size throughout life. It is unable to shed its older cells, as is the case with the nails and skin. The gradually enlarging lens tends to push the root of the iris forwards, narrowing the small drainage angle between the iris and the cornea. This may be sufficiently advanced at the age of 45 to be an important factor. Also, in people with relatively small corneae the disproportion between the lens and the cornea is mechanically disadvantageous. In addition, early incipient cataract is of more frequent occurrence than might be supposed. These lens changes are associated with varying degrees of water absorption and swelling of the lens. The swelling of the lens gives rise to the important clinical sign, when noted, of progressively increasing myopia, actual or relative.

Should the pupil of an eye in which these conditions prevail individually or in concert be dilated, the "bunching up" and thickening of the iris at its root may, and probably will, sufficiently plug up the drainage outflow to induce the onset of "simple" or of acute glaucoma. If atropine was the mydriatic used the situation would be difficult even if recognized early.

When to Use Atropine

It must not be assumed that advancing age contraindicates the use of atropine. It is the condition of the eye itself, irrespective of age, that may contraindicate the drug, and special difficulties arise when more than one clinical intra-ocular condition coexist, as in the secondary glaucomas. One of my patients who has double iridocyclitis is aged 90, and I have instilled atropine into both his eyes, but not before I had amply satisfied myself that there was no predisposition to glaucoma.

It may be impossible even for those in constant practice to decide by digital means that an intra-ocular pressure is not slightly raised, and other methods and data should be relied on in the important finer variations. The digital method of judging the state of intra-ocular pressure requires special technique, and to attempt to do this with the tarsal plate of the lid interposed between the finger-tips and the eye is fatuous.

For ophthalmoscopic examination euphthalmine lamellae and B.W. euphthalmine ophthalmic "Tabloid" are efficient and safest, while for the more simple conditions requiring rest of the eye by mydriasis and cycloplegia homatropine (not homatropine and cocaine, in repeated instillations) may be sufficient. Where full mydriasis and cycloplegia are indicated atropine should be employed boldly by instillation of the solution, the solid form, or if necessary by the subconjunctival route, but not before efficient drainage of the aqueous has been proved, and never indiscriminately.

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A Supplement to the *London Gazette*, dated May 7, announces the appointment as M.B.E. (Civil Division) of Burgess Barnett, M.R.C.S., and Capt. J. D. Sawyer, M.B., Army in Burma Reserve of Officers. The announcements state that Dr. Burgess Barnett was a member of the party which evacuated from Burma via the Chaukan Pass and was one of the last dozen men to be rescued from Tilung Hka. He elected to remain with the remnants of the party until the end, and thus secured to them the medical attention they all so sorely needed. Dr. Barnett's conduct throughout this long and difficult march over uninhabited country, in the most trying conditions of the monsoon, was worthy of the best traditions of the medical Service. Capt. Sawyer, after retreating into Manipur with the Burma Army, volunteered to remain behind in the Naga Hills in an endeavour to extricate the many thousands of refugees who were still coming out. He served during June and July with great distinction and helped many hundreds of refugees on the Tonhe-Yaripok-Imphal route. Early in September he volunteered to go out again in a final attempt to rescue those unfortunate evacuees who had been forced to spend the rains at Shinbiyang. No other doctor was available for this duty, and he remained there until the 1,600 survivors had been brought out safely to Margherita by Dec. 5, 1942. Capt. Sawyer showed an outstanding sense of duty and self-sacrifice and saved many lives.

SPECIFICATIONS FOR DARK-ADAPTATION TESTS

BY

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As the question of the exact specification of the light used in adaptometers has been raised by Mr. Bishop Harman (1943), it seems opportune to emphasize that there are two aspects to this problem. The first is *standardization*, or agreement as to the size of field, form, or figure used, colour temperature of light, duration of exposure, retinal area to be tested, presence or absence of a fixation point, etc., irrespective of the physical method of obtaining these things; while the second is *calibration*, or exact measurement of the physical properties of the instrument and their accurate reproduction in copies of it.

Standardization

Regarding the first, there is as yet insufficient information on the relation between rate of adaptation, cone threshold, final rod threshold, and acuity or form sense at low illuminations to show what is the best presentation or type of test to use, either as a selection test (for picking out people with dangerously poor or strikingly good night vision) or as a vitamin-A-deficiency test. However, much work with different kinds of tests is proceeding in many parts of the country, and some work directly intended to show the relation between the results of different tests and to indicate what differences between tests are important and what are unimportant.

Calibration of Instruments

Regarding calibration, the most important characteristics to be measured are the size of field, the size of the form or figure used, if any, the colour of the light, the retinal area to be tested, and the duration of the exposure (if this is a flash, as in the Steven-Wald apparatus, or the time given to the subject for his decision in other tests). These characteristics have been accurately measured and described in most of the best work on dark adaptation—e.g., that of Hecht and his collaborators. In the Army pentagon test (Rycroft, 1942) it is specified that the translucent screens in any one instrument must all be made from the same sheet of material, and the brightness of the outside surface of the screens is measured directly with a photometer in calibrating the instruments, so that variations between one batch of sheets and another do not matter. The dark filters used in the goggles worn by the subject are individually measured for density and are all of the same material. The brightness and angular size of the surface of the screen, as seen by the subject, are the main features on which the threshold depends. As pointed out by Dr. Yudkin (p. 633), the illumination falling on the eye does not really determine the threshold, since the same illumination may be visible (if it comes from a small bright field) or invisible (if it comes from a much larger but dimmer one). In the pentagon test arrangements are being made to check the surface brightness of the screens periodically by sending round a portable photometer. There is as yet no agreement even among photometrists as to the colour temperature of the light, which should be standardized for brightness and illumination measurements, and this introduces a serious difficulty in adaptometry, as a bluish-white and a yellow light having the same brightness at high intensities may differ threefold or more in apparent brightness when very dim. For this reason it was decided to specify the brightness of the pentagon test in terms of the brightness of the screens, the type of bulb, and the "neutral" material used for the filters; it is easier to obtain a uniform batch of a material than to get special materials made to a known spectral transmission curve and density; but as these properties are measurable it would be possible to specify the equivalent colour temperature and the brightness of the screens as seen by the subject in equivalent foot-candles or candles per square foot. It is admittedly not easy to ensure that many instruments are identical within certain limits; for instance, the small bulbs so desirable on account of their low current consumption can sometimes change a little, and instrument-making firms do not

usually possess suitable equipment for calibrating such instruments. Yet it appears that such bulbs, with a good voltmeter or ammeter, provide the best light source.

I have measured the candle-power of two of the standard candles provided for the Bishop Harman test in their draught-proof lamphouse, and found that during the first 40 minutes of burning there was a gradual increase from 0.75 to 2.0 c.p., and after that a decline to 0.6 c.p. without there being evidence of anything wrong with the candle. After this the candle failed in each case to move up in its spring socket, though there was about 1½ in. unburnt; if this escaped notice the light dropped further to 0.2 c.p. Thus the light varies over a threefold range when the instrument appears to be functioning properly, and if one does not watch the behaviour of the candle carefully a tenfold change can occur. The literature indicates twofold or threefold threshold changes as significant in vitamin A deficiency, and suggests that the individual variation in thresholds among a large population, excluding cases of retinitis pigmentosa and other pathological conditions, is about sixteenfold. Thus a twofold or threefold variation in light can be very serious for clinical purposes, and a variation as great as tenfold would invalidate the test even for rough personnel-selection purposes. An endeavour should be made to achieve about $\pm 15\%$ in the accuracy of night-vision tests for such work.

Conclusion

I should like to add two remarks to Major Rycroft's paper on Army night-vision testing. First, it may not have been clear that the reason for using goggles with dark filters during the test was to exclude stray light in the hut—for a blacked-out Nissen hut is by no means totally dark. Secondly, the pentagon was originally designed as a multiple or group test for examining five men simultaneously, but individual testing proved superior in practice. The attempt to make a multiple test had, however, introduced instrumental difficulties in obtaining even illumination on several panels, which need not arise in an individual test. A neutral wedge seems an almost ideal method of light control, giving a continuous logarithmic scale without appreciable change in the colour of the light, and permitting calibration of the wedge at high intensities.

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A CRITIQUE OF THE BISHOP HARMAN TEST FOR NIGHT VISION

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A new apparatus for the measurement of night vision has recently been described by Bishop Harman (1941a, 1941b, 1943). It consists of 4 groups of white disks, each half an inch in diameter, mounted on a black background. Each group comprises 4, 5, 6, or 7 disks, and only one group is uncovered at a time. The illumination is provided by a standard candle 5 metres away. The subject, after 15 minutes in the dark room, is required to stand at such a distance from the disks that they can just be distinguished and counted. It was found by Bishop Harman that "the average person can count these . . . at a distance of 5 metres." A shorter distance (down to 1.5 metres) is taken to indicate poorer night vision, and a greater distance (up to 8 metres) to indicate exceptionally good night vision.

It is clear from the description of the instrument and its mode of use that the measurements which are recorded involve factors other than dark adaptation. The following considerations in particular show this (see also Godding, 1941).

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1. The test objects are small and close to each other, so that they are perceived mainly by the cones of the macular region. Dark adaptation, on the other hand, is much greater in the rods of the peripheral field. It might be argued that it is macular vision which is concerned with accurate vision, by night as well as by day; in fact, however, vision by night is not accurate, and is to a great extent peripheral. In using this apparatus we found that the test objects are perceived better if the observer is looking a few degrees away from them. It would appear, therefore, that to some extent rods as well as cones are used; it seems that a compromise is established between the clarity given by the cones and the better dark adaptation of the rods.

2. Subjects are tested after they have been in the dark room for 15 minutes or longer. As Bishop Harman tested many subjects at a time, some were in the dark for longer than 15 minutes. Now, dark adaptation, particularly after exposures to light of high intensity such as outdoor sunshine, continues for 30 or 35 minutes. It is the rods which are mainly concerned in this prolonged improvement, and, as we have seen in the previous section, rods are to some extent used in this test. Adaptation therefore may not be complete in 15 minutes if there has been a long exposure to bright light before the test. In view of these facts, it seems likely that subjects tested after just 15 minutes might appear to be worse than others tested later, simply because the former had not yet attained their best possible adaptation.

3. The small size and the proximity of the disks suggest that the ease with which they are seen may be greatly affected by minor errors of refraction. Bishop Harman examined all his subjects for visual acuity and confined the test to those whose acuity was normal according to his "rotary E" test. It is quite likely, however, that differences in acuity, even among these "normals," might affect the ease with which the disks are seen. In other words, the E test might not eliminate sufficiently those whose visual acuity is slightly imperfect and whose ability to see the disks is consequently limited by this factor. The statement of Bishop Harman that only one of 427 Canadian soldiers failed to pass the E test lends support to this suggestion.

4. The use of a candle as a standard of illumination has been obsolete for 40 years or more. As Walsh (1926) says, "Although once officially adopted in several countries and by various testing bodies, candles have now been entirely superseded as practical standards of light. For instance, the British Parliamentary candle, defined in the Metropolitan Gas Act of 1860, was discarded in favour of the pentane lamp by the Metropolitan Gas Referees in the Notification for 1898."

5. The principle of varying the amount of light entering the eye by varying the distance between the test object and the observer is highly undesirable. In the first place, it is difficult to calculate the illumination entering the eye. Bishop Harman gives the following values: at 1 metre = $1/393$; 2 m. = $1/527$; 3 m. = $1/688$; 4 m. = $1/871$; 5 m. = $1/1075$; 6 m. = $1/1302$; 7 m. = $1/1550$; 8 m. = $1/1816$ f.c. These values appear to have been derived by assuming that the disks act as mirrors, reflecting the incident light in one direction only. This is manifestly incorrect, and the disks must be taken as themselves acting as new light sources. In other words, the illumination on the eye is inversely proportional to the square of the distance of the disks from the subject, whereas Bishop Harman takes it as inversely proportional to the square of the distance of the source of light from the disks plus the distance of the disks from the subject. The actual illumination at the eye may be calculated thus: The intensity of light at the disk is given by the formula:

$$\text{reflection factor} \times \frac{(\text{angular size of disk})^2}{\pi} \times \text{candle-power of source.}$$

The illumination at the eye is then: $\frac{(\text{distance of eye from disk})^2}{\text{intensity at disk}}$. Assuming a reflection factor at the disk of 80%, the illumination at 1 metre from the disk is 158×10^{-9} equivalent foot-candles; the illuminations at other distances are shown in the table.

Table showing Illumination at Eye at Different Distances from a Disk 1½ in. in Diameter, illuminated by Standard Candle at 5 metres from Disk

Distance of Eye from Disk (metres)	Illumination at Eye, c.p. $\times 10^{-9}$	
	According to Bishop Harman	Recalculated
1	2,540,000	158
2	1,900,000	39.4
3	1,450,000	17.5
4	1,150,000	9.9
5	930,000	6.3
6	770,000	4.4
7	645,000	3.2
8	550,000	2.45

The two methods of calculation give very different values, so that the illumination according to Bishop Harman varies