# THE PARTIALLY SIGHTED PATIENT: A STUDY OF 917 CASES*

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THERE ARE NO SPECIFIC MINIMUM OR MAXIMUM VISUAL ACUITIES which outline the visual boundaries of the partially sighted. For this paper a partially sighted person is defined as one whose visual acuity ranges from 2/400 to 20/70 in the better eye with proper correction. Although the majority of these people fall within the category of legal blindness (less than 20/200 in the better eye with correction), many still have enough residual visual efficiency to benefit from properly prescribed optical and non-optical aids.

The magnitude of the problem of the partially sighted was shown in a letter from the National Society for the Prevention of Blindness[1] dated July 1965. According to estimates by this organization, 2,143,600 persons in the United States are partially sighted. Of this number 153,900 are under 20 years of age (under 5, 40,900; 5–17–school children, 97,900; 5–17–not in school, 2,100; 18–19, 13,000); 236,200 are aged 20–39; 586,100 are 40 to 64 years; and 1,167,400 are 65 or over. This estimate was determined from data obtained from various States and from studies of special population groups. Among the partially sighted children in school in 1965, the same source reports that about 10,000 or only one out of every ten received treatment and visual rehabilitation. One consequence of this lack of care is that a number of the children who had enough sight to be helped by visual aids were placed in schools for the blind. Hatfield[2] reported a study of 7,757 legally blind children who in the school year 1958–59 were placed in residential or public day schools for the blind, although 45 per cent of them had a visual acuity of 5/200 or better. In another survey of blind children who were registered in school in January 1960, 38 per cent of them could read print.[3] While almost half the pupils of the St. Vincent School for the Blind and Partially Sighted had markedly

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decreased vision, they were still within the category of the partially sighted.[4] In 1963, a survey of 726 blind children revealed that "167, or 23 percent, had some vision from ability to count fingers up to an acuity of 20/200; and another 188, or 26 per cent, had an acuity of 20/200."[5] This means that some of these children should have been taught to read print rather than braille.

Another facet of the problem of the partially sighted is that few ophthalmologists are treating them in their regular practice. In Pittsburgh, for example, the author knows of only three others out of 51 certified opthalmologists who are doing low vision work as a regular part of their practice. In January 1964, an estimated 47 low vision clinics existed in the United States, many of them connected with medical schools, but it is only in recent years that the techniques of low vision evaluation have become a standard part of the training of residents in ophthalmology. Although procedures for the care of the partially sighted are available, many ophthalmologists are not familiar with them. Consequently, they feel that low vision is a specialization requiring lengthy procedures, complex equipment, and particular knowledge.

Since the problem of the partially sighted is widely accepted and because the basic knowledge and techniques for improved low vision already exist, the purpose of this paper is to organize the knowledge about partially sighted patients in order to simplify their evaluation and care by other ophthalmologists.

The bases for the observations and conclusions are the author's clinical experience with 917 partially sighted patients seen from February 1953 through November 1966. During this period data were collected and examined to determine what procedures and techniques were most successfully employed; what types of special equipment were needed; what kinds of visual aids were available and most frequently prescribed; and what, if any, were the similarities among the patients who were treated. These observations were used to evaluate three hypotheses:

1. That simple techniques, procedures, and equipment are readily available for ophthalmologists in private practice to use in treating partially sighted persons quickly and effectively;

2. that certain population characteristics can be used as prognosticators of successful treatment;

3. that the successful use of aids is determined by the extent and location of the pathology rather than by the actual condition of the eye.

From an analysis of the data, the most pragmatic techniques for the use of the private ophthalmologist will be recommended. In addition to providing insights into the general problems and specific treatment of the partially sighted, an evaluation of how the patients respond to treatment should give further criteria for the preselection of patients for visual rehabilitation.

## SURVEY OF LITERATURE

During the past decade, articles by ophthalmologists on the problems of the partially sighted have generally fallen into two categories: a very large group which are confined to a description of the principles and the merits of specific optical and non-optical devices, and a small group concerned with the clinical evaluation of the low vision patient, particularly with procedures of examination and care. Since the latter approach is stressed in this thesis, this survey of recent literature is confined to a selection of these articles. However, mention should be made of the following authors for their notable and valuable contributions to the fundamentals of instrumentation: Kestenbaum, Linksz, Fonda, Sloan, Lebensohn, Volk, Keeler, and Bier.

Moffatt,[6] in describing the problems of providing magnifying lenses for partially sighted children, emphasized the need for psychological training before the patient used an acceptable visual aid. The personality pattern of the low vision patient was correlated with the successful use of an aid by Freudenberger and Robbins.[7] They found that a personable, industrious, and self-accepting patient tended to use an aid but that a hostile, indolent, and self-denying patient would usually reject it. They stressed that the ophthalmologist should attempt to recognize these types.

Tillett[8] reported on the ease and the short examining time needed for treatment of partially sighted patients and stressed that only a small number of inexpensive aids are necessary for their evaluation and treatment.

From an analysis of 350 low vision patients at Moorfields Hospital (London) Moffatt[9] found that 85 per cent of the patients fitted with visual aids were able to read Jaeger 4 or better. In a survey of 1,000 patients in the visual aid service established at the National Institute for the Blind and Partially Sighted in Copenhagen, Braendstrup and Skydsgaard[10] reported that practical reading ability was obtained in approximately 65 per cent, limited reading ability in 15 per cent, and negative results in 20 per cent.

Weiss[11] reported on a study of 434 patients in which he found that children and young adults make the best candidates for visual assistance because their motivation is better. He also obtained the most favorable results in cases with depressed macular function and the poorest results in advanced glaucoma, optic atrophy, and retinitis pigmentosa since these pathological states have associated field loss. Gunstensen,[12] in an investigation of 231 partially sighted patients, found that all of the 100 patients who were supplied with an aid demonstrated visual improvement. In many cases the patient increased his efficiency at work and in others he was able to resume his education. Seventeen pathological ocular conditions were seen in this group. In some cases with field loss due to optic atrophy and glaucoma, the visual rehabilitation with an aid was surprisingly good.

## METHODS AND MATERIALS

### *Sample Population*

A sample of 917 patients was selected from a total of 1,284 partially sighted persons who were examined either in the clinic service or in the author's private practice. Of the 917 patients, 575 were clinic and 342 were private cases. The clinic patients were seen in the period from October 1957 to November 1966 and were obtained from three referral sources: (1) from private physicians located in Pittsburgh and its environs; (2) from the outpatient eye department at the Falk Clinic, a facility of the University of Pittsburgh School of Medicine; (3) from various agencies for the blind. Because of the specialized nature of the clinic, ophthalmologists were invited to refer their own private partially sighted patients to the service. As a result, about 60 per cent of the patients in the clinic series were attributable to private sources, about 30 per cent were sent by residents assigned to the outpatient eye department, and about 10 per cent were from various blind agencies and the local school for the blind. The private series of cases, seen in the period from February 1953 through November 1966, included the author's own patients and those referred by other ophthalmologists whose patients preferred a private evaluation.

The final selection criteria were: (1) personal examination and testing by the author; (2) availability of complete case histories and clinic records. No other preselection was done.

Since the characteristics of the clinic and private population seemed to be similar they were studied together. From an analysis of the case history data, it was hoped to extract any patterns that could be useful for improving patient selection in terms of prognostication for successful treatment. The characteristics investigated included age, sex distribution, age of onset, education, and greatest visual need.

## *Examination*

Each patient who was seen by the author either in private practice or at the clinic received the same comprehensive examination which included a detailed case history, determination of distant and near visual acuities, refraction, assay of magnification, testing, and prescription and training in the use of visual aids.

### DATA COLLECTION

A detailed case history was taken by a nurse or secretary in the private cases and a trained social worker in the clinic cases. Such questions as the patient's greatest visual needs, present visual usage, and indications of general motivation were noted. During the examination, the author completed the clinical evaluation form, or verified it if the examination was done initially by an associate or a resident. (See forms in the Appendix.)

### EQUIPMENT

The ophthalmologist does not require an unusual or extensive variety of equipment, in addition to the normal refracting equipment, for low vision examination or treatment. An outline of the many types of aids available is given below. A relatively small number, however, were used in the examination and testing of the majority of the patients (italics); the powers used most frequently are noted.

A. Distance Vision Aids
  1. *Standard plus and minus lenses* (with 12 through 20 diopter powers in #1801 trial rings)
  2. Telescope
     (*a*) *Monocular* (2.5× and 6× )—focusable
     (*b*) *Binocular* (2.5× and 3.5× sports binoculars—focusable
  3. Contact lens

B. Near Vision Aids
  1. *Standard plus lenses*
  2. High power plus lens in spectacle frame
     (*a*) *Unifocal lens* (12, 16, 20, 24, 28 diopters)

   (*b*) Compound lens
   (*c*) Bifocal
      (1) High power addition
      (2) *Aspheric inserts* (20, 24, 28, 32, 36 diopters)
3. *Clip-on high plus lens* (8, 12, 19, 24, 36 diopters)
4. *Monocular telescope with reading caps*
5. Handheld magnifier
   (*a*) Convex hand lens
      (1) *Single mount* (4, 9, 16, 20 diopters)
      (2) *Folded mount* (6, 10, 20 diopters)
6. *Fixed-focus stand magnifier with optional illuminating attachment* (low magnification of 4, 8, 12 diopters)
7. *Focusable stand magnifier with optional illuminating attachment* (high magnification of 17, 24, 30, 37, 53 diopters)

C. Non-Optical Aids
1. *Multiple pinhole spectacle*
2. *Prentice slit*
3. Writing guide

The three types of visual aids for distance, listed in order of importance, are the standard lens, the telescope, and the contact lens. The standard lens has the proper compensating sphere and cylinder correction for the refractive error. Two types of telescopes are used: (1) those that are headborne, focusable, and give weak magnification; (2) those that are handheld, focusable, and provide stronger magnification. The corneal contact lens is used.

For near vision, the standard reading lens prescribed for the presbyope is the same in principle as that used for the partially sighted. The important difference is in the strength of the lenses used: those up to +4 diopters are arbitrarily considered to be reading additions while stronger ones are low vision magnifiers.

A more detailed appraisal of aids and their use will be discussed later.

## PROCEDURES

### *Evaluation of Distant Visual Acuity*

The first phase of the routine examination was conducted to determine the degree of distant visual loss. Although 74 per cent, or 679, of all clinic and private patients wore distant spectacle lenses at the time of their initial examination, only 18 per cent, or 122, showed improved distant vision (except for some severe myopics, aphakics, and keratoconus cases). As a result, relative visual acuity, that is uncorrected distant visual acuity in the better eye, was measured for analysis rather than the corrected, or absolute, visual acuity.

Adult vision was tested with Snellen letters constructed on a visual angle of five minutes with each detail subtending an angle of one minute. A projector with a 50-watt bulb was used to throw opto-types on a screen. Initially, special card charts were used with Snellen letters as large as 20/800 and graded from 20/500 through 20/320, 20/100, 20/80, and 20/60. These were discarded, however, in favor of a projection chart which begins with a 20/400 notation. Although vision could be recorded numerically at any distance from one to twenty feet from the eye using the 20/400 notation, a testing distance of five feet was found to give the best results. When other than a 20-foot distance was used in testing, these results were converted to a standard designation by multiplying the numerator and the denominator by the appropriate number to transfer the denominator to 20. When a patient could not see 1/400 in the better eye, recordings were made using light perception, recognition of hand movements, or a count of the number of fingers seen at one foot.

To test the distant visual acuity of preschool children several variations of the Snellen method were tried including the illiterate E, the silhouette figures,[13] and the Sjögren[14] modification which employs pictures of a hand with fingers extended in any of four cardinal positions. For three- to five-year-old children who had difficulty recognizing both silhouettes and directions, the symbols of circles, crosses and hearts were found to be useful since they did not require spatial discrimination. For children over four years of age, the illiterate E chart gave the most reliable results particularly if parents cooperated by giving preliminary home instruction using a sample test card.

Some children over three years responded to a series of pictures by Allen[15] which were particularly helpful in determining eye difference in early amblyopia. In this series, four cards were used which had clearly recognizable black figures on a white background corresponding to the Snellen letter E at 30 feet. After these characters were identified using binocular vision at 14 inches, one eye was occluded and the cards moved away from the child. The furthest distance at which the characters could be identified served as the numerator of the Snellen fraction with 30 as the denominator.

### *Evaluation of Near Visual Acuity*

Of the 917 patients in the study, 82 per cent, or 752 wore conventional glasses for near vision when first examined. However, only 23 per cent, or 173, received slight improved acuity from their use.

To determine the near visual acuity of patients, several methods were tried and discarded in favor of Jaeger notation which was found to be a simple and relatively efficient test. Although the method does not give a definite angular difference between letters, it does give size variations which were adequate for testing. All patients were evaluated with the usual Jaeger charts which utilize words rather than isolated letters. The criterion for measuring vision was the distance in inches at which a particular size of print was readable.

Children up to four or five years of age were tested using Allen near vision test cards[16] which had the same characters as in the Allen preschool distance test. These figures were scaled down for examination at a reading distance.

*Refraction*

Before determining the required degree of magnification, a thorough refraction was needed so that the patient could obtain as clear a retinal image as possible.

Because 75.7 per cent, or 695 of those studied had no densities or irregularities in their refractive media, a careful retinoscopy, particularly under cycloplegia, was possible. Where corneal scars, opacities, or densities of the media occurred, refraction was done subjectively using a Snellen chart at five feet. Patients tested at this distance were found to give less equivocal responses in lens selection during the manifest refraction than previous refractions at a 20-foot distance with a telescope in the front cell of the trial frame.[17]

To perform a retinoscopy on young children, a simplified procedure was found to be successful. To reduce anxieties, the entire examination and refraction was conducted in the same room which was not darkened. In children under ten years, a keratometer reading, if obtainable, was quite important. In 90 per cent of the cases of corneal astigmatism in the young, the keratometer readings were found by Tait[18] to be within 0.50 diopters of the cylinder found with the retinoscope.

During subjective testing, those patients whose visual acuity was greatly diminished by ocular pathology had difficulty determining small variations in the power of the lens. Patients with 20/400 or less in the better eye could perceive little variation between a $\mp 0.25$ sphere or cylinder and a $\mp 0.50$ sphere or cylinder. As a result, a $\mp 0.75$ or a $\mp 1.00$ diopter lens was substituted. Similarly, a $\mp 1.00$ cross cylinder was found to be more desirable than one of lower strength.

Loose lenses in the trial test were found to be more efficient and flexible for power changes needed in each individual situation than the use of a phoropter. The trial frame was carefully placed so that the center of the test lens was aligned properly to the visual axis, eliminating some of the peripheral distortion inherent in high-power lenses. Plus lenses up to 20 diopters were put in the rear cell of the trial frame and additional lenses placed in the front cell.

*Determination of Magnification*

Although no method for determining magnification was without inconsistencies, the Kestenbaum method[19] was found to be the simplest and most satisfactory for estimating the amount of magnification needed. Using this method the distant visual acuity was measured with Snellen isolated letters at 20 feet and transferred to a formula for obtaining the magnification needed for near correction. In this formula the reciprocal of the distant visual acuity expressed as a single fraction indicated the amount of plus lens addition required to read Jaeger 5 (9-point magazine type). In order to read Jaeger 3 (6-point type of a telephone directory), 40 per cent was added to the dioptric power. Thus, 20/400 = 20 diopters for Jaeger 5 plus 8 diopters or a total of 28 diopters to read Jaeger 3. To read Jaeger 1 the reciprocal of distant vision was doubled. Thus, 20/400 = 20 diopters × 2 or 40 diopters for Jaeger 1.

*Subjective Testing*

After determining the approximate amount of magnification needed, subjective testing was started to select the appropriate visual aid. It should be noted here that whenever active pathology was found, the low vision evaluation was postponed until the patient received remedial care.

One major problem in outlining a procedure for the prescription of aids, however, is the number of uncontrolled variables that must be considered including the patient's physical condition, visual need, and motivation. Keeping these in mind, certain principles were followed to coordinate the actual required correction with the greatest visual needs expressed by each patient. Patients tried the various headborne and handheld aids which fell into two rough categories: the weaker and simpler which were under 16 diopters and the more elaborate aspheric lens systems for over 16 diopters. Although each patient was permitted the ultimate choice of whether or not they wanted a particular aid, a device was prescribed only when the improvement in visual performance warranted it.

During the subjective testing, the patient was asked to perform pragmatic visual tasks to test the adequacy of each aid. Care was taken to avoid patient fatigue and frustration which could affect an evaluation. Records were made of the degree of success a patient had using each device as well as observations of pertinent patient characteristics. For example, where a patient had equal vision in both eyes, but required a uniocular lens because of the high power needed, the patient's dominant hand was noted so that the aid would be prescribed for the same side. This was done because a right-handed person was generally more comfortable holding material to his right eye.

Since variations in the amount of illumination can have a profound effect on visual efficiency, a trial with artificial lighting was made in every examination, using an inexpensive, flexible, swivel-type lamp that housed a 100-watt incandescent bulb. This hooded bulb could be brought closer or further away from the reading matter. It could also be guided at various angles from the plane of an imaginary line coming from the center of the patient's pupillary area. Since the use of a visual aid requires an extremely short depth of focus, the angle must, of necessity, be about 30 to 45 degrees in order to avoid the patient's head. The lamp was aimed from the side of the eye using a uniocular device or from the side of the better eye if a binocular aid was employed. A 100-watt bulb was not found to be too powerful even at a close distance, as the illumination was decreased when the light was angled. Even though the printed page had to be held very close to the eye when using spectacle lens systems with high powers over 28 diopters, it was seldom found necessary to attach a light to the frame or to have any integral battery illumination. A lamp directed properly by means of a flexible arm provided uniform illumination without annoying reflections or shadows.

The patient was asked to return in a week bringing with him books or materials representing his greatest visual need in reading or performance of vocational or avocational tasks. During the second visit the aids which had been tried most successfully were reevaluated. An aid was seldom prescribed until the second, and not usually until the third visit. The only exceptions were a few patients who for reasons of distance or poor health were unable to return for further visits. In these cases an aid was ordered only if the author was quite optimistic about successful results.

*Training*

Up to this point, the same procedure was used for both clinic and private patients. Following the prescription of an aid, private patients returned for a visit as soon as they received the aid. As a result, they were given orientation and training before they used their device. Not only were they instructed in the use of the aid and the time schedule to follow in adapting to it, but they were also told what problems and limitations they might anticipate. At least one member of the patient's family was asked to be present during training. That person was made aware of the possibilities and limitations of the aid by actually trying it, and they also listened to the instructions given the patient for the use of their aid in order to be able to help the patient follow the recommended procedure. Clinic patients, on the other hand, did not return until they had been using their aid for at least a month. Their orientation was based on instructions given during the preliminary testing visits.

During these sessions, each patient read or performed appropriate visual tasks while being observed for several specific factors: (1) reading range; (2) hand-eye coordination; (3) correct lighting; (4) direction of gaze; and (5) correct positioning of the aid. Although most of these will be discussed more fully later, brief explanations follow. Reading range implies the distance at which the printed page was held from the eye dependent upon the focal length of the prescribed lens. For example, a distance of two inches from lens to page was recommended if a +20 diopter lens was used in a spectacle frame. Hand-eye coordination refers to whether a patient should be directed to move his eyes and keep the page stationary or vice versa, depending upon which benefitted him most. Correct lighting is concerned with improving vision by increasing or decreasing the light and by finding the optimum direction for the illumination. Direction of gaze is used to determine whether direct or eccentric gaze should be recommended. Correct positioning of the aid is important only when a bifocal spectacle was ordered. In such a case, the lens segment had to be set at a higher level than ordinary bifocals, so that it was parallel to the upper border of the pupil.

Private patients were given an adaptation schedule for using an aid which started at 10 minutes each day for one week and then increased by 10 minutes per day until they were reading comfortably. They were also seen in the office for two or three adaptation visits to make sure that they were using the aids correctly. They were then instructed to return in about six months for reevaluation. In the clinic, however, patients were asked to return in six months after only one follow-up visit.

*Considerations of Ocular Pathology*

Some ophthalmologists have classified ocular diseases as "favorable" or "unfavorable"* with regard to the likelihood of a patient with a certain condition being helped by visual aids.[20,21,11] One hypothesis that this author investigated was that the extent and location of the pathology is a more important prognosticator of successful treatment than the type of pathology. To study this concept, the clinic and private cases were not screened or preselected. They were routinely divided into Stimson's two general pathological groups: anterior segment and posterior segment pathology.[22] The first group included those patients who had densities or irregularities of the refractive media, while the second was composed of cases with decreased chorio-retinal function or impaired optic nerve conductivity. These two categories were later subdivided into definitive ocular disease entities in order to determine how many patients had each ocular disease, how many of these were given aids, and consequently, whether specific diseases seemed, indeed, favorable or unfavorable with regard to the use of an ocular aid.

## *Recall Study*

To determine the long-range effectiveness of the prescribed aids, a recall study was done in the fall of 1965 for patients with available addresses. Questionnaires were sent to 365 clinic and 287 private patients; 151 clinic and 193 private patients, 41.4 and 67.3 per cent respectively, completed and returned the questionnaire. The first 125 replies received from each group which met the criterion of six months' use of a visual aid were arbitrarily selected for comparison. Of those whose questionnaire was used, 82, or about one-third of the recall sample, were re-examined.

*Favorable: albinism, macular degeneration (senile and juvenile), post-cataract aphakia, corneal opacities, severe myopia, congenital nystagmus, retrolental fibroplasia, diabetic retinopathy without hemorrhage or proliferans. Unfavorable: retinitis pigmentosa, advanced glaucoma, advanced optic atrophy, retinal detachment, diabetic retinopathy with hemorrhage or proliferans, homonymous hemianopsia, hypertensive and arteriolar sclerotic retinopathy with irreversible changes.

## RESULTS

The results of this study are based upon the total of 575 clinic patients and 342 private patients examined over the past 14 years. In addition, the 250 cases of the recall group provide a primary source of data for determination of patient satisfaction; these data will be incorporated where necessary throughout this section and will also be summarized under a separate heading.

This section begins with a survey of the characteristics of the partially sighted and their relation to the number and kind of optical aids prescribed. Of particular interest are those characteristics that may relate to prognosis of treatment, including age, age of onset, educational level, distant and near visual acuity, and ocular pathology.

Because 60 per cent of the clinic group were private referrals, the private and clinic populations seem to be similar in a number of characteristics including the following:

1. AGE. Not unexpectedly an increase of the number of partially sighted seems to be concomitant with the aging process. Over 70 per cent of all cases were 45 years or older.

2. SEX. The sex ratio in the sample population seemed to be roughly in accord with that of the general population, with females outnumbering the males in the over-45-year categories. Under that age, however, slightly more males than females were treated probably as a result of their specific occupational requirements.

3. AGE OF ONSET. The majority of the visually handicapped fall into three main categories: (1) onset in youth (19 or under) of whom 50 per cent have congenital abnormalities or birth injuries; (2) onset at middle age where the visual loss is mostly due to ocular diseases or trauma; and (3) onset after 60 in those whose decreased vision has resulted from senescence or accumulated ocular pathology.

4. EDUCATION. The level of education was relatively high in both groups, with over three-quarters having a minimum of a high school education. However, a slightly larger percentage of the private cases had a college or postgraduate education.

5. GREATEST VISUAL NEED. Patients were asked to indicate their greatest visual needs, both near (reading, writing, sewing, and other close tasks) and distant (movies, television, and travel, for example). Because some patients indicated more than one major need, the total is higher than the total number of patients (Table 1). The results show that 849 requests were primarily for near vision help as compared to 299 requests for distant visual improvement.

TABLE 1. NUMBER AND PERCENTAGE OF CLINIC AND PRIVATE PATIENTS BY GREATEST VISUAL NEED

| | Clinic | | Private | |
|---|---|---|---|---|
| | Number | Percentage | Number | Percentage |
| Close needs | 560 | 68.2 | 289 | 64.8 |
| Distant needs | 178 | 21.7 | 121 | 27.1 |
| Not recorded | 83 | 10.1 | 36 | 8.1 |
| TOTAL | 821 | 100.0 | 446 | 100.0 |

OPTICAL AND NON-OPTICAL AIDS PRESCRIBED

To determine whether sample population characteristics were related to the successful prescription of visual aids, a number of tables were prepared. Table 2 relates distant visual acuity by age with the number of optical and non-optical aids prescribed. The majority of all patients in this study had uncorrected distant visual acuity ranging from 6/400 to 20/400 in the better eye. A very large number of these

TABLE 2. NUMBER OF CLINIC AND PRIVATE PATIENTS AND NUMBER AND PERCENTAGE OF AIDS PRESCRIBED BY DISTANT VISUAL ACUITY

| | Age (years) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 5–14 | 15–29 | 30–44 | 45–59 | 60–74 | Over | Total | 1* | 2† |
| | | | *Clinic Cases* | | | | | | |
| Light perception | 0 | 0 | 1 | 2 | 1 | 0 | 4 | 0 | .0 |
| Hand movements | 1 | 2 | 3 | 5 | 1 | 0 | 12 | 0 | .0 |
| Count fingers | 1 | 2 | 3 | 6 | 7 | 3 | 22 | 3 | 1.3 |
| 1/400–5/400 | 7 | 16 | 5 | 17 | 26 | 2 | 73 | 23 | 10.3 |
| 6/400–10/400 | 11 | 37 | 9 | 33 | 77 | 16 | 183 | 74 | 33.2 |
| 11/400–15/400 | 6 | 15 | 7 | 40 | 10 | 16 | 94 | 35 | 15.7 |
| 16/400–20/400 | 4 | 8 | 10 | 41 | 52 | 8 | 123 | 47 | 21.1 |
| 20/300–20/70 | 3 | 12 | 10 | 14 | 11 | 14 | 64 | 41 | 18.4 |
| TOTAL | 33 | 92 | 48 | 158 | 185 | 59 | 575 | 223 | 100.0 |
| | | | *Private Cases* | | | | | | |
| Light perception | 0 | 1 | 1 | 3 | 1 | 2 | 8 | 0 | .0 |
| Hand movements | 2 | 2 | 1 | 4 | 1 | 2 | 12 | 0 | .0 |
| Count fingers | 0 | 0 | 1 | 3 | 2 | 2 | 8 | 3 | 1.4 |
| 1/400–5/400 | 4 | 4 | 4 | 10 | 10 | 1 | 33 | 20 | 9.2 |
| 6/400–10/400 | 9 | 10 | 19 | 19 | 46 | 12 | 115 | 79 | 36.4 |
| 11/400–15/400 | 6 | 7 | 14 | 28 | 12 | 10 | 77 | 47 | 21.7 |
| 16/400–20/400 | 3 | 3 | 6 | 15 | 24 | 2 | 53 | 41 | 18.9 |
| 20/300–20/70 | 3 | 3 | 9 | 10 | 8 | 3 | 36 | 27 | 12.4 |
| TOTAL | 27 | 30 | 55 | 92 | 104 | 34 | 342 | 217 | 100.0 |

*1, number of aids prescribed.
†2, percentage of total population receiving aids.

patients fall into the over 45 age group. Table 2 also shows that a much higher percentage of private cases received aids although the percentage distribution of aids among the various acuity groups was similar for both clinic and private patients.

Closer inspection of distant visual acuity reveals that the clinic and private cases varied in three general areas. In the acuities ranging from 1/400 to 15/400 at ages five to 29 a third more clinic cases were seen than private ones. In the acuities ranging from 16/400 to 20/70 a higher percentage of clinic patients was noted again. In general, aids were rarely prescribed for patients with vision below 1/400. Curiously, the number of aids prescribed was greatest in the acuities from 6/400 to 10/400 rather than in the better than 16/400 range. It would seem that most referring ophthalmologists considered patients beyond visual improvement only when the 6/400 to 10/400 range is reached.

The numbers prescribed of each type of aid are given in Table 3. With the exception of the standard lens, aids for distant vision repre-

TABLE 3. NUMBER AND PERCENTAGE OF DISTANT AND NEAR AIDS PRESCRIBED FOR CLINIC AND PRIVATE PATIENTS

| | Clinic | | Private | | Total | |
|---|---|---|---|---|---|---|
| Type of aid | No. | % | No. | % | No. | % |
| *Distance* | | | | | | |
| Standard lenses | 69 | 31.0 | 76 | 35.0 | 145 | 33.0 |
| Telescopes | | | | | | |
| Monocular | 22 | 9.9 | 18 | 8.3 | 40 | 9.1 |
| Binocular | 6 | 2.7 | 1 | 0.5 | 7 | 1.6 |
| Multiple pinhole spectacles | 0 | 0.0 | 7 | 3.2 | 7 | 1.6 |
| Contact lenses | 2 | 0.9 | 5 | 2.3 | 7 | 1.6 |
| *Near* | | | | | | |
| Standard lenses | 11 | 4.9 | 6 | 2.8 | 17 | 3.9 |
| Unifocal spectacle lenses—high power | 35 | 15.7 | 23 | 10.6 | 58 | 13.2 |
| Bifocals—high power | 8 | 3.6 | 4 | 1.8 | 12 | 2.7 |
| Aspheric inserts | 48 | 21.5 | 33 | 15.2 | 81 | 18.4 |
| Clip-on high plus lenses | 6 | 2.7 | 3 | 1.4 | 9 | 2.1 |
| Telescopes—monocular and reading caps | 2 | 0.9 | 3 | 1.4 | 5 | 1.1 |
| Convex hand lenses | 3 | 1.3 | 2 | 0.9 | 5 | 1.1 |
| Fixed focus stand magnifiers | 7 | 3.1 | 16 | 7.4 | 23 | 5.2 |
| Focusable stand magnifiers | 3 | 1.3 | 11 | 5.1 | 14 | 3.2 |
| Prentice slits and high plus reading lenses | 1 | 0.5 | 9 | 4.1 | 10 | 2.2 |
| TOTAL | 223 | 100.0 | 217 | 100.0 | 440 | 100.0 |

sent only 13.9 per cent of the total. Since most telescopes provide a maximum of 2.2× magnification, their use was generally restricted to patients having vision of 16/400 to 20/70 in the better eye. The clinic patients in this category numbered 187; 15 per cent, or 28, had telescopes prescribed. The private cases totalled 89, and 21 per cent, or 19, of them received telescopes. Of the 47 telescopes prescribed, 40 were uniocular and 7 binocular.

Of all aids for near vision, 13.2 per cent were high-power unifocal lenses, 2.7 per cent were high-power bifocals, and 18.4 per cent were aspheric inserts. The last aid in high powers provided the least amount of aberration and this accounted for its popularity. Although head-borne aids were the most satisfactory, handheld devices were prescribed in over 9 per cent of the cases.

Tables 4 through 6 relate the population characteristics of age, age of onset, and level of education of the sample population to the number of aids prescribed. In addition, the success of these aids is measured in terms of the results of the recall study. In this follow-up, patients were asked whether their aid "met their needs." The first column of the recall shows the population distribution by the specific characteristic for all 250; the second shows the population distribution for the 139 recall patients who indicated that their aid met their needs.

As can be seen in Table 4, age does not seem to be related either to the number of aids prescribed or to the success of the aids. However, the 33 to 44 age group formed a larger proportion of the recall population than of the total sample; and a large proportion of these were happy with their aids. Table 5 shows that the age of onset did not seem to vary between private and clinic cases. Age was inversely proportional to aids prescribed; that is, the younger the patient at the time of onset, the higher the likelihood that an aid would be prescribed. About 34 per cent of all cases, representing those whose age of onset ranged from birth to 39 years, received about 47 per cent of all aids. The sample in the recall study contained a somewhat higher percentage of patients whose visual deficiency began before age 39 than the primary group. However, no real differences in success were found.

Educational level in Table 6 shows that a larger percentage of the private cases attended college or graduate school. Also, more aids were prescribed for the population at the college and postgraduate levels. In the recall study, the lower educational levels show the lowest rate of benefit. Patients with a higher level of education showed greater satisfaction with the visual benefits derived from their aids.

TABLE 4. NUMBER AND PERCENTAGE OF PATIENTS AND AIDS ORDERED INCLUDING AN ANALYSIS OF 250 RECALL PATIENTS, BY AGE GROUP

| Age groups | Number and percentage total population | | | | | | Number and percentage aids prescribed | | | | | | Recall of 250 cases (meets needs) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Clinic | | Private | | Total | | Clinic | | Private | | Total | | | | | |
| | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| 5–14 | 33 | 5.7 | 27 | 7.9 | 60 | 6.6 | 11 | 4.9 | 10 | 4.6 | 21 | 4.8 | 14 | 5.6 | 8 | 5.8 |
| 15–29 | 92 | 16.0 | 30 | 8.8 | 122 | 13.3 | 41 | 18.4 | 21 | 9.7 | 62 | 14.1 | 43 | 17.2 | 22 | 15.8 |
| 30–44 | 48 | 8.3 | 55 | 16.1 | 103 | 11.2 | 26 | 11.7 | 41 | 18.9 | 67 | 15.2 | 58 | 23.2 | 39 | 28.1 |
| 45–59 | 158 | 27.5 | 92 | 26.9 | 250 | 27.3 | 62 | 27.8 | 67 | 30.9 | 129 | 29.3 | 78 | 31.2 | 37 | 26.6 |
| 60–74 | 185 | 32.2 | 104 | 30.4 | 289 | 31.5 | 64 | 28.7 | 63 | 29.0 | 127 | 28.9 | 42 | 16.8 | 23 | 16.5 |
| 75 and over | 59 | 10.3 | 34 | 9.9 | 93 | 10.1 | 19 | 8.5 | 15 | 6.9 | 34 | 7.7 | 15 | 6.0 | 10 | 7.2 |
| TOTAL | 575 | 100.0 | 342 | 100.0 | 917 | 100.0 | 223 | 100.0 | 217 | 100.0 | 440 | 100.0 | 250 | 100.0 | 139 | 100.0 |

TABLE 5. NUMBER AND PERCENTAGE OF PATIENTS AND AIDS ORDERED INCLUDING AN ANALYSIS OF 250 RECALL PATIENTS, BY AGE OF ONSET

| Age of onset | Number and percentage total population | | | | | | Number and percentage aids prescribed | | | | | | Recall of 250 cases (meets needs) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Clinic | | Private | | Total | | Clinic | | Private | | Total | | | | | |
| | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| Birth–19 | 86 | 15.0 | 52 | 15.2 | 138 | 15.0 | 51 | 22.9 | 45 | 20.7 | 96 | 21.8 | 73 | 29.2 | 35 | 25.2 |
| 20–39 | 112 | 19.5 | 59 | 17.3 | 171 | 18.7 | 59 | 26.4 | 51 | 23.5 | 110 | 25.0 | 72 | 28.8 | 47 | 33.8 |
| 40–59 | 123 | 21.4 | 73 | 21.3 | 196 | 21.4 | 47 | 21.1 | 48 | 22.1 | 95 | 21.6 | 60 | 24.0 | 34 | 24.5 |
| 60 and over | 222 | 38.6 | 152 | 44.4 | 374 | 40.8 | 66 | 29.6 | 73 | 33.7 | 139 | 31.6 | 43 | 17.2 | 23 | 16.5 |
| Not available | 32 | 5.5 | 6 | 1.8 | 38 | 4.1 | 0 | .0 | 0 | .0 | 0 | .0 | 2 | .8 | 0 | .0 |
| TOTAL | 575 | 100.0 | 342 | 100.0 | 917 | 100.0 | 223 | 100.0 | 217 | 100.0 | 440 | 100.0 | 250 | 100.0 | 139 | 100.0 |

TABLE 6. NUMBER AND PERCENTAGE OF PATIENTS AND AIDS ORDERED INCLUDING AN ANALYSIS OF 250 RECALL PATIENTS, BY LEVEL OF EDUCATION

| Level of education | Number and percentage total population | | | | | | Number and percentage aids prescribed | | | | | | Recall of 250 cases (meets needs) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Clinic | | Private | | Total | | Clinic | | Private | | Total | | | | | |
| | No. | % | No. | % | No. | % | No | % | No. | % | No. | % | No. | % | No. | % |
| None | 26 | 4.5 | 8 | 2.4 | 34 | 3.7 | 9 | 4.0 | 4 | 1.9 | 13 | 3.0 | 3 | 1.2 | 0 | .0 |
| Elementary | 113 | 19.6 | 76 | 22.2 | 189 | 20.6 | 35 | 15.7 | 27 | 12.5 | 62 | 14.1 | 43 | 17.2 | 15 | 10.8 |
| High School | 271 | 47.1 | 130 | 38.0 | 401 | 43.7 | 86 | 38.6 | 87 | 40.0 | 173 | 39.3 | 100 | 40.0 | 65 | 46.7 |
| College | 104 | 18.1 | 88 | 25.7 | 192 | 20.9 | 71 | 31.8 | 75 | 34.6 | 146 | 33.2 | 74 | 29.6 | 35 | 25.2 |
| Postgraduate | 17 | 3.0 | 23 | 6.7 | 40 | 4.4 | 14 | 6.3 | 17 | 7.8 | 31 | 7.0 | 20 | 8.4 | 15 | 10.8 |
| Not recorded | 44 | 7.7 | 17 | 5.0 | 61 | 6.7 | 8 | 3.6 | 7 | 3.2 | 15 | 3.4 | 10 | 10.4 | 9 | 6.5 |
| TOTAL | 575 | 100.0 | 342 | 100.0 | 917 | 100.0 | 223 | 100.0 | 217 | 100.0 | 440 | 100.0 | 250 | 100.0 | 139 | 100.0 |

It should also be noted that the recall population had a greater percentage of patients with higher levels of education than those in the original sample.

Tables 7 and 8 summarize the prescription and recall findings for specific ocular diseases in the 917 patients. These diseases are divided into two groups, Table 7 referring to densities or irregularities of the refractive media and Table 8 to diminished chorioretinal or optic nerve function. These tables show that the clinic and private patients did not differ markedly with respect to the frequency of various pathologies. It also can be seen that a significant percentage of the patients in each pathological category received aids, even in those categories generally considered to be "unfavorable" for such aids.

A significant finding is the frequency of macular degeneration as a cause of partial sight. Though the prevalence of this pathology is disturbing, it is encouraging to note that 30 per cent of the aids prescribed were for this condition. In the recall group, almost half of the macular degeneration cases replying reported successful use of their aids, although the category was underrepresented here as compared to the original population group.

The recall data for the "favorable" diseases showed a high ratio of success—in nystagmus and albinism, for example. Because of the small number of cases, however, dependable general conclusions are impossible. In the "unfavorable" categories, the most striking results occurred in cases of hypertensive and arteriolar sclerotic retinopathy. Although a total of 49 aids were prescribed for 83 patients, less than one in six found that the aid met their needs. In the other "unfavorable" categories, however, the results were relatively successful. In glaucomatous optic atrophy, 9 out of 15 patients in the recall group were satisfied with their aids; in non-glaucomatous optic atrophy, 9 out of 11 were satisfied; in retinitis pigmentosa, 7 out of 8 were satisfied; and in retinal detachment, both cases found that their aid met their needs.

Table 9 brings together the figures given in Tables 7 and 8 for the rating of aids by the 82 cases reexamined during recall. Because the number of cases is small, no percentages are given.

Table 10 shows how the distant visual acuity related to the successful use of aids in the 139 patients who found the aid met their needs. Again, the patients in the 6/400 to 10/400 range, formed by a small margin the largest percentage both in number and in success of aids, even though the percentage they formed in the recall population was not quite equivalent to that in the original sample. Although only 3 patients out of 19 in the 1/400 to 5/400 group were satisfied with their aids, this is still a higher percentage than might be expected

TABLE 7. NUMBER AND PERCENTAGE OF PATIENTS AND AIDS ORDERED INCLUDING AN ANALYSIS OF 250 RECALL PATIENTS, BY DENSITIES OR IRREGULARITIES OF THE REFRACTIVE MEDIA

| | Number and percentage total population | | | | | | Number and percentage aids prescribed | | | | | | Recall of 250 cases (meets needs)* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Clinic | | Private | | Total | | Clinic | | Private | | Total | | | | | | | |
| | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | C | P | No. | % | No. | % |
| Congenital cataract[1] | 38 | 25.2 | 15 | 21.2 | 53 | 23.9 | 15 | 24.2 | 11 | 24.4 | 26 | 24.3 | 7 | 6 | 13 | 5.2 | 6 | 4.3 |
| Senile cataract[1] | 29 | 19.2 | 11 | 15.5 | 40 | 18.0 | 6 | 9.7 | 7 | 15.6 | 13 | 12.2 | 2 | 4 | 6 | 2.4 | 4 | 2.9 |
| Post cataract aphakia[1] | 18 | 11.9 | 12 | 16.9 | 30 | 13.5 | 8 | 12.9 | 7 | 15.6 | 15 | 14.0 | 6 | 5 | 11 | 4.4 | 7 | 5.0 |
| Corneal opacities[1] | 11 | 7.3 | 6 | 8.5 | 17 | 7.6 | 3 | 4.8 | 3 | 6.7 | 6 | 5.6 | 1 | 1 | 2 | .8 | 1 | .7 |
| Iritis (old)[3] | 11 | 7.3 | 2 | 2.8 | 13 | 5.9 | 7 | 11.3 | 2 | 4.4 | 9 | 8.4 | 0 | 0 | 0 | .0 | 0 | .0 |
| Keratoconus[1] | 9 | 5.9 | 4 | 5.6 | 13 | 5.9 | 5 | 8.1 | 4 | 8.9 | 9 | 8.4 | 0 | 2 | 2 | .8 | 2 | 1.4 |
| Interstitial keratitis[4] | 8 | 5.3 | 2 | 2.8 | 10 | 4.5 | 5 | 8.1 | 1 | 2.2 | 6 | 5.6 | 0 | 0 | 0 | .0 | 0 | .0 |
| Corneal dystrophy (hereditary)[4] | 7 | 4.3 | 11 | 15.5 | 18 | 8.1 | 2 | 3.2 | 5 | 11.1 | 7 | 6.5 | 0 | 0 | 0 | .0 | 0 | .0 |
| Miscellaneous | 20 | 13.2 | 8 | 11.2 | 28 | 12.6 | 11 | 17.7 | 5 | 11.1 | 16 | 15.0 | 0 | 0 | 0 | .0 | 0 | .0 |
| TOTAL | 151 | 100.0 | 71 | 100.0 | 222 | 100.0 | 62 | 100.0 | 45 | 100.0 | 107 | 100.0 | 16 | 18 | 34 | 13.6 | 20 | 14.3 |

[1]Represents "favorable" to successful use of aid.
[2]Represents "unfavorable" to successful use of aid.
[3]Represents either "favorable" or "unfavorable" depending upon stage of pathological process.
[4]Represents "unclassified category."
*Column 1 represents distribution of clinic and private cases who completed questionnaire. Column 2 represents total number and percentage of clinic and private cases who completed questionnaire. Column 3 represents number and percentage of clinic and private cases whose aid "met their needs."

TABLE 8. NUMBER AND PERCENTAGE OF PATIENTS AND AIDS ORDERED INCLUDING AN ANALYSIS OF 250 RECALL PATIENTS, BY DIMINISHED CHORIORETINAL OR OPTIC NERVE FUNCTION

| | Number and percentage total population | | | | | | Number and percentage aids prescribed | | | | | | Recall of 250 cases (meets needs)* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Clinic | | Private | | Total | | Clinic | | Private | | Total | | | | | | | |
| | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | C | P | No. | % | No. | % |
| Macular degeneration (senile-juvenile)[1] | 183 | 43.2 | 123 | 45.4 | 306 | 44.0 | 63 | 39.1 | 73 | 42.4 | 136 | 40.9 | 45 | 38 | 83 | 33.2 | 44 | 31.6 |
| Hypertensive and arteriolar sclerotic retinopathy[3] | 52 | 12.3 | 31 | 11.3 | 83 | 11.9 | 26 | 16.1 | 23 | 13.4 | 49 | 14.7 | 16 | 11 | 27 | 10.8 | 4 | 2.9 |
| Myopia (severe)[1] | 31 | 7.3 | 16 | 5.9 | 47 | 6.7 | 7 | 4.4 | 12 | 7.0 | 19 | 5.7 | 5 | 9 | 14 | 5.6 | 9 | 6.5 |
| Optic atrophy (glaucomatous)[2] | 30 | 7.1 | 21 | 7.8 | 51 | 7.3 | 13 | 8.0 | 10 | 5.8 | 23 | 6.9 | 8 | 7 | 15 | 6.0 | 9 | 6.5 |
| Diabetic retinopathy (proliferating and non-proliferating)[3] | 26 | 6.1 | 20 | 7.4 | 46 | 6.6 | 8 | 5.0 | 14 | 8.1 | 22 | 6.6 | 6 | 9 | 15 | 6.0 | 8 | 5.8 |
| Optic atrophy (non-glaucomatous)[2] | 17 | 4.0 | 8 | 3.0 | 25 | 3.6 | 9 | 5.6 | 6 | 3.5 | 15 | 4.5 | 7 | 4 | 11 | 4.4 | 9 | 6.5 |
| Chorioretinitis (healed)[1] | 15 | 3.5 | 11 | 4.0 | 26 | 3.7 | 3 | 1.9 | 8 | 4.7 | 11 | 3.3 | 0 | 5 | 5 | 2.0 | 4 | 2.9 |
| Retinitis pigmentosa[2] | 13 | 3.0 | 6 | 2.2 | 19 | 2.7 | 6 | 3.7 | 5 | 2.9 | 11 | 3.3 | 5 | 3 | 8 | 3.2 | 7 | 5.0 |
| Retrolental fibroplasia[3] | 12 | 2.8 | 8 | 3.0 | 20 | 2.8 | 2 | 1.3 | 5 | 2.9 | 7 | 2.1 | 2 | 5 | 7 | 2.8 | 4 | 2.9 |
| Congenital nystagmus[1] | 10 | 2.4 | 5 | 1.9 | 15 | 2.2 | 6 | 3.7 | 4 | 2.3 | 10 | 3.8 | 5 | 4 | 9 | 3.6 | 6 | 4.3 |
| Albinism[1] | 7 | 1.7 | 6 | 2.2 | 13 | 1.9 | 5 | 3.1 | 3 | 1.7 | 8 | 2.4 | 3 | 5 | 8 | 3.2 | 8 | 5.8 |
| Retinal detachment[2] | 2 | .5 | 4 | 1.5 | 6 | .9 | 2 | 1.3 | 1 | .6 | 3 | .9 | 0 | 2 | 2 | .8 | 2 | 1.4 |
| Miscellaneous | 26 | 6.1 | 12 | 4.4 | 38 | 5.7 | 11 | 6.8 | 8 | 4.7 | 19 | 5.7 | 7 | 5 | 12 | 4.8 | 5 | 3.6 |
| TOTAL | 424 | 100.0 | 271 | 100.0 | 695 | 100.0 | 161 | 100.0 | 172 | 100.0 | 333 | 100.0 | 109 | 107 | 216 | 86.4 | 119 | 85.7 |

[1]Represents "favorable" to successful use of aid.
[2]Represents "unfavorable" to successful use of aid.
[3]Represents either "favorable" or "unfavorable" depending upon stage of pathological process.
*Column 1 represents distribution of clinic and private cases who completed questionnaire; Column 2 represents total number and percentage of clinic and private cases who completed questionnaire; Column 3 represents number and percentage of clinic and private cases whose aid "met their needs."

TABLE 9. RATINGS OF AIDS FOR 82 CASES REEXAMINED IN RECALL BY DISEASE CATEGORY

| Pathology | Total number of cases | Successful | Satisfactory | Failure |
|---|---|---|---|---|
| Congenital cataracts[1] | 7 | 5 | 2 | 0 |
| Senile cataracts[1] | 4 | 1 | 1 | 2 |
| Post-cataract aphakia[1] | 7 | 4 | 0 | 3 |
| Corneal opacities[1] | 2 | 2 | 0 | 0 |
| Keratoconus[1] | 2 | 2 | 0 | 0 |
| Macular degeneration[1] | 22 | 15 | 3 | 4 |
| Hypertensive and arteriolar sclerotic retinopathy[3] | 2 | 1 | 1 | 0 |
| Myopia[1] | 2 | 1 | 0 | 1 |
| Optic atrophy (glaucomatous)[2] | 6 | 5 | 1 | 0 |
| Diabetic retinopathy[3] | 4 | 2 | 0 | 2 |
| Optic atrophy (non-glaucomatous)[2] | 5 | 3 | 1 | 1 |
| Chorioretinitis (healed)[2] | 2 | 1 | 0 | 1 |
| Retinitis pigmentosa[2] | 2 | 2 | 0 | 0 |
| Retrolental fibroplasia[3] | 2 | 2 | 0 | 0 |
| Congenital nystagmus[2] | 4 | 4 | 0 | 0 |
| Albinism[2] | 2 | 2 | 0 | 0 |
| Retinal detachment[2] | 3 | 1 | 1 | 1 |
| Miscellaneous | 4 | 4 | 0 | 0 |
| TOTAL | 82 | 57 | 10 | 15 |

[1]Considered "favorable" to successful use of visual aids.
[2]Considered "unfavorable" to successful use of visual aids.
[3]May be either "favorable" or "unfavorable" to the use of visual aids depending upon the stage of pathological process.

because of the severity of the visual loss. Without aids, these people would be considered in a non-visual category.

A follow-up questionnaire to 250 patients (125 clinic and 125 private) who had used aids for a minimum of six months was designed to determine how successful the aids were in meeting patients' needs. These general results, given in Table 11, indicate a disparity between the clinic and private patients. While over 78 per cent of the private patients indicated they were using their aid (about 66 per cent daily), only 56.8 per cent of the clinic group were using their aids (only 40.8 per cent daily). Of the two groups, 64.8 per cent of the private cases felt that the aid "met their needs." This response was similar to the number who were using their aids daily (as compared to rarely or once a week). Only 46.4 per cent of the clinic patients felt that their aids met their needs, or a slightly larger number than were using their aid daily.

Of the 49 per cent of the clinic and 70 per cent of the private cases who desired a reexamination, about a third in each group actually returned. Eighty-two patients were reexamined during the recall study:

TABLE 10. AN ANALYSIS OF 250 RECALL PATIENTS, BY DISTANT VISION

| | Recall of 250 cases | | Meets needs | |
|---|---|---|---|---|
| Distant vision | Number | Per cent | Number | Per cent |
| Light perception | 0 | .0 | 0 | .0 |
| Hand movements | 0 | .0 | 0 | .0 |
| Count fingers | 0 | .0 | 0 | .0 |
| 1/400–5/400 | 19 | 7.6 | 3 | 2.2 |
| 6/400–10/400 | 68 | 27.2 | 39 | 28.0 |
| 11/400–15/400 | 53 | 21.2 | 31 | 22.3 |
| 16/400–20/400 | 67 | 26.8 | 37 | 26.6 |
| 20/300–20/70 | 43 | 17.2 | 29 | 20.9 |
| TOTAL | 250 | 100.0 | 139 | 100.0 |

39 clinic and 43 private individuals. Fifty-nine per cent of the clinic and 79 per cent of the private patients were classified as successful—that is, they used the aid with relative ease almost daily for more than one hour to perform visual tasks that they could not do without the aid. Eighteen per cent of the clinic and 7 per cent of the private cases were considered to be satisfactory which meant almost daily use of the aid, but for less than one hour and with some difficulty. However, they were able to perform some visual tasks which previously they could not do. Twenty-three per cent of the clinic and 14 per cent of the private cases were considered failures because their aids presented too many difficulties to be effective. Of the failures, five clinic and four private patients received new aids after a reevaluation was made during a subsequent visit.

TABLE 11. REEVALUATION OF SUCCESS IN 82 PATIENTS REEXAMINED DURING RECALL

| Criterion | Clinic | Private | Total |
|---|---|---|---|
| Successful | 23 | 34 | 57 |
| Fair | 7 | 3 | 10 |
| Poor | 9* | 6* | 15 |
| TOTAL | 39 | 43 | 82 |

*Of these failures, new aids were ordered for five and four of these cases respectively.

## DISCUSSION

### CRITERIA

One problem in evaluating the results of this study was the limited application of objective measures. To indicate the improvement of vision solely in terms of Snellen or Jaeger notations or percentages of visual efficiency does not really show whether a patient used a device successfully. Consequently, a combination of clinical evaluation and the patient's subjective responses and acceptance of the aid was needed to determine whether a visual appliance was appropriate and useful. Although a patient might show some improved visual efficiency with an aid, the more important issue was what that improvement enabled him to do. The extent to which it permitted him to perform some of the tasks which he considered to be important to his well-being, productivity, or independence thus provides a more realistic evaluation of success.

DISPARITY OF RESULTS

Although it is possible that certain unknown differences in the general characteristics of the clinic and private patients caused the discrepancy between the groups in the successful use of prescribed visual aids, either, or both, of two related suggestions could account for these differences. The first is that the physician-patient relationship plays a significant and critical role in the motivation and training of patients in the use of their aids. In the privacy of his office, the ophthalmologist can observe the patient in a more relaxed setting, give encouragement when needed, and correct problems immediately. The clinic atmosphere in contrast, is not always conducive to personal rapport between the doctor and patient, if only because the environment is distracting and impersonal. I admit that this judgment reflects a personal bias; I feel that I can accomplish more in a private than in a clinic setting. The results, however, tend to reinforce this bias.

A second explanation for the disparity in results may be found in the manner of procedure after an aid was prescribed. The only instructions which clinic patients received before using their aid were during subjective testing. About a month elapsed before a follow-up appraisal, and, as a result, some of these patients may have already adopted an incorrect method of using their aid. The training in the office which the private cases received immediately after they received the aid, and before any trial, may have made the difference between successful and unsuccessful use. When problems developed, immediate additional instruction and encouragement was available in this early and important phase of adaptation. For example, many patients initially found the short focal length which the high-power lenses necessitated to be very uncomfortable. With the author's support and training during the first two or three brief adaptation visits, this difficulty was generally overcome.

Many other factors, of course, enter into the reasons why 61.2 per cent of the clinic and 36.4 per cent of the private patients did not receive aids. The major cause was the lack of screening or preselection of patients, but an unscreened population was necessary to test the hypotheses about population characteristics and favorable or unfavorable pathology. As a result, however, 32.1 per cent of the clinic and 22.3 per cent of the private patients were found to have insufficient visual acuity to profit from an aid. Of the remaining number who did not receive aids, 11.1 per cent of the clinic and 2.3 per cent of the private patients did not return to complete the testing which required two to three visits. Another group, 9.1 per cent of the clinic and 6.3 per cent of the private patients, resisted aids because of family opposition, cosmetic reasons, or discomfort brought about by the short focal length of the optical device. And several patients, representing 5.5 per cent of the clinic and 2.7 per cent of the private cases, were not given aids because they resisted attempts to teach them the proper use of the aids during the testing phase. A very small percentage of both groups refused aids because they had erroneously expected to receive medical or surgical assistance rather than an aid.

### NEAR VISUAL ACUITY

The evaluation of near vision in Tables 12 and 13 shows that both clinic and private populations had similar acuities and also confirms how serious the partial sight was in the majority of cases. Over 60 per cent of all cases had a near acuity of J 8 at 2 to 3 inches, or less.

### MONOCULAR AND BINOCULAR AIDS

Table 14 shows about 80 per cent of all aids prescribed were uniocular. Even though there is a psychological advantage to the use of both eyes, patients soon adjusted to uniocular viewing.

### POPULATION CHARACTERISTICS

Although the results did not prove the hypothesis that population characteristics can be used as selectors for successful treatment, certain trends were indicated. For instance, the younger, better educated patients had a high prescription and success rate.

Some other population characteristics reflected the reactions of patients. For example, children who had already learned braille initially resisted a visual aid. Adolescent children reacted negatively for cosmetic reasons. Adult patients whose visual loss was recent often presented emotional complications of fear of blindness and resentment of the need to learn new visual habits. Many of these cases felt that surgery or medication must be available and resisted recourse to aids

TABLE 12. NUMBER AND PERCENTAGE OF CLINIC GROUP, BY CORRECTED NEAR VISUAL ACUITY IN THE BETTER EYE

| Near vision | Age (years) | | | | | | Total | Percentage of total |
|---|---|---|---|---|---|---|---|---|
| | 5–14 | 15–29 | 30–44 | 45–59 | 60–74 | 75–over | | |
| J 14 at 1-2 in. | 0 | 12 | 6 | 32 | 37 | 16 | 103 | 17.9 |
| J 12 at 1-2 in. | 0 | 7 | 9 | 24 | 32 | 9 | 81 | 14.1 |
| J 10 at 2-3 in. | 2 | 15 | 8 | 34 | 45 | 8 | 112 | 19.5 |
| J 8 at 2-3 in. | 3 | 11 | 3 | 15 | 24 | 8 | 64 | 11.1 |
| J 7 at 3-4 in. | 2 | 8 | 3 | 9 | 14 | 7 | 43 | 7.5 |
| J 6 at 3-4 in. | 8 | 9 | 7 | 15 | 14 | 6 | 59 | 10.3 |
| J 5 at 4-5 in. | 7 | 5 | 3 | 15 | 9 | 5 | 44 | 7.7 |
| J 3 at 4-5 in. | 4 | 9 | 3 | 7 | 3 | 0 | 26 | 4.5 |
| J 2 at 5-6 in. | 4 | 7 | 2 | 2 | 3 | 0 | 18 | 3.1 |
| J 1 at 5-6 in. | 3 | 9 | 4 | 5 | 4 | 0 | 25 | 4.3 |
| TOTAL | 33 | 92 | 48 | 158 | 185 | 59 | 575 | 100.0 |

TABLE 13. NUMBER AND PERCENTAGE OF PRIVATE GROUP, BY CORRECTED NEAR VISUAL ACUITY IN THE BETTER EYE

| Near vision | Age (years) | | | | | | Total | Percentage of total |
|---|---|---|---|---|---|---|---|---|
| | 5–14 | 15–29 | 30–44 | 45–59 | 60–74 | 75–over | | |
| J 14 at 1-2 in. | 3 | 4 | 11 | 21 | 31 | 6 | 76 | 22.2 |
| J 12 at 1-2 in. | 2 | 4 | 8 | 25 | 19 | 4 | 62 | 18.1 |
| J 10 at 2-3 in. | 2 | 1 | 5 | 11 | 13 | 5 | 37 | 10.8 |
| J 8 at 2-3 in. | 6 | 5 | 7 | 7 | 9 | 3 | 37 | 10.8 |
| J 7 at 3-4 in. | 2 | 3 | 5 | 7 | 8 | 2 | 27 | 7.9 |
| J 6 at 3-4 in. | 4 | 3 | 4 | 6 | 9 | 4 | 30 | 8.8 |
| J 5 at 4-5 in. | 3 | 2 | 4 | 4 | 6 | 4 | 23 | 6.7 |
| J 3 at 4-5 in. | 3 | 4 | 6 | 4 | 3 | 2 | 22 | 6.5 |
| J 2 at 5-6 in. | 2 | 3 | 3 | 3 | 3 | 2 | 16 | 4.7 |
| J 1 at 5-6 in. | 0 | 1 | 2 | 4 | 3 | 2 | 12 | 3.5 |
| TOTAL | 27 | 30 | 55 | 92 | 104 | 34 | 342 | 100.0 |

with their inherent restricted fields and short depth of focus. The reverse reaction was found in many elderly patients who felt that blindness was inevitable and therefore resisted adaptation to an aid.

In short, it is clear that patients must be strongly motivated to use their aids successfully. One of the important responsibilities of the ophthalmologist is to provide encouragement through compassion and reassurance during the period of orientation and training.

## PATHOLOGICAL CONSIDERATIONS

In general, the hypothesis that pathologic conditions are not in themselves criteria for whether or not an aid should be prescribed has been demonstrated. The author contends, rather, that the extent and

TABLE 14. MONOCULAR AND BINOCULAR VISUAL AIDS PRESCRIBED FOR CLINIC AND PRIVATE PATIENTS

| Distant vision (uncorrected—better eye) | Monocular | | Binocular | | Total | |
|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % |
| | | *Clinic Cases* | | | | |
| L.P.–10/400 | 98 | 44.0 | 2 | 0.9 | 100 | 44.8 |
| 11/400–20/400 | 57 | 25.6 | 25 | 11.2 | 82 | 36.8 |
| 20/300–20/70 | 28 | 12.5 | 13 | 5.8 | 41 | 18.4 |
| TOTAL | 183 | 82.1 | 40 | 27.9 | 223 | 100.0 |
| | | *Private Cases* | | | | |
| L.P.–10/400 | 97 | 44.7 | 5 | 2.3 | 102 | 47.0 |
| 11/400–20/400 | 59 | 27.2 | 29 | 13.4 | 88 | 40.6 |
| 20/300–20/70 | 14 | 6.4 | 13 | 6.0 | 27 | 12.4 |
| TOTAL | 170 | 78.3 | 47 | 21.7 | 217 | 100.0 |

location of the ocular pathology are the prime considerations and not the disease itself. Although aids cannot be prescribed by disease type, the characteristics and limitations of several ocular diseases should be noted.

Macular degeneration of the juvenile or senile type was responsible for more cases of partial sight than any other single ocular disease. In the early stages the changes were uniocular but binocular involvement was most frequently seen. Thirty-three per cent of the 917 cases studied were found to have macular degenerative changes. This incidence is significantly higher than other studies have indicated. In several instances, patients with this degeneration were not aware that their vision could be improved by changing their direction of gaze. Eccentric fixation was often found helpful. High plus lenses or lens systems, in unifocal or bifocal form, were found to be the most useful optical aids.

Senile cataracts without other complications caused low vision in 29 of the clinic cases and in 11 of the private group. Since cataracts are operable, this incidence would seem to be quite high; however, in most of these cases, cataract surgery was contraindicated because of the patient's severe apprehension or an accompanying serious disease. Distant visual improvement with the use of strong myopic lenses was striking in some cases with nuclear cataracts. Fixed-focus stand magnifiers were helpful in elderly patients who had hand tremors or other infirmities.

Patients with residual homonymous hemianopsia have difficulty avoiding collision with objects or people encountered on their blind side. Levi and King[23] recommended contact lenses to help the patient scan or glance to each side without the distortion obtained when looking to the side of high-powered lenses. This was tried in two cases with questionable results.

The associated refractive errors in albinism were usually simple myopia or compound myopic astigmatism, the majority of which were corrected with conventional lenses for distance. The required reading aid was usually the simple bifocal type. Scleral contact lenses fashioned with an opaque sclera and colored iris did not help the extreme photophobia.

Although only 15 of the clinic and private cases had congenital nystagmus, searching nystagmus was often found associated with other ocular defects. A contact lens was tried in three cases but produced no visible decrease in the amplitude of the searching movements. It should be noted that a retinoscopy was difficult to perform in these patients since the shifting fovea made it impossible to establish the visual axis. In these cases, refraction was best determined by direct subjective testing. Because ordinary trial lenses of high powers were found to have apertures too small for testing, special lenses with larger aperture diameters were substituted.

Diabetic retinopathy of the proliferating and non-proliferating types was found in 46 of the cases. Because of improved treatment for infection, ketoacidosis, and coma, the life span of the diabetic has been lengthened with a concomitant increase in vascular and proliferative complications. White,[24] in a study of 1,027 juvenile diabetics who survived for 20 or more years, found diabetic retinopathy in 59 per cent of those who had the disease for 15 to 19 years, and, of this group, 18 per cent had retinitis proliferans. Even though the visual loss in a few patients was severe, visual improvement for near was often possible with high plus reading lenses, either in spectacle form or as a stand magnifier. Expensive aids were never ordered due to the vacillating nature of the retinal changes.

The first hypothesis of this paper was that simple procedures and techniques for the care of the partially sighted are accessible to the ophthalmologist. To support this thesis, it is necessary to explain in greater detail the author's reasons for the selection of certain simple methods in the examination and treatment, and to expand on some of the topics covered earlier.

## CONSIDERATIONS IN THE SELECTION OF PROCEDURES AND TECHNIQUES

### *Near Vision Testing*

It should be noted that several testing methods for near vision were tried initially along with the Jaeger notations. These included the

Snellen notations, the Sloan charts, the point type system, and the Stimson discs. The author's experience using them is noted below.

The Snellen method was found to be a more complicated and less orderly procedure than the one using individual Jaeger numbers. This was particularly evident from the recordings done by eye residents who rotated on the clinic service.

The Sloan charts did not furnish a comparable Snellen equivalent for near vision but directly determined the magnification needed for effective reading. Patients tested with these charts wore their distant correction with the addition of a +2.50-diopter sphere. Each chart had words printed in multiples of the fundamental size, that is, 10 print sizes from 1M (newsprint) to 10M (10× larger). The number recorded was the smallest print which could be seen at 16 inches (40 centimeters). Because better results in testing for near vision were found at distances of two to six inches from the eye this method was not used.

Although the point type system used a series of reading cards giving a wide range of graduated type sizes, this method was discarded because it was not as universally popular as the Jaeger and was no more helpful.

Stimson discs formed a monocular test at 35 centimeters using groups of three round discs arranged in triangular form. In each group, made up of different diameters, the first disc had concentric circles with intervening spaces of the same width. The second, light gray, disc and the third, dark gray, disc had no concentric rings. The patient was asked to identify the circles in each group. In the first group the circles were seen at an angle of 2.5° with a visual range of 35/35, or 100 per cent to 35/170 (32.7 per cent). The second group seen at an angle of 5° had a visual range down to 35/209 (12 per cent) and that of the third group seen at an angle of 10° was down to 35/1554 (2.2 per cent). This method was not used since circles were easier to recognize than words, letters, or numbers, and thus, the visual acuities were found to be relatively higher than those from the Jaeger readings.

*Refraction*

One result of the careful examination and refraction of all patients revealed that 12 per cent, or 69, of the clinic and 28 per cent, or 96, of the private cases were wearing erroneously prescribed distant corrective lenses. In each of these cases, some visual improvement was gained with newly prescribed lenses. A large percentage of inadequate refractions in the private cases were due to the laxity of the referring ophthalmologists in doing periodic refractions. In the clinic group, however, each patient had been examined in the refraction clinic before being assigned for low vision evaluation.

*Magnification*

An optical aid for the partially sighted should accomplish two purposes: (1) correction of the refractive error in order to obtain as sharp a retinal image as possible, and (2) provision of magnification to enlarge the image for recognition. In the normal eye, two adjacent points of an object viewed can be perceived if their images fall on two foveal cone receptors with, at least, a third receptor intervening. In this instance the angle subtended at the two separate retinal points equals one minute of arc. However, when there is a marked reduction in vision, the interval between the receptors may be so large that the angle subtended may be equal to more than 10 minutes of arc. In this case, magnification is necessary to spread the retinal impulse over parts of the retina that are light perceptive, thus providing easier object identification.

The retinal image can be enlarged without hampering orientation of the field by: (1) placing the object of regard closer to the eye, (2) using large-sized print, or (3) using either a headborne or handheld strong convex lens, or system of lenses, before the eye.[25] A lens that doubles the angular size of the image has a magnification of 2× (8 diopters) and one that triples a magnification of 3× (12 diopters). It must be remembered that four diopters corresponds to one unit of magnification and so forth.

A simple formula was used in order to calculate the power of a magnifying lens. Using an approved standard for the viewing distance of 10 inches or 25 centimeters from the unaided eye, divide this number by the focal length of the lens: $M = 10/F$ or $M = 25/F$. The focal length is basically the equivalent of the working distance of the lens. Thus, a spectacle magnifier of +8D. would provide magnification of 2× at a working distance of 5 inches (12½ centimeters), as $M = 10/5 = 2\times$ or +8D. A +10D. magnifier would allow a viewing distance of 4 inches (10 centimeters) and the magnification would be 2.5×, as: $M = 10/4 = 2.5\times$ or +10D.

The Kestenbaum method was of value as a starting point for determining magnification but has a limitation which should be mentioned. Even though the reciprocal of distant vision was supposed to determine the dioptric strength for near, practical experience with this approach demonstrated that objective testing of the patients usually uncovered the need for more lens power than indicated. Although not always scientifically accurate, the simplicity of this method eliminated the need for more extensive charts or tables and it proved to be the method of choice to begin with.

Since the patient's amplitude of accommodation could produce a discrepancy in determining the effective magnification at near, its effect must be clarified. Magnification is not only produced by the dioptric power of the lens itself; additional magnification can be supplied by the patient exerting accommodation.[26] This is most commonly found in young patients, particularly those with recent visual loss, where substantial reserves of accommodation of around 10 diopters are available. These patients generally prefer to read by reducing the distance from eye to book rather than by using aids. However, in many patients with a long history of partial sight, no accommodative power was present, regardless of age. Also, when the visual acuity was markedly reduced, the accommodative response generally could not be stimulated.

## CONSIDERATIONS OF OPTICAL AND NON-OPTICAL EQUIPMENT

To show that only limited knowledge is necessary for the prescription and application of optical and non-optical aids, the author's experience has been categorized to provide a body of knowledge for the practicing ophthalmologist.

### *Visual Aids for Distance*

The best telescopic lenses are constructed according to the Galilean or Dutch principle of a positive converging objective lens directed towards the object being viewed and a stronger negative diverging ocular lens in front of the eye. The anterior focus of the convex lens matches the posterior focus of the concave lens. Thus, the positive objective lens converges the parallel incident rays and the negative ocular lens reestablishes the parallelism as the rays enter the observer's eye. The difference in the focal length which separates the two lenses indicates the magnifying power of the telescopic system as shown by the formula: $F_1/F_2$ = magnification at infinity, where $F_1$ = focal length of the objective lens and $F_2$ = focal length of the ocular lens. If the object viewed is closer than infinity, this formula is not accurate since the effect of magnification decreases as the distance to the object decreases.

There are two reasons why a telescope more powerful than 2.2×

magnification is impractical. The first is that in order to obtain magnification greater than 2.2×, considerable variation in the strength between lenses would be necessary. Since this difference could only be obtained by increasing the distance between the objective and ocular lenses, the telescope would become too cumbersome to handle. Secondly, too powerful magnification will create confusion by dangerously narrowing the field of vision, with the result that the user cannot see objects moving at normal speeds. Such telescopes could not be used for walking around, particularly since patients are unable to estimate relative distance. Objects look deceptively large and consequently nearer than they are, because of telescopic parallax or apparent shifting of the image toward the patient. For prolonged viewing of a classroom blackboard, athletic events, or television, however, a monocular telescope of 2.2× magnification attached to a spectacle frame by a clip-on device is available.

A simple telescopic system for providing 4× distant magnification, first proposed by Kestenbaum,[19] made the patient unnaturally hyperopic by placing a minus lens before the eye properly corrected with a lens. A −20.00 diopter lens was placed in a spectacle frame or in an attached loupe before the patient's corrected eye with a supplementary +5.00 diopter hand lens held about five inches in front of the eye until the object being viewed became dimly recognized. The hand lens was then slowly moved forward until the object came into focus. Although this procedure was attempted in eleven cases, only one patient was satisfied with the result. The remaining patients quickly discarded this system because the distant blurring was too severe for any visual identification.

Nine private cases with macular degeneration tried a somewhat similar 4× telescopic system advocated by Fonda.[27] Using a +3.00 diopter biconvex lens, 50 millimeters in diameter and held about 10 inches in front of a −12.00 diopter sphere before the corrected eye, distance vision in four out of nine cases improved one to two lines on the Snellen chart. Since the lens had to be held at a critical distance from the eye, however, three of the patients with unsteady hands could not use this system due to the limited aberration-free area of the lens.

Several highly myopic patients with a vision of 10/200 or less were helped with a 6× prism monocular telescope. By focusing the eyepiece, this instrument could compensate for about 15 diopters of myopia but only at distances greater than 30 feet.

A handheld monocular telescope was prescribed for 40 patients with better than 20/200 vision, since recognition of objects or faces at a reasonable distance requires relatively good visual acuity. These telescopes were used for intermittent visual needs such as identifying street signs and the numbers of street cars, buses, or houses.

Since comparatively few of the patients had binocular vision, a binocular telescope was not frequently prescribed. When it was indicated, the telescope was ordered either as a small, compact, handheld opera glass or headborne sports telescope. In binocular telescopes, an arrangement for individual focusing of each lens was found to be indispensable. In the 2.2× telescope such focusing permitted error adjustment of the spherical refractive component in a latitude of about five diopters each for hyperopia and myopia. However, because of the difficulty in ensuring that the axes of both lens were parallel, the author found the use of binocular telescopes very limited.

In severe myopia, usually associated with myopic retinal degeneration, a contact lens enlarges the image on the retina. A myope of −20 diopters can acquire a 45 per cent increase in the size of the retinal image,[28] as well as a wider field of vision. Also, the peripheral and prismatic distortions of strong minus lenses are avoided. In seven highly myopic patients for whom a contact lens was ordered, a mean increase of three lines on the Snellen chart was obtained, although no deceleration or arrest of the myopia could be demonstrated.

Contact lenses were helpful in some disorders of the cornea, particularly where slit-lamp examination showed irregularities of the anterior surface of the cornea with a relatively clear stroma, as in keratoconus, isolated maculae of the cornea, and cases where large amounts of irregular astigmatism follow corneal injury. The vision in keratoconus was dramatically improved in three of the four cases for whom a contact lens was ordered. Visual improvement was greater in those with an astigmatism of over six diopters, particularly if accompanied by an oblique axis.

In unilateral aphakia with corrected normal vision, the contact lens allowed for binocularity and reduced the aniseikonia to 10 per cent from 30 per cent with spectacle lenses.[29] However, for partially sighted aphakic patients contact lenses were a failure when results were compared to those achieved using aphakic spectacle lenses. The contact lenses did not improve central vision appreciably and decreased the size of the retinal image below that given by an aphakic lens.

In cases of nystagmus, even with an amplitude of only two to three millimeters, the use of a contact lens did not curb the range or rate of the eye movement.

*Visual Aids for Near*

The primary visual need expressed by 80 per cent of the patients was the ability to work at close range. This figure corresponds to those obtained at the Brooklyn Industrial Home for the Blind and the Lighthouse of the New York Association for the Blind which were 80 and 90 per cent, respectively.[30]

A high-power lens in a spectacle was the most frequently ordered optical aid for near vision. In strengths less than 16 diopters a binocular spectacle was used and in strengths over 16 diopters a uniocular lens was prescribed. A selection of three forms of higher plus lenses is available: (*a*) single unifocal lenses; (*b*) compound lens systems of the aspheric type; and (*c*) bifocals with a strong reading addition or with an aspheric lens insert positioned in an aperture in the lower part of the mother or base lens.

The single unifocal lens is a simple high plus lens mounted in a spectacle frame, like an unsophisticated microscope, that produces an enlargement of the retinal image. The magnification equals one-quarter of the dioptric lens power when the object being viewed is located in the focal plane of the lens. Because the lens to object distance is short, this distance becomes increasingly critical and rigid the higher the lens power, since a simultaneous decrease in the depth of focus occurs. When the required lens strength is under 16 diopters, binocularity is found to be possible only if the disparity with the magnification required is not more than four to six diopters.

Compound lenses are necessary in powers exceeding 28 diopters. When used these are made as a lens system of two or three high-power convex lenses of the same refractive index mounted in a single holder. The air space at the periphery of the lens helps to reduce the inherent deficiencies in a convex lens of high power. However, such a system proved to be difficult to mount in a frame and could not be made in bifocal form. It was also unsightly in appearance. As a result, this type of aid was not found to be practical.

The conoid magnifying lens is made of conic sections which produce a wide, flat field of vision in the lower powers of +15 to +20 diopters, but do not fully neutralize aberrations in the higher magnifications. They cannot be made in bifocal form and are inconvenient because of thickness, weight, and the limitation to a 40-millimeter size.

A bifocal lens was found to be very advantageous for the partially sighted since it avoided the extreme distance blur found in full aperture spectacle magnifying lenses. In powers over 16 diopters an insert or button in the base lens was helpful. The aspheric qualities of an insert, formed by a doublet or triplet system, corrected for aberrations even to the periphery of the lens. The magnifying insert used ranged up to 56 diopters and had the same diameter in millimeters. It was threaded for interchange to allow for future power increases. For example, a 72-year-old male clinic patient with bilateral senile macular degeneration read J 3 with the right eye using a 16-diopter insert placed in a base lens. Three years later, his near vision with the same strength of insert decreased to J 10 due to enlargement of the macular pathology. Substitution of a 36-diopter insert again improved his near vision to J 3.

Clip-on high plus lenses were available in two types of spectacle magnifying lenses: a fixed mount and a folding mount. The fixed mount, which could be slipped on and off an ordinary spectacle frame as needed, was found beneficial for limited periods of use or for detailed viewing when combined with a high convex reading lens. The folding mount had a spring attachment for fastening to a spectacle frame. When not in use it could be lifted away from the line of vision for distant viewing without taking it off the frame.

These clip-on aids were also used to help assess the patient's acceptance of, or adaptation to, a shorter than normal working distance before more complicated and expensive optical devices were ordered. In cases where the ocular pathology and vision fluctuate, as in diabetes, the clip-on spectacle lens was often prescribed as a temporary aid.

The monocular telescope and reading cap is a plastic reading lens which acts as a magnifier when attached to the object side in front of the objective component of a telescope. For work at close range, monocular vision is possible with telescopic spectacles adjusted for infinity and reading additions of two to 12 diopters in strength. These are required even if the patient is emmetropic and has a large amplitude of accommodation. In order to ascertain the magnification supplied for close work, the following formula was used: $M = D/4 \times MT$, where $M$ = magnification for near, $D$ = dioptric power of the reading cap, $MT$ = magnification supplied by the telescopic unit. Therefore, a reading cap of 12 diopters with a 2.2× telescope provided a 6.6× magnification as $12/4 = 3 \times 2.2\times = 6.6\times$.

When a longer eye to object distance was needed than that obtained with a convex lens of identical magnifying power, a telescope with a reading cap of the same strength provided about twice as long a working distance. Where a longer distance was not imperative, the convex lens or aspheric insert was better since either could be positioned close to the eye to allow for a wider field of view.

Detached magnifiers have often proved to be successful where other standard aids have failed. These are grouped into three main types: (1) those that are handheld and consist of one convex lens or a combination of convex lenses in a lightweight single or folded mount; (2) those framed in a fixed stand that may be illuminated or non-illuminated; (3) those mounted in a focusable stand that may be illuminated or non-illuminated. The latter are supported by a clear plastic base that eliminates the need for an auxiliary light.

If the object of regard lies within the anterior focal plane of the magnifying lens its retinal image is enlarged. Because the lens acts in a field somewhat removed from the eye, it provides a longer reading distance than the spectacle magnifier and has fewer aberrations. In general, the simple hand magnifier and the magnifier supported in a spectacle frame have the same inherent disadvantages in that they both have a rigid lens to object distance which older patients find troublesome during prolonged reading. Although the handheld magnifier did provide for a longer distance between the eye and the lens, this advantage was cancelled to some extent by a decrease in the field of vision.

Convex hand lenses are available in numerous types, magnifications, sizes, appearances, and weights; however, the two most frequently used in this study were the rectangular or circular form and the folding model. They were constructed of a single lens system, except in the higher powers where the aspheric plastic lens afforded a wider field with comparatively lighter weight. The distance between the lens and the patient's eye could be easily lengthened to increase the working distance, although the field of view would be decreased. Depending upon patient requirements, the general power range was from 8 to 20 diopters.

The folding magnifier with two or three separate lenses in equal or graded strengths was most helpful for students as a supplementary reading aid to their weaker spectacle lens. A two-strength bifocal hand lens was designed for three patients but did not prove superior to the folding type with different lens strengths.

A fixed-focus stand magnifier uses both single lenses and doublets. Since the principle focus of the lens is greater than the fixed lens to object distance, a virtual image of the object of regard is formed just behind the lens. Thus, the distance of the patient's eye from the image determines the amount of magnification. A 20-diopter magnifier was found to be efficient since the object was close to the focal length of the lens and required little accommodation. These magnifiers were constructed of plastic to decrease their weight.

A fixed-focus stand magnifier with low magnification was used for 7 clinic cases and 16 private cases who were unable to use a headborne magnifier because of the required close lens to object distance. These were prescribed mainly for patients in the 60- to 75-year age group who had head and hand tremors associated with cerebral palsy, Parkinson's disease, arthritic deformities of the hands, or neurological disorders affecting the upper extremities. Three private patients with arthritic fingers and hands were supplied with an aspheric oil-filled lens with 8 diopters of magnification. This lens was fitted to a stand that had an adjustable book rest a little distance behind it. The lens could be raised vertically for easy adjustment. The device provided a field large enough for binocular reading. One patient was even able to knit under magnification by placing her yarn behind the lens.

The planoconvex or paperweight magnifier was another of the fixed-focus type that proved to be advantageous for some patients who required only low magnification of about 8 diopters. This aid, constructed of solid glass with a +16.50 diopter upper surface curve and a plano lower surface, was used alone or as an adjunct magnifier to a handheld or headborne device with less than 20 diopters of power.

Fixed-focus magnifiers were never ordered for young patients since they were able to accommodate with a spectacle magnifier and did not need to hold the reading material at a critical lens to page interval. In many instances, a fixed-focus magnifier was used in the examination of our patients to determine the amount of progress produced by magnification before prescribing more expensive aids.

When high magnifying power was needed and the patient could not use a strong spectacle magnifier with its short working distance, a focusable stand magnifier was often helpful. Much of the renewed popularity of this kind of aid is due to Sloan,[31] who advocated magnifications of 18 to 53 diopters. These provide a modicum of aberrations and a wider field. The size of the actual image is directly proportional to the dioptric power of the magnifier. The use of this device allows a change in the lens to object distance by turning a threaded mount. This alters the degree of magnification and helps to offset the viewer's spherical errors of refraction. The hyperope without correction requires a longer distance between lens and object and the uncorrected myope needs a shorter distance. In order to receive the highest magnification and the widest field, the eye should be as close to the lens as accommodation allows, and to decrease the amount of aberration, a compound system of lenses is used in the mount. Since the viewer's head must be close to the lens, incidental light is obstructed. This is rectified by a clear plastic support that permits the entrance of light, or by additional surface light furnished from a battery or a plug-in supplementary attachment.

*Non-Optical Aids*

Three unrelated non-optical aids are the multiple pinhole spectacle, the Prentice typoscope, and the projection magnifier. Only the first two were found to be helpful.

Opacities of the corneal stroma or lens that are situated along or near the visual axis will create a retinal blur even when the macula is free of pathology. Due to the variations in the size and extent of the opacifications, many small optical systems are created. The use of a multiple pinhole spectacle decreases the diffusion circles that are caused by these small refractive systems, producing clearer retinal images.

The multiple pinholes used were 1 millimeter or 1.5 millimeters in diameter and 4 millimeters apart to eliminate monocular diplopia and to lessen the annoying variegated light pattern produced by the design of the pinhole. This aid was made by boring similar holes in a plastic or rubberized occluder which was fastened to a spectacle frame. It was prescribed for three patients with lenticular changes, two with post-surgical aphakia and corneal opacities, and two with keratoconus.

Among the examples of improvement with this aid was a 67-year-old male who had posterior cupuliform cataracts and interstitial keratitis. His distant vision was hand movements in the right eye and 4/200 in the left. Using the multiple pinhole spectacle, the vision in the left eye was improved to 10/200. A second case was a 72-year-old male, with post-cataract aphakia and corneal opacities. His corrected distant vision was 3/200 in the right eye and 4/200 in the left eye. Using the multiple pinhole, distant vision was improved to 5/200 in the left eye and 11/200 in the right. A third case, a 35-year-old male with keratoconus, showed a corrected distant vision of 7/200 in the right eye and 10/200 in the left eye. Using the multiple pinhole, his vision was improved to 10/200 in the right eye and 20/200 in the left. All patients wearing this device were cautioned to adjust their eyes in order to keep alignment with fixation. The seven patients for whom a multiple pinhole spectacle was prescribed wore the aid only at home not only because it was unsightly in appearance but also because it markedly decreased their visual field.

The Prentice[32] typoscope reading slit[33] was prescribed and found to be helpful in 17 private cases. This non-magnifying reading aid was made by cutting a rectangular opening of 4½ by ⅜ inches on a black piece of cardboard which was held between the thumb, index, and middle fingers for easy manipulation. Using this slit, the patients were helped to concentrate their attention by exposing only a part of the line at a time and by being guided to the next consecutive line. Because the slit masked light from surrounding brighter areas, patients with cloudy media and corneal or lens opacities were not disturbed by the dazzle produced from reflected light on the printed page. In one 77-year-old female patient with senile nuclear cataracts, who could not have surgery because of congestive heart failure, near vision was improved from Jaeger 6 to Jaeger 3 with the use of this reading slit. A private male patient, age 53, with a right homonymous hemianopsia, had difficulty reading since he was not able to see ahead and constantly lost his place. A Prentice typoscope made his attempts at reading less difficult.

Nine of the 17 patients who used the slit employed a +6.00 to +10.00 diopter reading lens together with the slit. In all nine patients using this combination, an average increase of two progressions in the Jaeger notation was found.

A projection magnifier provides a real rather than a virtual page image through a set of mirrors which bend the rays to cause the image of a page placed downward on a transparent piece of plastic to fall on a screen behind the projector. The size of the retinal image is contingent upon the distance of the eye from the screen as well as on the magnification that the particular projection instrument can supply. The closer the individual is to the projection device the larger the retinal image—that is, a viewing distance of 20 centimeters provides a retinal image twice the size of that possible at 40 centimeters. Thus, magnification of 10× would be produced if the viewer sat 20 centimeters from the screen and only 5× magnification if the viewer sat 40 centimeters from the screen.

Some of the patients were tested with one of the popular projection devices that provided 5× magnification. Because several problems were observed, use of a projection magnifier was not prescribed for anyone in the study. First of all, the illumination was insufficient and below the patient's visibility curve. Secondly, if the viewer shifted his line of sight from the central area of the screen, the inadequacy of illumination became more evident and caused decreased word recognition. Finally, these magnifiers were not portable, were inconvenient to handle, and were very expensive.

*Factors Related to Low Vision Aids*

Several considerations—aberrations, convergence, lens power, and illumination—which are unrelated except in that they concern the prescription or use of visual aids will be discussed briefly.

Because the lenses used for the partially sighted are of strong plus or strong minus strengths, they produce aberrations which are classified according to whether they affect the axial or the oblique pencils.[34] In the former, chromatic and spherical aberrations are involved and in the latter coma, oblique astigmatism, curvature of image, and distortion must be considered.

To decrease lens aberrations in high powers from 28 to 56 diopters of reading strength, specially designed systems of plastic or glass were prescribed. Oblique astigmatism was largely neutralized and curvature of the image and distortion reduced by using one of the following specialized lenses: (1) aspheric; (2) systems with air-spaced doublet or triplet lenses; or (3) aspheric inserts or buttons. The decided advantage of the aspheric lens systems over conventional lenses of the same power was easily recognized by our patients when they compared the relative performance of the two types.

Although chromatic aberrations are caused by the material of the lenses they are not a serious problem because most of the partially sighted have a decreased color sense. This type of aberration is caused by refractive differences of the colored rays of the spectrum, each of which has its own focus. More disturbing to the patient, however, are spherical aberrations which depend on the lens form and often cannot be completely eliminated.

To decrease as many of the critical aberrations as possible, several fundamentals in lens design were used, as emphasized by Fonda.[27]

1. High-power plus lenses, up to 10 diopters, were ground with a plano on the inside or ocular curve.

2. For a biconvex lens in excess of 10 diopters, a small amount of the plus was ground on the inside curve and the larger amount on the outside curve.

3. High-power minus lenses were ground with a plano external curve in powers up to $-15$ diopters.

4. When greater strength is required, a biconcave lens was ground

with a small amount of minus on the outside curve and the larger amount on the inside curve.

There is a need for more convergence when a binocular high-power convex lens is used. For example, a patient with an interpupillary distance of 60 millimeters at near who exerts 18 prism diopters of convergence at 13 inches and 60 prism diopters at 4 inches must have lenses with decentration. One method was to incorporate prisms in the amount of one diopter of base-in prism for each diopter in each single vision lens, and in bifocal lenses by decentering each lens in 1 millimeter for each diopter of power.[27] Another practical decentration procedure used was Lebensohn's[35] formula: Interpupillary distance for far/Reading distance in inches + 1. If a patient had a distance P.D. measuring 68 millimeters and the reading distance was 4 inches, then 68 divided by five = 13.6 millimeters; thus a decentration of 6.8 millimeters was required in each eye.

Examination of both clinic and private patients showed agreement with the finding of Sorsby[36] that a distance of 4 inches (10 centimeters) was the approximate limitation for binocular vision. However, in the private group, two patients with nearly equal vision in each eye and with normal muscle balance experienced binocularity using +16 diopters in each eye at 2 inches. These strong magnifiers were ordered with proper decentration in the reading addition in each eye. Case one was a 32-year-old male with a vision of 7/200 in the right eye and 4/200 in the left eye; case two was a 26-year-old female who had vision of 4/200 in the right eye and 5/200 in the left eye. Of course, in patients with considerable convergence excess, too much decentration cannot be used in the reading correction. In the large majority of patients who required a correction of 10 or more diopters, an aid was ordered for the better eye and the poorer one occluded to eliminate this convergence problem.

A very rigid rule adhered to in both clinic and private practice was that a strong magnifier should not be prescribed when a weaker would suffice. Furthermore, the power of the lens should be commensurate with the desired performance. Several problems occur with lenses that are too powerful: (1) depth of field is decreased making work distance very short and critical; (2) field of vision is diminished limiting vision to a minute section of a printed page; (3) head or hand tremor would make objects move rapidly in and out of the field of vision, since magnification of speed occurs with all magnifying devices.

Three aspects of lighting must be considered in low vision evaluation: (1) the luminous intensity of the light source; (2) the distance of the light source from the page or object; and (3) the use of a non-glossy surface. Although many patients demonstrated improved reading ability with individual variations in the amount of lighting or in the direction of the light source, there was considerable inconsistency in responses even from individuals having the same ocular disease.

Of the 71 private cases who had densities of the refractive media, 12 improved their reading performance when illumination was decreased while 18 improved when illumination was increased (see Table 15). Of the 271 private patients with diminished chorioretinal or optic nerve function, 46 read with more facility using less illumination and 61 improved with increased illumination (see Table 16).

It was found that the amount of illumination needed for the use of an optical aid frequently depended upon the location and density of the pathological process. If the opacity or density was not near the optical center, then normal illumination proved adequate. If, however, it approximated the optical axis of the eye, then increased light made the pupils miotic and handicapped visual performance. Conversely, dim illumination under these circumstances improved vision since mydriasis was produced. Intense illumination was seldom beneficial as the cloudy media dispersed light according to the Tyndall principle. A multiplicity of reflections and refractions due to the different indices of refraction of the suspended particles in the media obscured the vision by scattering the light.

TABLE 15. NUMBER OF PRIVATE PATIENTS HAVING DENSITIES OR IRREGULARITIES OF THE REFRACTIVE MEDIA SHOWING IMPROVEMENT BY ADJUSTMENTS IN ILLUMINATION, BY OCULAR DISEASE

| | Decreased illumination | Increased illumination |
|---|---|---|
| Macular degeneration (senile and juvenile) | 27 | 24 |
| Hypertensive and arteriolar sclerotic retinopathy | 4 | 5 |
| Optic atrophy (non-glaucomatous) | 1 | 7 |
| Diabetic retinopathy | 2 | 5 |
| Optic atrophy (glaucomatous) | 2 | 6 |
| Myopia (severe) | 1 | 0 |
| Chorioretinitis (healed) | 1 | 4 |
| Retinitis pigmentosa | 0 | 5 |
| Retrolental fibroplasia | 1 | 4 |
| Retinal detachment | 1 | 1 |
| Albinism | 6 | 0 |
| TOTAL | 46 | 61 |

TABLE 16. NUMBER OF PRIVATE PATIENTS HAVING DIMINISHED CHORIORETINAL OR OPTIC NERVE FUNCTION SHOWING IMPROVEMENT BY ADJUSTMENTS IN ILLUMINATION, BY OCULAR DISEASE

| | Decreased illumination | Increased illumination |
|---|---|---|
| Congenital cataracts | 1 | 9 |
| Corneal opacities | 4 | 1 |
| Post cataract aphakia | 0 | 5 |
| Bullous keratopathy | 2 | 0 |
| Keratoconus | 1 | 0 |
| Interstitial keratitis | 1 | 0 |
| Corneal dystrophy (hereditary) | 3 | 3 |
| TOTAL | 12 | 18 |

In the author's experience, experimentation with lighting is recommended during the subjective testing of the partially sighted.

## SUMMARY

The problem of the partially sighted is increasing with the general growth in population.

The study of two sample groups of clinic and private patients is broken down into population characteristics in order to see if one characteristic or a combination of several characteristics predisposes to better visual rehabilitation.

Simple techniques, procedures, and equipment are available for every ophthalmologist to use in the treatment of these cases. This need not be a specialization since work with the partially sighted can be adapted to the general type of ophthalmic practice. Only an average of 15 to 20 minutes more than the time needed for an ordinary examination and refraction is required.

It is not possible to compare the visual acuity or ocular pathology with a predetermined standard. Even those patients whose visual acuities categorize them as blind should not be ignored until an attempt has been made to find an aid that may increase vision, however slightly.

There is no general aid for all patients, and the aid prescribed is not contingent upon the choice of the examiner but on final selection by the patient. It must be chosen to give the patient the maximum vision possible relative to his greatest visual need.

It is a rewarding experience for the ophthalmologist to help better the performance of the visually handicapped in the confusion and din of the daily scene.

APPENDIX I

Eye and Ear
and
Presbyterian-University Hospital
Falk Clinic
Service for the Partially Sighted
Case History

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Date....................Phone Number.............Case No.................
Referred By.............................Referring Diagnosis...............

CASE HISTORY

Poor Vision: Age at Onset.............................................
Education: None....Elementary....High School....College....Postgraduate....
Occupation: Past..................................................
Present..................................................
Avocation..................................................
Greatest Visual Need: Close Work..........Reading..........Sewing..........
Distance Work..........Movies..........T.V...........Travel..........
Other....................................................

PRESENT STATUS

1. Use glasses: Yes... No.... Sun glasses: Yes... No.... A cane: Yes... No....
2. Walks in strange outdoor surroundings without assistance: Yes... No....
3. Sees street signs: Yes... No.... Recognizes proper street car or bus: Yes... No...
4. Watches movies: Yes... No... Watches T.V.: Yes... No... Viewing distance ..........
5. Reads headlines at 6 inches: Yes... No.... Subheadlines at 6 inches: Yes... No.... Newsprint at 6 inches: Yes... No....
6. Is vision better in strong daylight? ............ In twilight? ............
7. Has patient ever been examined for low vision device: Yes... No....
8. Device used: Distance: Brand..........Type..........Strengths..........
Near: Brand..........Type..........Strengths..........

DIFFICULTIES THAT MAY BE ENCOUNTERED

Senility............................Language Barriers....................
Youthfulness........................Tremors..............................
Illiteracy..........................Emotional problems..................
Others................................................................

Motivation for visual improvement expressed as: Mild....Moderate....Strong....
Ability to pay for Rx if prescribed: Yes....................................
No....................................

Eye and Ear
and
Presbyterian-University Hospital
Falk Clinic
Service for the Partially Sighted
Examination

Date....................Referred By...............Case No.................

Visual Acuity: Without Glasses With Glasses Correction
Distance: OD......OS...... OD......OS...... OD.................
Near: OD......OS...... OD......OS...... OS.................

Distant Pinhole Vision: OD......OS...... Tension: OD......OS......

Pupil Reaction: OD......OS......

Eye Movements and Fixation
Nystagmus: Yes...No...Type..............Eccentric Fixation: Yes...No...

External Exam: Lids...................Cornea.............................
Iris..............................Lens..............................

Ophthalmoscopy: Media................Optic Nerve........................
Choroid and Retina...................................................

Keratometer: OD....................OS................................
Retinoscopy: OD....................OS................................
Manifest: OD....................Vision.............ADD......J......
OS....................Vision.............ADD......J......

Field of Vision
Central OD....................OS......................
Peripheral OD....................OS......................
Hand Confrontation OD....................OS......................

Visual Aids Tried: Date...........Results................................
Date...........Results................................
Date...........Results................................

Visual Aid Prescribed:.............................................
Distance OD...............................................
OS...............................................
Near OD...............................................
OS...............................................

Number of Visits 1 2 3 4 5 6 7 8 9 10

Patient's General Reaction: Disappointed.....Appreciative..... Enthusiastic.....

FOLLOW-UP

| Date | Comments and Findings |
|---|---|
| ........... | .................................................................. |
| ........... | .................................................................. |
| ........... | .................................................................. |
| ........... | .................................................................. |
| ........... | .................................................................. |
| ........... | .................................................................. |
| ........... | .................................................................. |

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