



A LITERARY REVIEW ON VISUAL ACUITY

A. H. Ayshah Fazeenah

Senior Lecture, Institute of Indigenous Medicine, University of Colombo, Sri Lanka

Abstract: Vision is the most dominant of the five senses and plays an important role in every second of our lives. It is integral to interpersonal and social interactions in face-to-face communication where information is conveyed through non-verbal speech. Visual acuity (VA) is a measure of central vision, indicates how clearly an individual can see an object. It may range from normal to no light perception. It is the most commonly used and universally understood measure of visual function. It is important to measure the visual acuity because it provides a simultaneous measurement of central corneal clarity, central lens clarity, central macular function, and optic nerve conduction. It has to be tested in both eyes for both distance and near objects. If the patient is using spectacles, need to take reading with and without the spectacles, and is measured in each eye separately. Usually, the distance visual acuity is tested by using 'Snellen's chart' for educated and literate adults; 'Tumbling E chart' for illiterates; and 'Lea symbols' for the small children and infants. There are things to follow naturally to boost the eye health and potentially enhance the vision and visual acuity. The present literary review was undertaken to integrate the knowledge of visual acuity and its importance. Details and facts on visual acuity were gathered from the authentic books, published journals, PubMed, google scholar, research gate by using words like visual acuity, vision, eye health, central vision, eye examination etc., then analyzed and summarized the data. Therefore, it is concluded that the measurement of visual acuity is a most sensitive test of the integrity of the visual system and accomplish all standard criteria of a good screening test with minimal cost or risk to the patient.

Key words: Visual acuity, central vision, senses, Snellen chart, Tumbling E, illiterate.

I INTRODUCTION

Central visual acuity refers to the ability of the visual system to recognize fine differentiation in the environment as measured with printed or projected visual stimuli. The presence of excellent visual acuity (VA) tells the examiner that the ocular media are clear, the image is clearly focused on the retina, the afferent visual pathway is working, and the visual cortex has appropriately interpreted signals received (Levenson and Kozarsky, 1990).

Visual acuity is a measure of central (macular) vision, indicates how clearly the patient can see an object. Always test acuity carefully as loss of acuity is a grave sign. Record it accurately, especially in a patient with eye injury (Collier et al, 2000). Visual acuity may range from normal to no light perception (Sadun and Wang, 2011). In a global society built on the ability to see, vision plays a critical role in every aspect and stage of life. Vision is the most dominant of the five senses and plays an important role in every second of our lives. It is integral to interpersonal and social interactions in face-to-face communication where information is conveyed through non-verbal speech such as gestures and facial expressions. From the time of birth, vision is very important in the development of child. For infants, visually recognizing and responding to parents, family members, and caregivers facilitates cognitive and social development and the growth of motor skills, coordination and balance (WHO 2019).

According to the WHO 2019 report, from early childhood to later life, vision,

- enables ready access to educational materials and is pivotal to educational attainment
- supports the development of social skills to foster friendships, strengthen self-esteem and maintain well-being
- important for participation in sports and social activities that are essential to physical development, mental and physical health, personal identity and socialization
- facilitates participation in the workforce, contributing to economic benefits and a sense of identity
- contributes towards the enjoyment of many other areas of life that are often designed around the ability to see, such as sports or cultural activities
- helps with maintaining social contact and independence
- facilitates the management of other health conditions
- helps to sustain mental health and levels of well-being, both of which are higher among those with good vision.

According to the International Classification of Functioning, Disability and Health, an "Impairment" is a general term used to describe a problem in the function or structure of a person's body due to health condition. This definition is matched with the ICD 11 (International Classification of Diseases 11th Edition), and a vision impairment results when an eye condition affects the visual system and one or more of its vision functions (WHO 2019). The visual acuity is maximum at the macula (Nema and Nema, 2008).

II HISTORY

The Vision test types were invented by the German ophthalmologist Heinrich Kuechler in 1843. This test type chart was modified and improved by the Vienna oculist Eduard Jäger von Jaxthal in 1854, and also currently using Jaeger numbers were developed from this chart. In 1862 Herman Snellen, Dutch ophthalmologist, published the first visual chart based on "Optotypes", advocating the need for standardized vision tests. In 1888 Edmund Landolt introduces the broken ring, now it known as the Landolt ring. In 1894 Theodor Wertheim in Berlin presents detailed measurements of visual acuity in peripheral vision and in 1978, Hugh Taylor introduces a "Tumbling E Chart" for illiterates (https://en.wikipedia.org/wiki/Visual_acuity).

In 1982, Rick Ferris et al. of the National Eye Institute chooses the LogMAR chart layout, implemented with Sloan letters, to establish a standardized method of visual acuity measurement for the Early Treatment of Diabetic Retinopathy Study (ETDRS). These charts are used in all subsequent clinical studies, and did much to familiarize the profession with the new layout and progression. Data from the ETDRS were used to select letter combinations that give each line the same average difficulty, without using all letters on each line. In 1984, the International Council of Ophthalmology approves a new 'Visual Acuity Measurement Standard' with incorporating the above features (https://en.wikipedia.org/wiki/Visual_acuity).

In 1988, Antonio Medina and Bradford Howland of the Massachusetts Institute of Technology develop a novel eye testing chart using letters that become invisible with decreasing acuity, rather than blurred as in standard charts. They demonstrate the arbitrary nature of the Snellen fraction and warn about the accuracy of visual acuity determined by using charts of different letter types, calibrated by Snellen's system (https://en.wikipedia.org/wiki/Visual_acuity).

III METHODOLOGY

Details and facts on visual acuity were gathered from the authentic books, published journals, PubMed, google scholar, research gate by using words like visual acuity, vision, eye health, central vision, eye examination etc., then analyzed and summarized the data.

IV DESCRIPTION

Measurement of visual acuity is a most sensitive test of the integrity of the visual system and accomplish all standard criteria of a good screening test (Levenson and Kozarsky, 1990):

- i negligible cost or risk to the patient
- ii measurement can be performed quickly and easily with little or no examiner training
- iii there is a high preponderance of noticeable abnormalcy
- iv abnormal conditions are most often responsive to treatment.

Visual acuity has to be tested in both eyes for both distance and near objects. If the patient is using spectacles, need to take reading with and without using the spectacles.

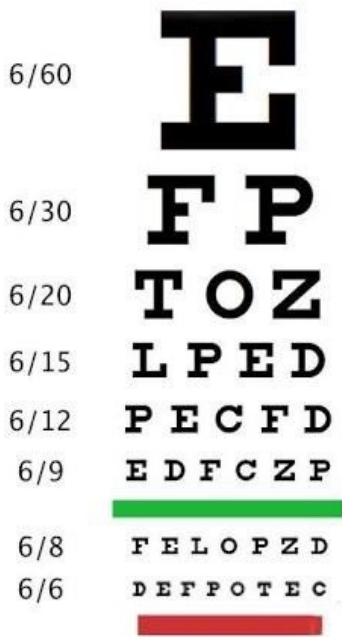
Visual acuity for distance objects

In order for central visual acuity to approach the normal range, several conditions must be met. Light rays must be properly refracted by the cornea and crystalline lens to be clearly focused upon a healthy foveal region of the retina and then neurally transmitted to the occipital cortex (Levenson and Kozarsky, 1990).

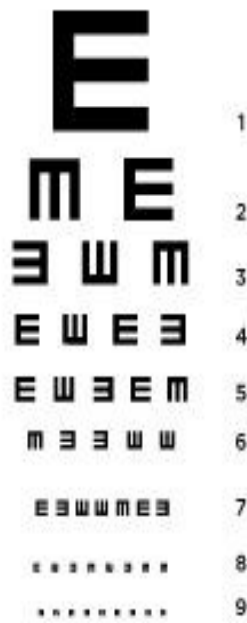
Visual acuity is measured for each eye separately. Usually, the distance visual acuity is tested by using 'Snellen's chart' (Figure-1) for educated and literate adults; 'Tubmling E chart' (Figure-2) for illiterates; and 'Lea symbols' (Figure-3) for the small children and infants.

The Snellen's test-type developed by Dutch ophthalmologist Hermann Snellen in 1862. This chart consists of a series of letters arranged in lines. The size of the letters gradually diminishes from above downwards, and are arranged as 60, 36, 24, 18, 12, 9 and 6 meters away from the eye.

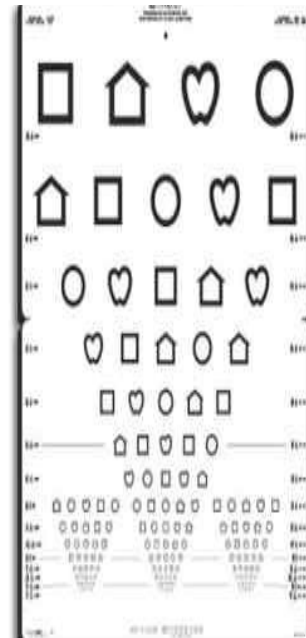
The top line of the chart is designed that can be read by an individual with normal vision at 60 meters (Baldwin et al, 2016), the next at 36 meters, 24, 18, 12, 9 and the last line at 6 meters respectively. The acuity is recorded as 6/60, 6/36, 6/24, 6/18, 6/12, 6/9 and 6/6 indicate the last line accurately read. For acuities worse than 6/60 the patients can be brought forward to 5, 4, 3, 2 and 1m from the chart to read the top line. If he can read it then acuity is expressed as that distance. For example, 5/60, 4/60, 3/60, 2/60 and 1/60. If vision is below 1/60 ask the patient to count examiner's fingers at ½ meters and recorded as CF (count fingers). If he cannot count the fingers, move examiner's hand in front of the patient's eye at ¼ meter distance. If the patient can appreciate the hand movement, then the visual acuity is recorded as record HM (hand movement). If the patient cannot appreciate the hand movement, dim the light in the examination room and shine a torch light in to the eye. If the patient perceives the light then the visual acuity is recorded as PL. If there is no perception, record it as 'NPL' which indicate the eye is blind (Collier et al, 2000).



(Figure-1)



(Figure-2)



(Figure-3)

For further understanding, 6/60 means the patient can see an object at 6meters what people with normal vision can see at 60 meters away. When a patient is unable to read any lines on the chart, they are moved closer until they can read the line with the largest letters. The acuity is still measured the same way. A ratio of 1/60 means the person being tested can see at 1 meter what a normal person can see at 60 meters.



(Figure-4)

If the patient sees less than 6/6 with or without glasses, examine with a pinhole (Figure-4) in front of the eye. A narrow beam of light enters in to the eye eliminating the need to focus a beam. If the patient has only refractive error, there will be an improvement in vision as seen through the pinhole.

Procedure

Visual acuity testing is part of every eye examination. It is important that it is done well, and accurately, as an incorrect measurement can lead to inappropriate decisions and management. It is important to assess visual acuity in a consistent way in order to detect any changes in vision. One eye is tested at a time (Marsden et al, 2019).

- Ensure good natural light or illumination on the chart.
- Keep the Snellen chart at the eye level of the patient
- Explain the test to the patient.
- Tell the patient it is not a test that they have to pass. Tell them not to guess if they cannot see.
- Sit or stand the patient at 6 metres away from the ‘6-metre Snellen or tumbling E chart’, or 3 metres away from the ‘3-metre Snellen or Tumbling E chart’. Traditionally 6 meters, but charts are available for the much more convenient 3 meters. When the space in the room is limited, the test-types may be seen after being reflected from a plane mirror kept at a distance of 3 meters from the patient.
- Test each eye separately, usually starting with the right eye, without spectacles.
- Tell the patient to cover the left eye with an ‘eye paddle’, a plain occluder, a simple cardboard, a tissue or by patient’s palm, not pressed the left eye which may affect the acuity of the right eye.
- Ask the patient to read the Snellen chart from top to bottom and left to right.
- The examination should be repeated for the fellow eye.

Recording of visual acuity

Record the visual acuity for the examined eye. It is expressed as a fraction ($VA=d/D$), in that 'd' is the numerator indicates how far the patient is standing away from the chart (the distance between the patient and the chart) and 'D' is the denominator which indicates the distance of a normal eye can read that particular line. Normally, a person can read the line marked 6 and the visual acuity is expressed as 6/6. i.e. 6/18 – 6 is the distance (in metres) between the patient and the chart. 18 is the smallest line on the chart the person can read accurately read.

For an example, if a patient can only read the top letter, his visual acuity is recorded as 6/60. In fact, a normal person ought to have read the letter from a distance of 60 meters. When patient reads the second, third, fourth, fifth, sixth and seventh lines the visual acuity of the patient is recorded as 6/36, 6/24, 6/18, 6/12, 6/9 and 6/ 6, respectively. Incomplete lines can be added to the last complete line or deleted from the particular line. e.g. 6/12+3, indicating that the patient read the '12' line at 6 metres and three of the letters on the '9' line, Or 6/9 – 3.

Visual acuity in illiterate individual

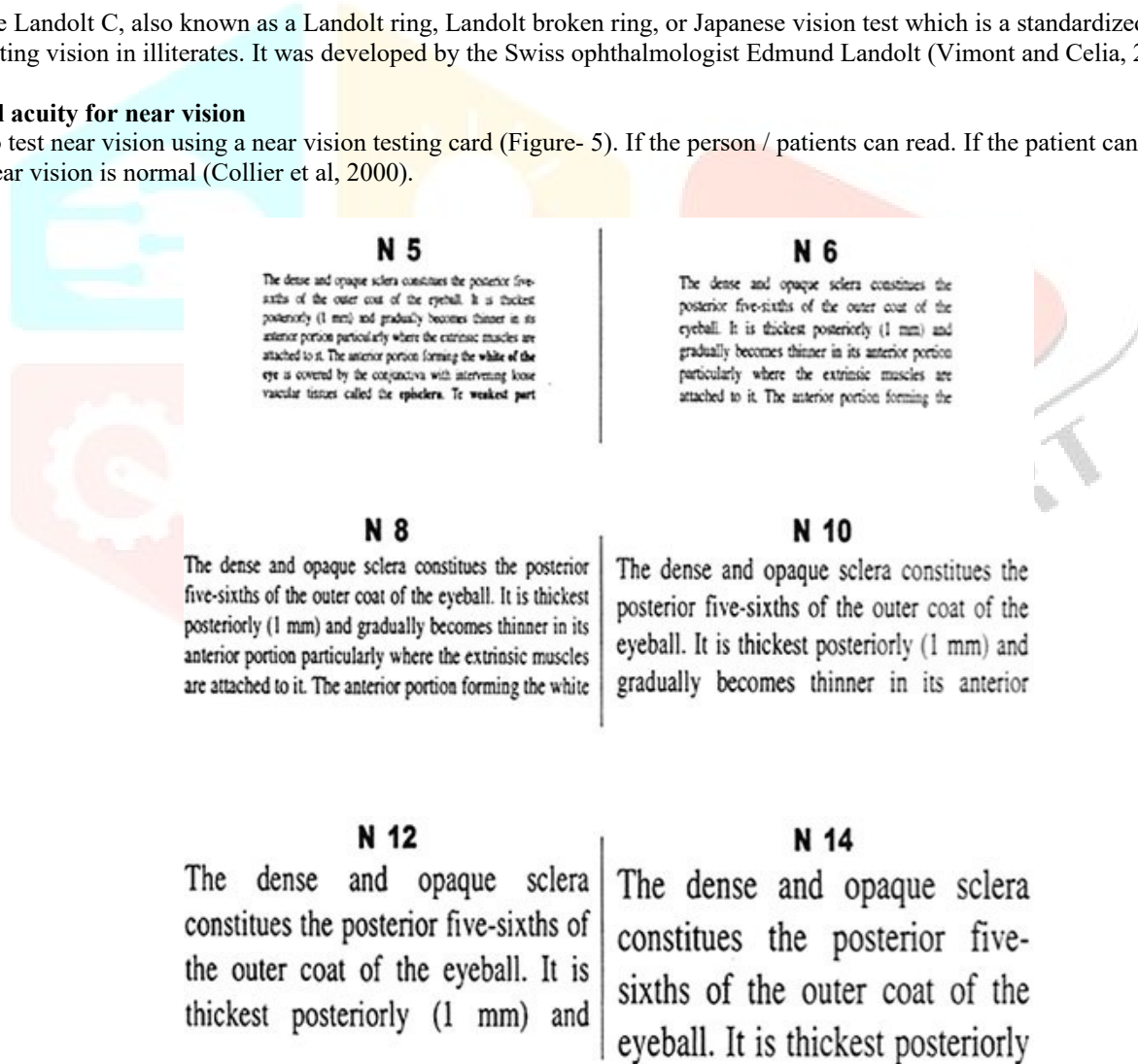
The testing of visual acuity in young children is a painstaking procedure postulate the use of pictures of different objects, circles, dots, letters and numerals. For children or adults who cannot read the letters, use a 'tumbling E' or 'C' chart to measure their visual acuity. Ask them to point in the direction that the 'legs' of the 'E' or the opening of the 'C' are facing. There is one in four chance that the patient can guess the direction; the patient should therefore correctly indicate the orientation of most letters of the same size, e.g., three out of four (Marsden et al, 2019).

Usually, 'E' test-types or Landolt's broken rings are to be used in the ophthalmic centers and/ or by optometrist to check the visual acuity of illiterate persons.

The Landolt C, also known as a Landolt ring, Landolt broken ring, or Japanese vision test which is a standardized symbol used for testing vision in illiterates. It was developed by the Swiss ophthalmologist Edmund Landolt (Vimont and Celia, 2020).

Visual acuity for near vision

To test near vision using a near vision testing card (Figure- 5). If the person / patients can read. If the patient can read N5 at 30 cm, near vision is normal (Collier et al, 2000).



(Figure- 5)

V. IMPORTANCE OF VISUAL ACUITY

Visual acuity is the most commonly used and universally understood measure of visual function. It is important to measure visual acuity because it provides a simultaneous measurement of central corneal clarity, central lens clarity, central macular function, and optic nerve conduction (Chambers, 2021).

There are a number of excellent reasons for determining the central visual acuity in each eye when performing any ocular examination (Levenson and Kozarsky, 1990).

- i Biologically the central visual acuity is the "vital sign" of ocular function. When the visual acuity is 6/6 or 20/20, a great deal of info is obtained as the eye is refracted properly, clear the ocular media, proper function of the foveal region of the retina and generally intact the optic nerve and visual cortex. Taken together with confrontation visual field testing and pupillary function, the measured level of visual acuity can be used to support or question a patient's complaint of decreased visual acuity. The determination with a bright light of no light perception is highly significant and even in the acute setting usually denotes total, irreversible visual loss.
- ii Functionally the visual acuity worse than 6/12 is frequently associated with difficulty in reading small print. If the visual acuity of 6/12 to 6/18 or better in at least one eye is generally required for driving an automobile. Visual acuity of 6/60 or worse in the better seeing eye is a frequently used parameter in determining legal blindness. When the ability to count fingers is lost, the patient is no longer able to walk efficiently and safely.
- iii Legally in examining a patient for any ocular complaint, especially in an emergency setting, testing and recording the visual acuity before any ophthalmic examination or treatment are imperative. Visual acuity recorded in this setting can prevent future ambiguity regarding the time and cause of visual loss.

Visual acuity tests have proven to be useful for assessment of refractive error, screening for ocular health, following the course of eye disease, evaluating the effectiveness of medical and surgical treatment, prescribing aids for the visually impaired, and setting vision standards for employment and driving (Rubin, 2013).

VI. DISORDERS OF VISUAL ACUITY

The key mechanisms of central visual loss are twofold as (Levenson and Kozarsky, 1990):

- i the optical properties of the eye changed to cause failure or distortion of light on its path to the retina and
- ii the retina is unhealthy or the neural pathways or cortical reception is abnormal.

A number of factors such as the size of the pupil, degree of myopia and the type of cataract often affect the visual acuity of the patient.

Normally, the lens absorbs the near ultraviolet light which is transmitted by the cornea. Occasionally, aphakic (absence of lens) patients develop the sensation of transient red vision following exposure to the ultraviolet light is known as erythropsia wherein objects appear red, but visual acuity is seldom affected (Nema and Nema, 2008).

Higher degrees of astigmatism often cause poor visual acuity, which does not improve in cases of irregular astigmatism with spectacle correction. If corneal scars left after healing of ulcers and they cover the pupillary area, visual acuity is grossly impaired (Nema and Nema, 2008).

Meesmann dystrophy is a rare autosomal dominant epithelial dystrophy which manifests early in life with mild irritation and decrease in visual acuity. VA is grossly reduced to hand movements or light perception in mature cataract. Recurrent uveitis reduces the visual acuity significantly. A person having a visual acuity of less than 3/60 or 10/200 with correcting glasses in the better eye in day light is defined as blind (Nema and Nema, 2008).

VII. HOW TO IMPROVE VISUAL ACUITY?

There are things to follow naturally to boost the eye health and potentially enhance the vision and visual acuity;

- i Eat well balanced healthy diet with rich in antioxidants and vitamin A. Leafy vegetables, carrots, and fish can aid in maintaining eye health. A nutritious dishes can help to enhance vision and slow down age-related visual impairment or loss.
- ii When an individual get overtired, the eyes can be more easily strained. Hence, he/she feels gritty and dry eye. Healthy amounts of sleep, which depend on an individual's age, working hours etc. can decrease tired eyes and therefore improve vision.
- iii Regular physical exercise can enhance the circulation of the blood and oxygen flow to the eyes. This can help to decrease eye strain and dry eyes.
- iv Wearing sunglasses help to protect the eyes from exposed to ultraviolet rays of sunlight, which are harmful rays diminish the eyesight with prolonged exposure.
- v Wearing eye protectors like goggles, sunglasses, eye shield, wide brim hat etc. could potentially safe the eye from eye injuries. The American Optometric Association (AOA) publishes that the most common visual issues for young adults (people between the ages of 19 and 40) are related to injuries and stress on the eyes (<https://www.nvisioncenters.com>).
- vi Follow the 20-20-20 rules. When an individual spends more time looking at a screen of television, computer or smartphone, better to take a break at every 20 minutes and look 20 feet away from the screen for 20 seconds at a time. This can help to prevent digital eye strain or computer eye syndrome, which can cause eye fatigue, headaches, neck tension, and decreased vision.

- vii The National Eye Institute (NEI) publishes that the regular eye examination is the best way to ensure the eyes are in the best health. It can help to catch potential issues right away, aid in maintaining eye and vision health (<https://www.nvisioncenters.com>).
- viii Smoking and alcohol can increase the risk for many physical health issues, including optic nerve damage, macular degeneration related to age and cataract all of which can negatively impact vision.
- ix Practice good hygiene like wash hands thoroughly before touch the eyes and face. Avoid cosmetics and chemicals. If wear contact lens, use as per the direction of ophthalmologist, clean the lens and store them properly.

REFERENCES

- 1 Levenson JH, Kozarsky A. 1990. Clinical Methods: The History, Physical, and Laboratory Examinations. Chapter 115- Visual Acuity. 3rd edition. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK219/>
- 1 Collier J.A.B, Longmore J.M and Brown T.J.D. 2000. Oxford handbook of clinical specialties. 5th ed.: 476.
- 2 Sadun AA, Wang MY. 2011. Handbook of Clinical Neurology. Chapter 5- Abnormalities of the optic disc. Vol. 102:117-157.
- 3 World report on vision. World Health Organization. 2019:3,10.
- 4 Nema HV, Nema N. 2008. Textbook of Ophthalmology. 5th Ed. P 32, 75, 76, 80, 114, 167, 260, 267, 268, 490, 496.
- 5 https://en.wikipedia.org/wiki/Visual_acuity (14.06.2021)
- 6 Baldwin A, Hjelde N, Goumalatsou C, Myers G. 2016. Oxford Handbook of Clinical Specialties. 10th Ed. P 514
- 7 Marsden J, Stevens and Ebri A. 2019. How to measure distance visual acuity. Comm Eye Health Journal. Vol. 32 (107): 46. Published online 17 December 2019.
- 8 Vimont, Celia. 2020. "All About the Eye Chart". American Academy of Ophthalmology. American Academy of Ophthalmology.
- 9 Chambers WA. 2021. Drug-Induced Ocular Side Effects (Eighth Edition). Chapter 3-Methods for Evaluating Drug-Induced Visual Side Effects. P 13-18.
- 10 Rubin GS. 2013. Retina (Fifth Edition). Chapter 11-Visual Acuity and Contrast Sensitivity. Vol. 1:300-306.
- 11 <https://www.nvisioncenters.com/improve-eyesight/> (13.06.2021)

