LIGHTING, GLARE AND LOW VISION

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AIMS

This module aims to outline the role played by lighting and glare in low vision via developing an understanding of illumination control.

LEARNING OUTCOMES

After completing this module, students should be able to:

- Calculate the illuminance of an area
- Determine when higher or lower illumination is required
- Describe different methods and equipment to control illumination and glare

INTRODUCTION

Most patients with low vision have problems with illumination. The problems encountered include:

- The need for high, medium or low levels of illumination
- Sensitivity to glare and contrast
- Longer adaptation periods when entering photopic or scotopic conditions

Optimising lighting can be the equivalent of gaining one or more lines of low and high contrast acuity. It also makes tasks easier for the individual to perform. For example, a good light source can have a significant effect on the patient's everyday tasks such as reading, writing, food preparation and choosing clothes. Good quality lighting can allow the individual to maintain or improve their levels of independence and allows them to maintain their personal safety, especially in unfamiliar surroundings.

Providing appropriate lighting may improve independence and should be considered as important for patients with low vision as providing a proper refraction, prescribing a device, or any other optometric intervention.

CALCULATING ILLUMINANCE OF AN AREA

There are two mathematical equations that one can consider in determination of the illuminance of an area:

1. INVERSE SQUARE LAW:

The illuminance of an area is given by the equation:

$$\text{Illuminance} = \frac{\text{candle power of illuminating source}}{(\text{source to surface distance})^2}$$

The inverse square law indicates that doubling the power of the light source will double the illuminance. In addition, halving the distance between the light source and the illuminated surface will quadruple the illuminance.

2. COSINE LAW:

$$\text{Illuminance} = \frac{\text{cosine angle of a candle power source}}{(\text{source to surface distance})^2}$$

The cosine law indicates that the illuminance varies with the cosine of the angle between the source and the perpendicular to the surface. In other words, the equation suggests the greatest effect of the light source is produced when the source is perpendicular to the surface it is illuminating.

WHEN IS HIGHER OR LOWER ILLUMINATION REQUIRED?

The aetiology of the condition causing the visual impairment may determine how the patient responds to lighting, contrast and glare. However, lighting needs must be assessed for all low vision patients. Patients can purchase an inexpensive lux meter to test illumination levels themselves - it can be difficult to judge illumination levels by eye, because of adaptation.

CONDITIONS THAT MAY REQUIRE HIGHER LEVELS OF ILLUMINATION

Retinal efficiency can be improved with higher retinal illuminance and/or high contrast. For the following patients, high levels of task illuminance can be very beneficial.

- **AMD**
- **Macular holes**
- **Diabetic retinopathy**
- **Old central chorioretinitis**

- **Optic atrophy**
- **Glaucoma**
- **Retinal, choroidal or optic nerve colobomas**
- **Degenerative myopia**
- **Pinpoint pupils**
    - While higher levels of illumination may be required to provide a brighter retinal image, the illumination cannot be too high where it causes further miosis
- **Keratoconus**
- **Multiple corneal opacities or corneal dystrophy**
    - Patients require increased illumination to penetrate the opacities, however, the illumination provided cannot be too high where it causes significant light scatter and glare.
    - The opacities may become luminous sources and hence may require the elimination of extraneous light

CONDITIONS WITH POOR DARK ADAPTATION THAT MAY REQUIRE HIGHER LEVELS OF ILLUMINATION

- Retinitis pigmentosa:
    - Poor dark adaptation is an early and persistent characteristic in patients with retinitis pigmentosa

CONDITIONS THAT MAY REQUIRE REMOVAL OF EXTRANEOUS LIGHT

- Posterior sub-capsular cataracts
- Albinism

CONDITIONS THAT MAY REQUIRE LOWER LEVELS OF LIGHT

- **Achromatopsia**
    - Rod monochromats have a tendency to not tolerate high levels of light
    - Patients experience difficulty with changes in light levels
    - Patients prefer low light levels and elimination of extraneous light
    - Absorptive filters that transmit red light help these patients
- **Retrobulbar neuritis** and **more severe macular degenerations**
- **Cataracts**
    - Central opacities generally produce difficulties for patients when the pupils are smaller and hence reduced light and mydriatics are sometimes recommended
    - The opacities present in cataract produce light scatter leading to glare and therefore elimination of extraneous light is preferred
    - Incandescent light sources are generally preferred to fluorescent sources
- **Aphakia**
    - UV absorption needs to be addressed in patients with aphakia since their primary absorber of UV radiation has been removed
- **Aniridia**

METHODS OF ILLUMINATION CONTROL

OPTIMISED LIGHTING SHOULD:

- Provide increased contrast
- Provide reduced glare
- Provide increased clarity
- Be environmentally friendly (low energy)
- Be a low heat source and hence safer for patients with visual impairment

For a discussion of the various advantages and disadvantages of different sources of light, please see *Chapter 1: Environmental Modification*.

NATURAL LIGHT

- Providing additional lighting for reading can sometimes be as simple as asking the patient to read with their back to a window during daylight hours instead of providing a lamp for reading.
- However, one of the problems with only prescribing natural light is the inconsistency of the light source, since the individual does not have any control over sunlight conditions.
- If a patient is able to read by the window or in good sunlight and is unable to read indoors, then it generally means that the patient does not have the correct lighting indoors and this should be investigated and rectified.

LAMPS

- High levels of illumination can be obtained by simply reducing the distance from the source
    - Remember the 'inverse square law' means one-quarter lamp distance = 16x illuminance.
- Small high intensity lamps work well for patients requiring higher levels of light
    - Newer LED lamps provide high efficiency, do not produce external heat, and have a very long lifetime.

Considerations for using lamps

- If the lamp is placed in front of the patient, the shade must be completely opaque
- A gooseneck lamp may be the lamp of choice when reading and sewing while seated
- Table lamps directed over the shoulder can help reduce glare
- Mounting multiple fluorescent lights over extended work spaces can also contribute to improved lighting
- Lamps to provide higher illuminance for reading in bed, used in conjunction with optical aids can be useful
- A typoscope is a simple, inexpensive and helpful device for eliminating extraneous light

CONTROLLING OUTDOOR LIGHTING

Visors

- Allow the elimination of overhead light and glare
- Visors are also available as a spectacle attachment that can fit on spectacle frames
- Hat brims also allow the elimination of overhead light

Lens tints and colour coatings

- Different options to consider include solid or graduated tints in spectacles, clip-on sunglasses, photochromic lenses if glare outdoors only is the problem.
    - Remember photochromic lenses may not be dark enough for use in cars, because UV illumination is filtered by vehicle windows, and the lenses don't activate as strongly
- Clip-on filters and behind-the-lens shades can all help when glare sensitivity is severe.

Side shields

- Can be used when there is no obstruction or limitation of peripheral vision
- Can be in the form of a clip-on or permanently attached to spectacles

Stenopaic slits and holes

- These devices allow a decrease in illumination, however they result in mobility restrictions