

COLOR VISION DEFICIENCY (CVD) IN THE MEDICAL AND ALLIED OCCUPATIONS

Liaqat Ali

Department of Anatomy, University Medical & Dental College, Faisalabad.

ABSTRACT

Color is very important sign used in medical profession, but there have been few studies with reference to effects/problems of a color vision deficiency on medical skills of the persons involved in medical profession. Literature review indicates CVD in 8% cases congenitally. Insufficient data is available in acquired cases. Because of certain features of their work, medical and dental students, laboratory technologists, dentists, general practitioners and specialists may have special problems. Therefore, there should be very effective screening for CVD at every level of medical profession. It would at one hand test for severity of the condition and on the other hand help choice of career.

Keywords: Congenital and acquired color vision deficiency, prevalence, screening, counseling.

INTRODUCTION

Color is often used as an important sign in practicing medicine; as many descriptive and diagnostic terms in common use indicate its value when used in this way. For example, jaundice, cyanosis, erythema and malena are important signs in practice of medicine. It is also used in histology, histopathology, biochemistry, color doppler studies, and coding for many new technologies. But there have been few enquiries into the effects of a color deficiency on doctor's medical skills and the efficiency and competency of persons involved in allied occupations.

Congenital CVD has a prevalence in the general population of 8% for men and 0.4% for women; therefore, its prevalence in medical profession is likely to be high if there is no wide spread self-selection out of the profession as a result of it. More people will have suffered from the acquired forms, but the prevalence is not known.¹

Corresponding Author:
Dr. Liaqat Ali, Professor of Anatomy,
University Medical & Dental College, Faisalabad.
Email: drliaqatali@yahoo.com

Prevocational screening for CVD and further testing for severity are practiced for a number of occupations where certain standard of color vision are required, but, as far as is known,

medical students are screened at only one university of united kingdom^{5,6} and at a few in the rest of words.¹

This article gives background information on CVD, and then reviews the literature on the prevalence of the deficiencies of CV in the medical profession and allied occupations and the effects on medical skills, and the competency and efficiency of persons/experts involved in allied occupations.

MATERIALS AND METHODS

Studies to be reviewed were identified from three sources. First, from reference lists of the articles; secondly, MEDLINE and BIDS ISI, from 1996 to August 1997, thirdly, from personal recommendations.

RESULTS

Back ground information:

The first known scientific paper on CVD was written by John Dalton, who himself was color blind. So CVD is also called 'Daltonism', after John Dalton.²

Wide spread interest in CVD followed John Dalton's description¹⁵ (1798) of his own deutan (middle wave) deficiency¹⁶, but, for the preceeding centuries, the deficiency has been described as an immensely well kept secrete.¹⁷

Modern concept of color vision:

Many doctors may be unfamiliar with some modern concepts of color vision; however, excellent reviews are to be found.⁸⁻¹¹ Salient features are that normal vision is trichromatic, meaning that all spectral hues can be matched by additive mixtures of three primary hues taken from the red, green, and blue parts of the spectrum. The primary hues are detected by three types of cone cells containing pigments with photosensitive that overlap but peak in the green (long wavelength), yellow-green (middle wave length), and violet (short wave length) parts of the spectrum. By comparing the rates of absorption of photons, the visual system is able to discriminate colors. It is variation of hues, saturation and brightness that lead to an estimate that the human eye is able to distinguish, at equal luminance, 17000 perceptible differences in color¹² context, for example, adjoining colors, expectation¹³, and memory¹⁴ are among factors that influence the color actually perceived.

CVD:

Color blind people are not actually blind, but are color deficient, so, more appropriate term to be used for color blindness is color vision deficiency (CVD).² CVD is a condition characterized by disturbances of color perception that occur if the amount of visual pigment per cone is reduced, or if one or more of the three cone systems are absent.³

Types:

There are 4 main types of CVD. The four types of deficiency are protan (red or long wave), deutan (green or middle wave), tritan (blue or short wave), and achromatopsia (total absence of color vision, very rare disorder).

Causes:

Congenital CVD, present since birth, has a prevalence in general population of 8% for men and 0.4% for women.¹

The acquired deficiencies are caused by ocular and intracranial pathologies¹. Many drugs¹⁸, diabetic retinopathy, hypertension, glaucoma, macular degeneration, yellowing of the lens¹⁹ owing to ageing are common causes. Tritan deficiencies are the most common. The prevalence of acquired deficiencies are not

known but are probably greater than the congenital form, particularly in older people.²⁰

Inheritance:

Red-green perceptive disorders are X-linked²¹ recessive, but blue color perceptive disturbance is caused by a simple mutation in gene coding for blue receptor on chromosome 7, and is autosomal dominant.⁴

Testing and screening:

There are screening, classifying and vocational tests for CVD. These are; Ishihara test¹¹, Farns worth Munsell 100-line²⁹, Modified F2³⁰, computer graphic tests³¹, city university plates and Farns worth, Munsell 100-hue³², American optical companu charts³⁴, Dvorine³⁵, and SPP-C-part one.³⁶ Among these, Ishihara is most commonly used screening test but does not measure the severity. Computer graphic tests are under development and not widely used. Others are different grading tests for those identified by Ishihara tests. There is now a trend away from routine universal screening towards selective checks.

Prevalence of CVD in the medical profession and allied occupations in different studies:

Technicians:	
Ceramic technicians	7.9% of 88 exams ³³
Medical laboratory technician/officers	9.4% of 138
Medical technologists	2.4% of 633
Students:	
Medical students	12.8 % of 79 ³³
Histology students	8.7% of 320
Dental students	7.8 % of 635
Doctors:	
Endoscopist	10.8% of 139 ³⁰
Histopathologists	11.4 % of 132 ³²
Gastroentorologists	11% of 180 ³⁰

In a study of 40⁴² (38 men and 2 women) doctors with congenital CVD, of whom 38 were GPs, reported a wide range of difficulties.

CVD as disability:

Doctors with CVD have published accounts of their experiences in medical practice. Physicians³⁸, GPs³⁹, neurologists⁴⁰ and other specialists reported a wide range of difficulties and many were common to all. Blushing, pallor, faint rashes, cyanosis, erythema, blood in body products, ophthalmoscopy, otoscopy,

and microscopy could all cause difficulties in observation.

In a study⁴², the doctors reported a wide range of difficulties. The most common were:

- The wide spread body color changes of pallor, cyanosis, jaundice, and cherry red (25 doctors);
- Rashes and erythema of skin (25 doctors);
- Charts, slides, prints and codes (24 doctors);
- Tests strips for blood and urine (22 doctors);
- Ophthalmoscopy (18 doctors);
- Blood or bile in urine, faeces, sputum or vomit (18 doctors); and
- Otoscopy (14 doctors)

Tocantins *et al.*²⁷, reported the difficulties faced by junior medical students with CVD in chemistry and microscopy. These students made many incorrect matches compared with normal controls. Olson²⁸ observed similar findings by histology students with CVD.

Poole *et al.*³² studied the skills of histopathologists and medical laboratory scientific officers with CVD. Both groups with CVD were significantly poorer at identifying slides than normal sighted people, and also there was a significant trend towards those with severe deficiency making more mistakes ($P < 0.001$).

Doctors' awareness of their CVD:

Spalding³ reported that, of 40 doctors known to have CVD, 19 of these did not know this. Rigby *et al.*²⁹ reported similar unawareness among the histopathologists with CVD.

DISCUSSION

The evidence presented here suggests that the prevalence of congenital CVD in medical profession and allied occupations is about the same as for the population at large. The evidence^{7,43} also suggests that many of these persons (Doctors/Technicians etc) will not know of its severity in their own case and few will not know that they have any deficiency at all.

Published studies have shown that, in some common medical procedures, individuals with CVD perform less well than those with normal color vision. Persons (medical students, technicians) working in laboratories²⁷ have been shown to perform less well with certain colorimetric tests and in microscopy. Histopathologist's³² performance in examining slides has been markedly affected.

In the direct observations for physical signs in patients, there have been a number of accounts by doctors with CVD.^{7,26,27,37,41} The observations that are reported to cause difficulties, for example pallor, erythema, cyanosis, and body products, comprise the range of colors that are known to cause failures of discrimination for those with CVD.

CVD becomes very important in cases, where there is so-called pivoted observation^{44,45}, a single sign that is essential to observe for the correct course of action to be taken.

The detection of small features, for example, bacilli or a rash^{22,23}; and there are conditions of work, for example, at speed²⁴, alone, in poor illumination²⁵ when visiting, and the patient who cannot give a history; most of these features are particularly likely to affect the outcome.

The evidence for action in the medical profession and allied occupation, such as the prevocational screening of all individuals/candidates for CVD, derives from many sources that need different types of assessment. The finding that doctors and other associate professionals commonly do not know the severity of their deficiency is, for example, very significant⁷, and what can hardly be doubted is that professionals (doctors and associated professionals) who are aware of their limitations are more likely to make corrections.

CONCLUSION

The above facts point to the need for:

- Screening for CVD in medical, dental, and allied discipline students, and medical laboratory technologists and doctors. This would allow testing for severity, counseling, and an informed choice of career.
- Screening of occupational health physicians and teachers and examiners in medicine.
- A more detailed examination of effects of CVD on decision-making in general practice, and also in a number of specialities; for example, ophthalmology, ENT, paediatrics, gastroenterology and pathology.

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