A New System of Refraction for Use by the General Practitioner

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SUMMARY

A rapid, simple and economical method of refraction with a circular slide rule is described.

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Refraction and prescribing of spectacles to hospital patients at the State's expense should be of a high standard so that a pair of glasses has a maximum effective life. Another important consideration is that trivial errors, which should not be corrected even in private practice, should most certainly not be treated at the State's expense! This paper describes a system of refraction which fulfils these criteria and is easily carried out by nurses or orderlies. It has been used at Tygerberg Hospital during the past 18 months. More recently it has been adopted by the Day Hospitals Organization.

The essential equipment consists of:

1. A Snellen, illiterate-E, or other suitable chart for testing visual acuity.
2. A red glass screen and a green one, mounted side by side in contact, illuminated from behind and each bearing an identical opaque black figure. (Generally, this figure is a C in commercially supplied duochrome panels, but for illiterate persons the silhouette of a windmill is more suitable.)
3. A trial spectacle frame which allows cylindrical lenses to be rotated past the horizontal meridian.
4. A case of trial lenses with the usual range of convex and concave spheres and concave cylinders.
5. A medium-sized sewing needle with an elongated eye, and a reel of cotton thread.
6. A circular slide rule (Fig. 1).

The first step is to record the far visual acuity for each eye separately. The patient is asked to keep his eye wide open while reading the Snellen chart and to continue guessing the letters until he guesses wrongly; the visual acuity is recorded as the line where he can read only half of the letters.

The next step is to measure the near visual acuity for each eye after compensating for the normal age-related presbyopia. This is done by placing before the eye a convex lens of +0,5 D for ages 40 - 45, +1 D for ages 45 - 50, +2 D for ages 50 - 55, +2,50 D for ages 55 - 60 and +3 D for 60 years or over. The patient then has to thread the needle while one of his eyes is closed, and a record is made of whether he succeeds easily or not, after which the presbyopic correction, if any, is removed.

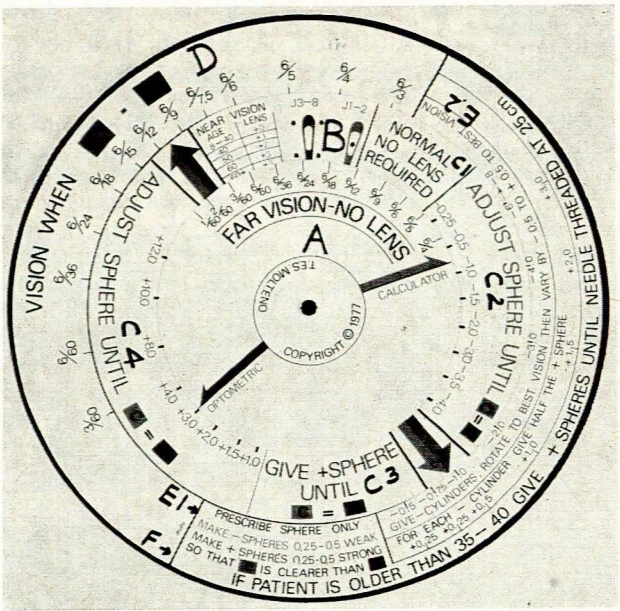

Fig. 1. The 'Optomat' optometric calculator. The operator sets scale A against scale B to obtain instructions C1, 2, 3 or 4. After obtaining duochrome balance, he sets a duochrome arrow against scale D. The opposite arrow then indicates either scale E1 or E2, after which instruction F and the final instruction are carried out.

At this stage the central disc of the slide rule is rotated to bring the recorded value of far visual acuity without glasses opposite a *red* threaded needle or a *green* unthreaded needle drawn on the intermediate disc, the choice depending on whether or not the patient is able to thread the test needle. When this has been done, a red arrow indicates the strength of the concave spherical lens and a green arrow indicates the convex spherical lens which has to be inserted into the trial frame.

The appropriate lens is inserted and the patient's attention is drawn to the duochrome panels; he is then asked which of the black figures is the clearest. If one is blurred, the lens is weakened or strengthened in 0,5 D and then in 0,25 D steps until both black silhouettes are equally sharply defined. Once this duochrome balance has been obtained, the lens is left in the frame and the visual acuity on the chart is recorded. The intermediate disc is next rotated to bring one of the two red and green (duochrome) arrows (it does not matter which one) against the appropriate visual acuity on a scale on the outermost

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disc, labelled visual acuity when the red figure equals the green one. The opposite duochrome arrow then indicates either that only the sphere should be prescribed, or, if astigmatism is present, it indicates the strength of the concave cylindrical lens needed to correct it; as well as instructions to insert a compensating convex sphere of half the strength, to rotate the cylinder to the best position and then to vary its strength to obtain the maximum visual acuity.

The principles used in this method are that, provided the normal age-related presbyopic correction is placed before the eye, the test of threading the elongated eye of a needle and urging the patient to try various orientations of the needle if he cannot succeed at first, separates the vast majority of patients with refractive errors into two groups: (*a*) myopes and myopic astigmatics who can thread the needle, and (*b*) hypermetropes and hypermetropic astigmatics who cannot thread the needle.

Once the eye has been allotted to a group, the far visual acuity gives a rough measure of the degree of refractive error present, and consequently of the strength of lens needed to correct it, while duochrome balance indicates with certainty that the best possible spherical lens has been inserted. If the visual acuity with duochrome balance is substandard, an astigmatic error is present and once more the visual acuity gives a rough measure of the cylindrical lens necessary to correct it.

The prescribing instructions are built into the slide rule: glasses are not indicated when the vision is better than 6/6 and the patient can thread a needle with ease; while cylinders of less than 0,5 D, concave spheres of less than 0,25 D and convex spheres of less than 1 D do not appear on any of the scales, so that trivial errors are not corrected. The instruction to adjust the spheres of the final prescription so as to make the figure on the red panel slightly clearer than that on the green panel, ensures that myopia is slightly undercorrected and hypermetropia slightly overcorrected, which is generally desirable. Presbyopia is fully corrected to give clear vision at 25 cm so that the glasses will give long service instead of having to be strengthened every 2 years.[1]

DISCUSSION

The advantages of this system of refraction include ease of operator training, rapid reliable refraction, and economical dispensing with stringent quality control. The training needed for refractionists using this method is minimal and our experience so far has been that nurses are able to refract after a few days, while otherwise untrained matriculants need 2 weeks of in-service training to produce quick and reliable results. So far we have not undertaken the training of less educated operators but there is no inherent reason why this should not be done, as a knowledge of optics is not necessary.

The method is surprisingly rapid, partially because the patient response can be limited to threading a needle, reading down the Snellen chart twice and deciding on duochrome balance twice (for each eye in turn), and partially because the lens inserted at each stage is approximately the correct strength. The reliability of refractions carried out according to this scheme is high, since the major cause of bad refraction — the patient's accommodating during the test — is automatically eliminated by the process of achieving duochrome balance, while the final accuracy depends, as with any other subjective method of refraction, on good communication between patient and refractionist.

The general public has such faith in glasses that many people are wearing and are continuing to wear plano and near-plano sheets of glass in the firm belief that they must see better. It is difficult to control this type of unnecessary dispensing, as it is impractical to employ highly trained staff to check all prescriptions. However, by insisting that near and far vision be recorded on all prescription forms and supplying the clerk who authorizes payment and the wholesaler who makes the glasses with identical slide rules, it becomes a simple matter for the clerk to block all prescriptions for small corrections which do not appear on the rule; while the wholesaler is able to detect gross errors in prescriptions such as an incorrect + or − sign.

The limitations of this system are those inherent in any system which depends on patient co-operation — malingerers, young children and very stupid patients cannot be refracted — nevertheless, it provides a means whereby at least 95% of patients can be refracted by minimally trained staff who can be locally recruited to overcome language and cultural barriers.

In setting up such a service it is important that, where possible, all patients should be screened by an ophthalmologist or experienced general practitioner in order to detect associated diseases. The common complaints which lead to requests for refraction are headache, blurred vision and double vision. It must be emphasized that refractive errors never cause headache in people who seldom read. The common diseases found in patients referred for refraction are meningovascular syphilis, severe hypertension, cervical osteo-arthritis, migraine, sinusitis and glaucoma which cause headache, and untreated diabetes which causes blurred vision due to irregular changes in the state of hydration of the lens.

The complaint of double vision is frequently merely the patient's way of describing blurred vision, particularly if he has an astigmatic component to his refractive error. However, true diplopia is of sinister import, being frequently due to myasthenia gravis, enlarging berry aneurysm, raised intracranial pressure or vascular disease involving the brainstem. Thus, in situations where individual evaluation of cases is not feasible it is important to measure the blood pressure, draw blood for serological testing for syphilis and examine the urine for protein and sugar. Provided screening on these lines is undertaken, we believe that this system of refraction offers a means whereby a sound economical service, staffed by locally trained people operating under the supervision of a physician, can be set up in all parts of South Africa.

'Optomat' optometric calculators, windmill duochrome panels and instruction sheets are obtainable from: Optomat Supplies, PO Box 25, Newlands, 7725 RSA.

REFERENCE

1. Primrose, J. *in* Sorsby, A., ed. (1964): *Modern Ophthalmology*, vol. 3, pp. 34 - 36. London: Butterworths.