For purposes of measuring legal blindness, the critical acuity levels presented are: 10/100 (20/200), 10/80 (20/160), 10/60 (20/120), and 10/40 (20/80).

It is important to note that this chart introduces acuity levels between 20/200 and 20/100 that are not present in the projected chart, or common wall chart. Equally important to note is that the level of 20/100 is not present. The chart goes from 20/120 to 20/80, skipping 20/100 in the middle.

This poses a unique dilemma to the tester. Quite possibly, an individual might have a true visual acuity level of 20/100. In testing, using this chart, it would be expected that they would reach a level of 20/120, then be unable to discern the numbers on the 20/80 line. The practitioner may rationalize that if the individual were tested on the Snellen chart, where intermediate acuities are not presented, they would show an acuity level of 20/200. Therefore, they would be qualified as legally blind, even though if presented with an acuity level of 20/100, they might be able to discern the characters.

Complicating matters further, are the numbers of characters presented at the different acuity levels. As seen previously in the projected and wall Snellen charts, only one character is presented at the 20/200 level, and two characters are at the 20/100 level. The Feinbloom chart has three characters on each of the 20/200 and 20/160 lines. The acuity level of 20/120 presents four numbers, and the 20/80 acuity level has five numbers. To try to equate the demand of the visual task at these different levels is like comparing the proverbial apples and oranges. It cannot be done.

In almost all cases, acuities measured with the

Feinbloom chart are noticeably improved over the acuity levels seen on the projected chart. Again this can prove a dilemma for the tester. If an individual performs at an acuity level of 20/200 on the projected chart, this qualifies them for legal blindness. If the same individual, in the same testing period, under the same conditions can read 20/120, or in some instances 20/80 on the Feinbloom chart, are they still legally blind? This issue is not clear in the law.

Pediatric Testing

When evaluating the visual acuity of partially sighted children, new considerations come into play. Accurate measurement of the level of vision is critical for determining special education needs, qualification for financial aid, and to monitor any changes over time. The results obtained will have a dramatic effect on the rest of the child's life.

Partially sighted children often suffer from other birth defects or ailments in addition to their visual problems. Many have cerebral palsy, retardation, deafness, or other neurological problems. These factors, coupled with the normal short attention span and illiteracy of youth make testing of blind children particularly difficult.

Tumbling E Chart

The A.O. project-o-chart used commonly by the eye care provider has a slide with a Tumbling E chart. This chart displays the letter E in four different orientations, with the three prongs pointed up, down, right, or left. The child is asked to respond by verbally describing the orientation, pointing the direction of the E, or in some cases holding a paper or wooden E in the same direction as those seen on the chart. (See appendix A figure 1)

The Tumbling E slide begins with the acuity level of 20/200, and has only one character presented, the E in normal orientation, pointing to the right. The odds of guessing this one character correctly are considerably higher than the odds for any of the adult charts. A visually impaired child has one in three odds of guessing this correctly. In practice, because the E is in normal orientation, the odds of guessing this correctly may be even higher, because a child might tend to associate it with the familiar written E.

As on the other projected charts, only two characters are presented on the 20/100 line, and the chart drops from 20/200 directly to 20/100. The problems presented before are the same for this chart, compounded by the higher odds for correct guesses.

The tumbling E has one further problem. To perform the test correctly, the child tested must understand the concept of spatial orientation. The concepts of right, left, up, and down are ambiguous to some people, especially those with learning disabilities. Additionally, if the child has suffered from any of the other problems mentioned previously, such as cerebral palsy, retardation, or neurological damage, it is very likely that they will be unable to perform the tasks correctly. Clearly, the Tumbling E slide would not be a good test to base a child's entire future on. However, it happens with great frequency.

Allen Figures

One further type of visual acuity chart is available on the project-o-chart slides, the Allen figures. These figures were developed by Henry F. Allen, M.D. for use in testing the vision of preschool children. On the slide for use in the projected system, the figures consist of a birthday cake at an acuity level of 20/400, a hand and a telephone at an acuity level of 20/200, and a bird and a figure on a horse at the 20/100 acuity level. Other figures presented at the different levels include a Christmas tree, a teddy bear, a telephone, a car, and a house. (See appendix A figure 1)

Many problems are presented by this type of acuity testing. First, it requires a certain level of education on the part of the child being tested. If they are not instructed on the possible choices for answer, the pictures might be interpreted in any number of ways. An odds ratio for guessing correctly is impossible to calculate. Second, the pictures presented offer a definite cultural bias. If a child does not have a telephone at home, they may not be able to identify it. The picture of the telephone presented has become outdated, and even a child familiar with the use of the telephone might not recognize it compared to today's models. The teddy bear, car, and horse all assume a certain level of socio-economic status. The birthday cake and Christmas tree assume cultural bias as well. For these reasons alone, not withstanding all of the technical problems, the Allen figures are not appropriate for use in testing anyone. However, under the law, the test might be used in practice legitimately.

Allen figures are also available for use on cards. (See appendix A figures 9 and 10) The instructions for use of the cards are as follows:

> This test is a valid index of visual acuity recorded in terms of a 30-foot denominator. It is intended for preschool children and has given reliable results from the age of two years and up. It is also useful for retarded children and for illiterate adults. It can be used for mass screening or for individual testing. No pretraining of younger children is necessary.
> Method of testing--The pictures are shown to the seated child at close range with both eyes open and the child is asked to give a name to each picture. The pictures most eagerly received are most likely to be useful. One eye is then covered and the examiner presents the pictures in sequence while backing away from the child. The greatest distance at which three of the pictures are consistently recognized by each eye is then recorded as the numerator of a 30-foot denominator, for example: right eye maximum distance = 15 feet,

vision = 15/30.
Not all of the pictures need be used, the same pictures should be shown to each of the child's two eyes in different sequence.
Interpretation--Comparison of the visual acuity of a child's two eyes is more important than the absolute values obtained. Normal children between two and three can usually identify the pictures at 12 to 15 feet. Children between three and four can usually identify them at 15 to 20 feet. Adults with excellent visual acuity can recognize them at distances greater than 30 feet in a good light. A difference of 3 feet between a child's two eyes is probable cause for referral.(Allen in Opthalmix, LaGrange, IL)

This type of test, and testing method should clearly not be used for epidemiologic purposes, or for purposes for certification of visual levels. It is not repeatable from one test subject to another, or from one tester to the next. The results have highly questionable validity, as the potential to record <u>any</u> fractional level of vision exists. The comparability of this vision measured to standard Snellen acuity is not validated. The levels of acuity expected are not even clear. They range from identification at 12 to 30 feet, and are dependent on some unknown definition of "good light". To think that this test could be used to determine a child's future is outrageous. Yet, under the current arbitrary law, it could easily happen, and it could be defended as well.

Lighthouse Cards

Another type of acuity card system are the Lighthouse cards developed by the New York Association for the Blind. These test cards consist of three figures, an apple, a house, and an umbrella.(See appendix A figures 11 and 12) It is stressed that in using this system, the cards do not necessarily have to be identified correctly by the child, but the name given should be consistent. For example, in warmer or desert climates, the umbrella is sometimes identified as a palm tree.

When the child understands that there are only three choices for each card presented, the odds for guessing correctly become one in three. However, without an understanding of this basic assumption, as might be commonly found in retarded children, it is impossible to calculate the odds.

The apple and the house are more similar in shape, and nearing the limit of the individual's acuity level, these objects might be confused, while the umbrella remains easily identified. Therefore, the odds to determine the apple and the house become one to one, or a 50/50 chance. This is a significant improvement in odds from the charts featuring letters or numbers, and invites questions about the comparability of any recorded visual acuity.

This test begins with a character size of 20/200. As in several of the other tests described, it jumps immediately to the 20/100 level next. From this level, it approaches 20/50, another doubling in visual capability.