CAUSES vs. CONSEQUENCES of Functional Loss
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The Problem
An issue that is often overlooked when developing scales or rating systems to measure and report functional losses, is that there are significant differences between methods that aim at clarifying the underlying CAUSES and methods that aim at predicting or measuring the resulting CONSEQUENCES.

Identifying underlying causes is the goal of most medical tests. Identifying the possible consequences is important for vocational tests and for rehabilitation. These differences may mean that similar tests should be administered and/or interpreted differently for different purposes.

This issue exists for all organ functions. This note will discuss it for vision in particular.

Color Vision
The Ishihara color plates are well known. They are exquisitely sensitive at detecting very slight (mostly hereditary) red-green problems. Thus, they are a good test to explore genetic patterns.

However, they are so sensitive that they will detect deficiencies that will never cause problems in everyday life. Furthermore, they are specifically tuned to the red-green part of the spectrum. Viewing them under a tinted light source or through tinted lenses or contact lenses will invalidate the test.

The Farnsworth D-15 test was designed for vocational applications. It is less sensitive and will miss minor deficiencies that are unlikely to cause vocational problems. Since it tests around the spectrum it cannot be defeated by colored lenses; such lenses will merely shift the area of deficiency. Thus, it is the preferred test for vocational applications.

Visual Acuity
Visual acuity is the visual function that is measured most often. So often, that a common misconception has taken hold that visual acuity is a general indicator of the overall quality of vision. This is not true.

Visual acuity is usually measured by comparing the smallest letter chart character that can be recognized by a subject to the smallest character that can be recognized by a “standard observer”. This is the Magnification Requirement (MAR). If the subject needs letters that are twice as big, MAR = 2x and VA = 1/2. If MAR = 5x, VA = 1/5, etc. Thus, visual acuity values reflect only one aspect of vision: the magnification requirement.
Visual acuity is an excellent screening test, since the letter chart test is simple and cheap, and since most visual disorders (but not all) affect visual acuity.

For the same reason, visual acuity is not a good diagnostic test. To pinpoint the cause of a visual acuity loss, additional tests are needed.

Visual acuity also predicts performance of detail-oriented tasks, such as reading. While for screening the actual visual acuity value is not very important (20/50, 20/100 and 20/200 all indicate that something is wrong), it is very important for rehabilitation. A person with 20/100 visual acuity needs twice as much magnification as one with 20/50; a person with 20/200 needs twice as much again.

Statistics

Public health statistics may be used to estimate the incidence of eye disease. Up to the 1960’s (ICD-8) the WHO recognized only two conditions: sighted or blind. In the 1970’s it was recognized that vision loss is not a black-and-white condition, so ICD-9 added a category for “low vision”. Later, increasing attention was asked for the burden of vision loss. A WHO consultation in 2003 resulted in recommendations, which were implemented in the interim revision of ICD-10 (2010). These changes impact the way visual acuity must be measured and reported for health statistics.

If the goal is the detection of EYE disease, the measurements should be made and reported for each eye separately. Since refractive error is not considered an eye disease, the classification is based on best-corrected vision. The condition of the person is generally considered to be reflected by the condition of the better eye.

If the goal is to reflect the burden of vision loss for the PERSON, the measurements should be made with both eyes open and with the presenting correction, since this reflects how people go through life. This methodology will include visual impairment resulting from uncorrected or under-corrected refractive error.

The statistical consequences from this shift are quite significant, since the new methodology increases the world-wide incidence of visual impairment from around 150 million to about 300 million.

Since both points of view are valid, it is proposed that ICD-11 will contain two sets of codes. One will describe the condition of the person (presenting acuity, both eyes open); the other will describe the condition of the eye (best-corrected, each eye separately).

Disability and Worker’s Compensation

The Functional Vision Score (FVS) system provides a method to derive a single number reflecting vision loss, based primarily on visual acuity loss and visual field loss. This method is implemented in the AMA Guides to the Evaluation of Permanent Impairment (5th and 6th ed., 2001, 2007).
It assigns 60% of the weight to vision with both eyes open and 20% to each eye separately. This single number approach, combining visual acuity and visual field, is justified, since the outcome is also a single number for monetary compensation. To treat all persons with similar losses similarly, the FVS estimates are based on statistical averages, which hide individual variations.

**Eligibility for Privileges**

Driving and other privileges must be assigned on an individual basis. This means that they cannot be based solely on statistical averages. Drivers’ license and other criteria may use statistical averages for screening, but must leave room for individual adjustments, based on individual evaluation of each applicant.

**Rehabilitation**

Vision rehabilitation plans must also be designed individually. Visual acuity loss and visual field loss cause different problems and ask for different remediation. Additional factors relating to vision as well as to motivation and environment need to be considered.

Therefore, the single number approach of the FVS is not applicable for rehabilitation; rather the prioritization of interventions and training must be based on an ability profile that considers a variety of skills and abilities.

**Outcome Studies**

Various studies of medical interventions have generally used visual acuity as an outcome measure. However, it may be necessary to look at other visual parameters as well and to also consider various patient related parameters. The NEI designed the NEI-VFQ for this purpose.

The general assumptions about the importance of binocular vs. monocular vision, of visual acuity vs. visual field and about central vs. peripheral vision, as used in the FVS model, may not apply to specific disorders and interventions.

**Visual Field**

Similar considerations apply for visual field measurements. To consider the condition of the person, the FVS system again assigns 60% of the weight to the binocular field. To follow the condition of a specific eye condition, the eyes obviously have to be considered separately.

To estimate the general ability/disability of the person, the FVS system assigns 50% of the weight to the central field (up to 10 degrees), because this part of the field is important for reading and because it corresponds to 50% of the primary visual cortex. The other 50% are assigned to the peripheral field (beyond 10 degrees), which is important for mobility.
However, this division would not be appropriate if the goal is to follow specific conditions, such as the progression of mid-peripheral scotomata in RP.

The FVS system assigns 60% to the lower field and 40% to the upper field, to reflect the relative importance of the lower half-field, both for reading and for mobility (there are more potholes than overhanging branches).

This division would not be appropriate if the goal is to follow the progression of a lesion in a specific retinal area.

**Testing Methodology**

To estimate the consequences of visual field loss for the person, it is important to test both the central and the peripheral field. In clinical practice, however, the concern is with the causes of visual field loss; here it is generally considered to be sufficient to test just the central 24 or 30 degrees, since this is where the vast majority of the retinal ganglion cells are. This means that if only clinical fields are available, it is not possible to rate the condition of the person, since the untested peripheral field could be entirely normal, entirely absent, or anything in between.

Another problem exists in the choice of stimulus. The FVS system is based on a fairly strong stimulus (Goldmann III4e, Humphrey 10 dB) with which a single isopter is plotted. Common automated perimetry is based on plotting the threshold in all parts of the visual field.

To estimate the mobility problems a person may experience, a quick confrontation field may be quite adequate, since the function of the peripheral field is mainly to detect large peripheral stimuli and then to direct central fixation to that area. To judge disease progress, however, a confrontation field is useless. Conversely, the grayscale plots of automated perimetry are good for clinical use, but harder to interpret with regard to their ADL consequences.

Automated perimetry is often reported in terms of mean deviation or pattern deviation. These measures are referenced to age-related controls. This is helpful for clinical use, but not for disability estimates. Consider a 20 year-old and an 80 year-old who have the same visual field. They should have the same ability estimate with regard to the performance of activities of daily living. It does not make sense to rate the 80 year-old less disabled, because the average 80 year-old has lost more vision already.

I have never seen evidence that the sensitivity loss in the central field is a good measure of ADL ability and that ignoring the field outside 30 degrees is justified for disability evaluation.

**Application to the ICD**

All of these concerns make it difficult to devise a single visual field rating that will satisfy all users. The ratings in the ICD will necessarily need to be a compromise between the needs of the WHO for reliable public health statistics that are often gathered under difficult circumstances, and the needs of specialized ophthalmologists, working in advanced countries with advanced equipment.
WHO statistics should reflect the consequences of visual field loss and relate to the general concept of the BURDEN of vision loss in the population.

Individual clinicians, delivering individual eye care, are primarily interested in the causes of visual field loss in the individual.

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