ROUTINE TONOMETRY IN 5,000 PATIENTS FOR DETECTION OF EARLY GLAUCOMA

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Glaucoma, like the poor, is always with us. All ophthalmic out-patient departments have their share of tragic cases of elderly men and women with glaucoma. The incidence of glaucoma in the general population is high. In 1956 Sorsby reported that 13.6% of all blindness in England is due to glaucoma. Zeller and Christensen (1954) state that in the United States 20,000 persons are blind from glaucoma, and a further 150,000 have lost the sight in one eye. Further, a number of workers have published the results of mass survey and found that the average incidence of glaucoma in people over 40 years of age is 2% (see Table I).

TABLE I.—*Incidence of Glaucoma in the General Population Over the Age of 40*

Authors	No. Surveyed	Results
Berens and Tolman (1950) ..	10,500	2.7% ocular hypertension
Brav and Kirber (1951) ..	10,000	1.53% definite glaucoma, 0.7% borderline cases
Wolpaw and Sherman (1954) ..	12,803	2% definite glaucoma
Vaughan <i>et al.</i> (1957) ..	7,943	2.01% "
Fortier (1958) ..	987	2.83% "

The alert ophthalmic surgeon is always looking for minimal cupping of the disk or early field defects that will suggest the onset of this insidious disease. Primary chronic glaucoma has a point in its natural history beyond which the disease progresses to blindness whatever treatment is employed. In 1948 Kronfeld and McGarry published a five-year follow-up of more than 300 glaucomatous eyes. They found that when glaucoma was detected in an early stage and treatment was adequate, 81% showed no visual deterioration in five years, but cases discovered at a late stage showed a much poorer response to treatment.

The problem is therefore to find cases early, before damage has been done to the nerve fibres of the retina. Our colleagues who deal with pulmonary tuberculosis are faced with a similar problem and have met it by introducing mass radiography in an attempt to diagnose early cases before symptoms have developed. Have we any similar way of detecting cases of early glaucoma before visual deterioration has occurred?

Glaucoma for the most part attacks people over the age of 40. Patients in this age-group tend to consult an ophthalmologist at regular intervals because of their presbyopic needs. This provides an excellent opportunity for the screening of these patients for the presence of this disease. Detailed field studies on every patient are not practicable, but we believe there is a method of selecting those who should be subjected to further investigation. In our practice for the last four years it has been our routine to measure the intraocular pressure of every patient over 40 years of age. We have

selected an arbitrary measurement of 25 mm. of mercury, and every patient whose pressure is above that figure undergoes careful investigation. Of course, we realize that this is not an infallible means of detecting glaucoma subjects, but we regard it as a practical method of screening patients for glaucoma.

Methods of Investigation

The intraocular pressure is measured by a Schiøtz or a Mueller electronic tonometer. We have trained our nurses to perform the simple test required, and in 5,000 cases we have had no complications. A drop of tetracaine (amethocaine in the U.K.) hydrochloride 0.5% is instilled into the eye. The lids are held apart by the fingers of the free hand and the instrument is rested lightly on the cornea, every care being taken to avoid all pressure on the globe. If the intraocular pressure is found to be below 25 mm. of mercury, glaucoma is assumed to be absent unless the disk appears to be cupped. If it is above 25 mm. of mercury, the patient is advised to have further investigation.

Our first step is to repeat the tonometry. If we agree that the pressure is above 25 mm. of mercury, we usually proceed to do a gonioscopy. We use an Obrig or a Goldmann gonioscopes. This is placed over the anaesthetized cornea, and by its means, using a hand microscope and a light with the Obrig lens, or the slit-lamp with the Goldmann lens, the corneo-scleral angle may be examined to determine whether it is of the wide or narrow type.

If the angle is narrow a mydriatic test is performed unless the pressure is significantly high. In this test the intraocular pressure is first measured, then a drop of a mydriatic solution such as homatropine hydrobromide 1%, phenylephrine hydrochloride 2.5%, or cyclopentolate hydrochloride 1% is instilled into each eye and the pressure is measured at 15-minute intervals. A rise of over 8 mm. of mercury in two hours is regarded as positive.

If the angle is wide or if the mydriatic test is negative the patient is brought back another day for a water-drinking test and for tonography. For a water-drinking test the patient attends in the morning without having had anything to eat or drink. The intraocular pressure is measured. The patient is then given a quart of water or other fluid to drink and the pressure is recorded at 15-minute intervals for one hour. A rise of 9 mm. of mercury is regarded as positive.

In cases of glaucoma there is an obstruction to the drainage of aqueous from the eye. With a tonometer it is possible to measure the degree of this obstruction and also to assess the rate of production of aqueous in the eye. This procedure is known as tonography.

We use a Mueller electronic tonometer and a Sanborn recorder. The tonometer is allowed to rest upon the eye for four minutes. The weight of the tonometer expresses aqueous from the eye and the intraocular pressure falls. This fall is recorded on a graph by the recorder and the facility of outflow of aqueous is calculated by a mathematical formula. When glaucoma is present the fall in intraocular pressure is reduced owing to the obstruction to aqueous outflow.

In practice we have tables to which we refer. From the original pressure and the fall in outflow we read off the facility of outflow and the rate of production of aqueous. We record our findings in the following way: Po—the original pressure; c—the facility of out-

flow; F—the rate of production of aqueous; P/c—the ratio between the first two. This last ratio was suggested by Becker (1956), who has shown that in a normal eye it is usually less than 100. We take 150 as indicative of glaucoma.

The visual fields are also investigated.

In some eyes the pressure as measured by the tonometer is too high or too low owing to an excess or lack of rigidity of the sclera. If an abnormal scleral rigidity is suspected it may be checked by measuring the intraocular pressure with two different weights on the tonometer. The coefficient of scleral rigidity may be obtained by referring to tables prepared by Friedenwald (1957).

Making the Diagnosis.—The criteria we use for the diagnosis of glaucoma are given below. No single indication should ever be accepted as adequate for a diagnosis of either wide- or narrow-angle glaucoma. The whole clinical picture must be considered in every case. (1) Pathological cupping of the disk. (2) Typical glaucomatous field defects. (3) An intraocular pressure of over 30 mm. of mercury on three separate occasions. (4) An intraocular pressure of over 40 mm. of mercury on any occasion. (5) A mydriatic test with a rise in pressure of 8 or more mm. of mercury. (6) A water-drinking test with a rise of 9 or more mm. of mercury. (7) Tonography with a value for the facility of outflow of less than 0.15 and with a P/c ratio of over 150.

Results

The results of our investigation are given in Table II. Routine tonometry was performed on 5,000 patients over the age of 40. On clinical grounds 43 cases were diagnosed as glaucoma (see Table III).

TABLE II.—Results of Routine Tonometry in 5,000 Cases

	No. of Cases	%
Patients selected by routine tonometry ..	217	4.3
Failed to return for investigation ..	82	1.6
Patients investigated ..	135	2.7
(a) Found to be normal ..	92	1.8
(b) Considered to have glaucoma ..	43	0.9

TABLE III.—Patients (43) Diagnosed Clinically as Glaucomatous

History of previous diagnosis of glaucoma ..	7
Cupping of the optic disk ..	15
Absolute glaucoma ..	5
Secondary ..	11
Acute closed-angle glaucoma ..	2
Glaucomato-cyclitic crisis ..	2
Pigmentary glaucoma ..	1

In 217 patients the intraocular pressure was found to be above 25 mm. of mercury in one or both eyes, though no other clinical signs of glaucoma were present. These were therefore regarded as possible cases of glaucoma. Of these, 82 failed to attend for a follow-up examination. 135 patients were investigated, and 92 of these were considered to be non-glaucomatous and 43 to have the disease.

Thus glaucoma was diagnosed in 86 patients (1.7%). Since it is likely that a similar proportion of the 82 patients who did not come for further investigation would have been found to have the disease, it may be assumed that about 2% of our 5,000 patients had glaucoma.

We wish to emphasize that 43 cases of early glaucoma had no clinical signs of the disease and were discovered entirely as a result of routine tonometry. None of them gave a history of haloes, or had cupped disks. They

would have been missed if tonometry had not been performed as a routine procedure.

Comment

Our finding that about 2% of patients over the age of 40 have glaucoma is in keeping with the results of similar studies which have been conducted in the United States of America and in Europe (see Table IV).

TABLE IV.—Results of Routine Tonometry in Clinical Practice

Authors	No. of patients	Glaucoma diagnosed before tonometry	Cases of Glaucoma which would have been missed without routine tonometry
Phelps (1949) ..	720 over 45 yrs.	2.5%	2.6%
Reed and Bendor-Samuel (1957) ..	2,000 over 40 yrs.	1.4%	1.5%
Hildreth and Becker (1957) ..	2,000 " 40 "	Not included	2.1%
Porter (1958) ..	2,000 " 40 "	0.85%	1.75%

Early diagnosis and adequate treatment are imperative to prevent blindness from glaucoma. We suggest that most cases can be found before damage has occurred and while treatment is of value by the routine screening of all patients over 40 years of age by tonometry. Since some might be concerned at the waste of time spent performing tonometries on the 98% without glaucoma, we would stress that our tonometries are performed by our nurses, so that no time is lost by the ophthalmologist.

We would go further and suggest that this is such a simple procedure that it should be done by every physician when conducting a routine physical examination. All patients found to have an intraocular pressure above 25 mm. of mercury should then be referred to an ophthalmologist for investigation. We realize that it may perhaps be difficult for a practising physician to make arrangements to learn a new test. It is our opinion that medical schools should seriously consider teaching this simple procedure to undergraduates as part of the normal training of a general physician.

Summary

The intraocular pressure of the eyes of 5,000 patients was measured routinely.

4.3% had a pressure in one or both eyes above 25 mm. of mercury.

1.7% were found to have glaucoma. If all those advised had attended for further investigation about 2% would have been found to have glaucoma.

0.9% of the patients were diagnosed as suffering from glaucoma on clinical examination, but 0.9% had no clinical signs of the disease and were discovered as a result of routine measurement of the intraocular pressure.

We believe that this simple test should be performed as part of the eye examination of every patient over the age of 40. It is easily performed by a nurse.

We believe that medical schools should teach undergraduates this simple test so that it is included as part of the physical examination of every patient over the age of 40.

We wish to record our thanks to our nurses, Mrs. T. Patterson, L.P.N., and Mrs. J. Proche, R.N., who have so efficiently and cheerfully performed tonometries on our patients.

REFERENCES

- Becker, B. (1956). *A.M.A. Arch. Ophthalm.*, **56**, 909.
 Berens, C., and Tolman, C. P. (1950). *J. Amer. med. Ass.*, **142**, 1360.
 Brav, S. S., and Kirber, H. P. (1951). *Ibid.*, **147**, 1127.
 Fortier, J. P. (1958). *Un. méd. Can.*, **87**, 720.
 Friedenwald, J. S. (1957). *Trans. Amer. Acad. Ophthalm. Otolaryng.*, **61**, 108.
 Hildreth, H. R., and Becker, B. (1957). *Amer. J. Ophthalm.*, **43**, 21.
 Kronfeld, P. C., and McCarty, H. I. (1948). *J. Amer. med. Ass.*, **136**, 957.
 Phelps, G. D. (1949). *J. Iowa St. med. Soc.*, **39**, 519.
 Porter, G. L. (1958). *Trans. Amer. Acad. Ophthalm. Otolaryng.*, **62**, 54.
 Reed, H., and Bendor-Samuel, J. E. L. (1957). *Trans. Ophthalm. Soc. U.K.*, **77**, 379.
 Sorsby, A. (1956). *Blindness in England, 1951-1954*. H.M.S.O., London.
 Vaughan, D. G., Shaffer, R. N., Asbury, T., Mettier, S. R., Ridgway, W. L., and Lotspeich, R. A. (1957). *Sight-sav. Rev.*, **27**, 145.
 Wolpaw, B. J., and Sherman, A. W. (1954). *Ibid.*, **24**, 139.
 Zeller, R. W., and Christensen, L. (1954). *J. Amer. med. Ass.*, **154**, 1343.

INCIDENCE OF PSYCHIATRIC ILLNESS AMONG HOSPITAL OUT-PATIENTS AN APPLICATION OF THE CORNELL MEDICAL INDEX

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Description and Review

The "Cornell Medical Index Health Questionnaire" (C.M.I.) is a four-page self-administered inventory comprising 195 questions, which correspond closely to those usually asked in a comprehensive medical interview. There are two forms of the questionnaire—one for men, one for women—which are identical except for six questions in the genito-urinary section. The questions are phrased in informal language and to each the patient answers "Yes" or "No." The average time needed to complete the questionnaire is 10-20 minutes, and most patients find it a satisfying diversion while waiting for the doctor. The questionnaire is arranged into sections, as Table I shows.

TABLE I.—Sectional Subdivision of C.M.I.

Section	Questions Referring to	No. of Questions
A	Eyes and ears	9
B	Respiratory system	18
C	Cardiovascular system	13
D	Digestive tract	23
E	Musculo-skeletal system	8
F	Skin	7
G	Nervous system	18
H	Genito-urinary system	11
I	Fatigability	7
J	Frequency of illness	9
K	Miscellaneous diseases	15
L	Habits	6
	<i>Mood and Feeling Patterns</i>	
M	Inadequacy	12
N	Depression	6
O	Anxiety	9
P	Sensitivity	6
Q	Anger	9
R	Tension	9
	Total	195

The development of the C.M.I. is described by Brodman *et al.* (1949), who point out that their intention was to provide a quick and reliable method of obtaining the facts of the patient's medical history, at no expense to the physician's time. In a trial of the C.M.I. in 180 consecutive out-patients it collected most of the critical data obtained independently by the physician, and, in addition, it often gathered important material not recorded in the medical history. The patients were shown to answer the questions as accurately as they answered similar questions at interview. The C.M.I. was developed as an adjunct to, not as a substitute for, oral interview; it ensures that when the doctor sees a new patient he already has a good deal of information about him, and so is less likely to overlook important symptoms.

Brodman *et al.* (1952a) have also used the C.M.I. for evaluating emotional disturbances. They postulated that the severity of the disturbance might be susceptible of estimation either by appraisal of the responses to individual items in the questionnaire or by the application of scoring procedures to the data. They administered the C.M.I. to a large sample of out-patients of the New York Hospital, and found that it successfully picked out most of the patients regarded clinically as being emotionally disturbed, and was a valuable pointer to such disturbance in many other patients (Brodman *et al.*, 1952b). It was an interesting finding that, whereas physicians diagnosed emotional disturbance in their patients six times as frequently as surgeons did in theirs, scoring levels on the C.M.I. were similar for both groups.

In 1952 the *British Medical Journal* suggested that the utility of the C.M.I. in this country should be explored, particularly its ability to pick out "the anxious, the fearful, the inadequate, and the depressed." No such comprehensive investigation has yet been reported, though Leigh and Marley (1956) have used the C.M.I. to compare different groups of asthmatic patients.

The aims of the present investigation were: (1) to discover whether any relation existed between the patient's state of emotional health, and the number of positive responses to questions on the C.M.I. (2) If such relation could be demonstrated, to determine the most informative method of scoring the C.M.I. and to establish a critical score representing a boundary between "emotionally normal" and "emotionally ill," with minimum misclassification. (3) Should it prove possible thus to validate the C.M.I., to apply it to other out-patient groups with a view to assessing the amount of psychiatric disturbance among them.

Method

During an investigation into the incidence of psychiatric illness amongst out-patients attending a general non-teaching hospital (Dulwich Hospital, London), the C.M.I. was given to various groups of patients: (a) 100 consecutive new referrals to the medical clinics (785)*; (b) 100 consecutive new referrals to the surgical clinics (985)*; (c) 64 consecutive new referrals to the gynaecological clinics (749)*; (d) 50 patients who had attended the gynaecological clinics on more than six occasions; and (e) 30 consecutive new referrals to the physical medicine clinics (510)*.

*The figures in parentheses indicate the number of new patients seen in the particular clinic in the year of investigation.