



# Blind to the risk: an analysis into the guidance offered to doctors and medical students with colour vision deficiency

Nicolas J. Raynor<sup>1</sup> · Gemma Hallam<sup>2</sup> · Niamh K. Hynes<sup>3</sup> · Brett T. Molloy<sup>4</sup>

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## Abstract

**Background/Objectives** Doctors and medical students with colour vision deficiency (CVD) are less capable and less confident at identifying colour in a wide range of clinical scenarios, some of which could be potentially life-threatening. There have been numerous calls for screening and counselling over the last 25 years.

**Subjects/Methods** Surveys were sent to all 33 UK medical schools and 154 acute trusts, to ascertain what screening and support exists for doctors with CVD. The response rate was 95%.

**Results** 1.4% of acute trusts and 16.7% of medical schools screen for CVD. 3.4% of trusts and 10.0% of medical schools had CVD-specific advice which they give to medical professionals. Guidance and advice given varied widely between different schools and trusts.

**Discussions** Despite research showing a clear problem and lack of support for doctors with CVD, there has been a failure to respond by the medical profession. Screening, national guidance, counselling, and further research is needed to provide full support for practitioners with CVD and ensure patient safety.

## Introduction

Colour vision deficiency (CVD), known colloquially as ‘colour blindness’, is a condition which affects up to 8% of males and 0.5% of females [1, 2], and the prevalence is thought to be similar amongst doctors [3]. CVD is a blanket term for different types and severity of CVD, meaning the problems encountered by people with CVD is varied. The effects on clinical practice have been well documented over the last 25 years. Medical students and clinicians have reported problems with a wide array of clinical skills and situations, which can be found in Table 1 [2–11].

Interpretation of colour can be important in medicine, and a misinterpretation by a clinician could potentially be

life threatening. One example of this is the pH testing of aspirate following naso-gastric tube insertion. Over a 2-year period, 11 patients died and one has to face serious harm following incorrectly placed feeding tubes being used [12]. As a result, NHS England state that it is a ‘never event’ to feed down a misplaced naso- or oro-gastric tube [13]. They advise staff to check the position of the tube by ‘*measuring the pH of aspirate using pH indicator strips/paper*’, and that radiology ‘*should not be used routinely*’ [12]. However, this relies on the correct interpretation of colour by the clinician inserting the tube, clearly a potential problem for some people with CVD, especially if undiagnosed.

Clinicians with CVD have performed significantly worse than colleagues with normal colour vision in objective tests of identifying clinical signs based on colour [6–8, 10, 11]. The type of mistakes varied, but identifying blood in stool and vomit [6], as well as the strip testing, such as urine or glucose [9], and identification of rashes [7], were the most common misinterpretations. Not only were doctors with CVD less likely to identify the clinical finding correctly, they were also significantly less confident with their answer [10].

A paper from 2010 by Spalding et al. stated that medical schools were not offering advice or screening [5] and in a separate paper, the same author stated that there is a failure

✉ Nicolas J. Raynor  
nick.raynor@doctors.org.uk

<sup>1</sup> Accident and Emergency, The Mid Yorkshire Hospitals NHS Trust, Wakefield WF1 4DG, UK

<sup>2</sup> Leeds Teaching Hospitals NHS Trust, Leeds LS9 7TF, UK

<sup>3</sup> University of Sheffield, Sheffield S10 2TN, UK

<sup>4</sup> Bradford Teaching Hospitals NHS Foundation Trust, Bradford BD9 6RJ, UK

**Table 1** Summary of potential clinical features/tests doctors or students with CVD may have difficulty with

Type of problem	Examples
Body colour changes	Jaundice, cyanosis, pallor
Skin rashes	Urticaria, erythema nodosum, rubella
Blood in bodily fluids	Haematemesis vs. bile, haemoptysis, melaena
Mouth and throat conditions	Pharyngitis, koplik spots
Ophthalmoscopy	Disc pallor, papilloedema, haemorrhages vs pigment
Otoscopy	Otitis media, wax vs. blood
Testing strips	Urine, glucose, gastric aspirates
Microscopy stains	Ziehl-Neelsen, Haematoxylin and eosin staining
Equipment	Charts, blood bottles

in the medical world to acknowledge the problem or put education in place [3, 14]. This paper aims to examine and quantify whether or not screening or guidance is in place at medical school or within occupational health departments, and furthermore, to look at what advice is given.

## Methodology

Primary data collection was done throughout 2016 via survey, sent out via email. All 33 UK medical schools, 137 acute non-specialist trusts and 17 acute specialist trusts within NHS England were invited to take part. Mental health trusts, ambulance trusts, community providers, CCGs and GP practices were not included. The survey consisted a mix of closed questions and open questions with a 'blank space' to provide details. Initial non-respondents were then sent the survey again, with the information requested via the Freedom of Information Act. We had one respondent from each institution and they were mainly from administrative staff responding to freedom of information requests, however occupational health staff replied to some of the enquiries to NHS trusts.

Quantitative data was analysed as simple percentages, focusing on the number of medical schools or trusts who performed certain actions. In terms of the 'blank space' questions, thematic content analysis, also known as framework approach was used. Trusts were randomised and allocated a number. All the answers were read through by a single researcher, to become familiar with the data and generate initial codes. The codes were then combined to find emerging themes from the answers. Once interpreted, the answers were reviewed to ensure themes and results were an accurate representation of the survey answers.

There was no patient involvement in this study.

Regarding ethics, discussions were held with the NHS Health Research Authority, who advised that the scope of this paper would come under 'service evaluation', and therefore did not need formal NHS Research Ethics Committee approval.

## Results

147 out of 154 acute trusts replied, and 30 out of 33 medical schools responded, giving response rates of 96% and 91%, respectively. The total response rate was therefore 95%.

### Acute trusts

Two of 147 acute trusts (1.4%) routinely screen for CVD. Four trusts (2.7%) have a specific policy for what to do if a doctor declares a colour vision deficiency or if a deficiency is picked up in screening. A further four trusts said that they had a policy or procedure for doctors with CVD, but that this was encompassed in a broader policy, such as health and safety, disability, or vision screening (Table 2).

Three trusts had collected data on how many doctors they employed with CVD (who all reported they had none). None of these trusts screened for CVD. One respondent commented that they had "not had a referral about this matter in the nine and a half years I have worked in occupational health".

Open questions focused on reviewing what type of advice was given out, and what trusts would typically do if a doctor declared a CVD. Practice varied quite significantly, and as pointed out by one trust, "Our occupational physician has confirmed that he would not expect the Trust to have a policy for doctors as there is no national guidance." The vast majority of trusts, when asked about what action would be taken if a doctor declared a CVD, spoke of "individual risk assessments", or making "reasonable adjustments" but there was a lack of themes regarding specific interventions for CVD. Seven trusts (4.8%) stated that they would take no action if CVD was declared, one commenting that they were "unsure what we would do if a doctor declared colour vision deficiency."

A breakdown of the major strategies/advice used by trusts can be found in Table 3.

Some trusts placed the onus onto others. Some spoke of it being the doctors responsibility to declare, stating "Good Medical practice a doctor who has a condition that they feel

**Table 2** Closed questions to medical schools regarding screening and guidance for CVD

“Does your medical school routinely screen all students for colour vision deficiency?”	Yes: 16.7% ( <i>n</i> = 5) No: 83.3% ( <i>n</i> = 30)
“Are any adaptations routinely made to examinations for students with colour vision deficiency?”	Yes: 50.0% ( <i>n</i> = 15) No: 50.0% ( <i>n</i> = 15)
“Does your medical school offer formal guidance for medical students with colour vision deficiency?”	Yes, specific CVD advice: 10.0% ( <i>n</i> = 3) Yes, but contained in broader policy: 33.3% ( <i>n</i> = 10) No: 56.7% ( <i>n</i> = 17)

**Table 3** Examples of CVD-specific advice offered by trusts

Theme	Frequency of NHS trusts ( <i>n</i> = 147)
Would make ‘reasonable adjustments to working environment for doctor with CVD	21.8% ( <i>n</i> = 32)
Would perform individual risk assessments on doctors who declare CVD	25.2% ( <i>n</i> = 37)
Would refer doctor to occupational health for assessment if declared CVD	27.2% ( <i>n</i> = 40)
Would provide ‘career specific advice’	8.8% ( <i>n</i> = 13)
Would refer doctors who declare CVD to ophthalmology	2.7% ( <i>n</i> = 4)
Would review impact on CVD on specific job	10.2% ( <i>n</i> = 15)
Provides guidance in the form of face to face interviews	2.0% ( <i>n</i> = 3)
Provides written guidance	0.7% ( <i>n</i> = 1)

**Table 4** Closed questions to acute trusts regarding screening and guidance for CVD

“Does your trust routinely screen for colour vision deficiency?”	Yes: 1.4% ( <i>n</i> = 2) No: 98.6% ( <i>n</i> = 145)
How many doctors currently employed by your trust have declared a colour vision deficiency?”	Zero: 2.7% ( <i>n</i> = 4) Data not collected or available: 92.5% ( <i>n</i> = 136) Data collected, but unable to give out: 1.4% ( <i>n</i> = 2)
“Does your trust offer formal guidance for doctors with colour vision deficiency?”	Yes, specific CVD advice: 3.4% ( <i>n</i> = 5) Yes, but contained in broader policy: 3.4% ( <i>n</i> = 5) No: 93.2% ( <i>n</i> = 137)

may impact on their judgement or performance is required to seek advice about any changes to their practice”, whilst another trust “...expected that any CVD would be picked up during training and/or by medical school.”

## Medical schools

Five of the 30 medical schools who replied, conducted screening for CVD (16.7%), although two of these did not collect data on how many students were affected. Fifteen medical schools (50.0%) made adaptations to examinations for students with CVD, but the adaptations that were made varied significantly, for a further breakdown of medical school responses see Table 4.

In response to open questioning about how adaptations are made to examinations, many schools allowed students to ask examiners in practical exams to confirm what colour something was, for example, in the interpretation of a urine dipstick. Others spoke about labelling colours in diagrams and written exams. Two of the schools spoke of allowing extra time in exams, with one saying that the student carries a card identifying them as having CVD, and that they ‘may take longer with colour related tasks’. In terms of broader support, many medical schools spoke of referring to the University disability service, occupational health, or an ophthalmologist. Table 5 provides a summary of the major themes and how many medical schools used these strategies.

**Table 5** Examples of exam adjustments made by medical schools

Theme	Frequency in medical schools ( $n = 30$ )
Makes individual adjustments to exams based on individual student needs	23.3% ( $n = 7$ )
Provides assistance and clarification of colours	30% ( $n = 9$ )
Additional time in examinations	10% ( $n = 3$ )
Use of colour overlays and other equipment in examinations	6.7% ( $n = 2$ )
Put students in contact with disability services when CVD declared	56.7% ( $n = 17$ )
Put students in contact with an occupational health physician	26.7% ( $n = 8$ )
Provide written guidance to students with CVD	10% ( $n = 3$ )
Hold face to face interviews to help provide guidance for students with CVD	10% ( $n = 3$ )

## Discussion

Previous research has clearly showed that doctors and medical students with CVD struggle with certain tasks, and that there is a general lack of awareness about the problem, or support for those with CVD [2, 3, 5, 14]. An incident categorised as a “never event” within the NHS relies entirely on one practitioner’s interpretation of colour. Many other critical diagnoses rely on adequate colour vision, and a failure to identify certain signs could prove life-threatening. Despite many years of evidence identifying the problem, and making recommendations for change, the findings from this research show a continued lack of awareness, support, and little consensus into how the problem should be managed.

Most people with CVD are aware of their deficiency during training [3]. They learn what they have difficulty seeing, and make adjustments as they go through their practice, to enable them to be safe practitioners. However, this may come as a response to real world clinical situations [6, 8], with clinicians reactively learning from mistakes, rather than being aware of specific difficulties before they encounter problems in practice. Even more dangerous would be the clinician with undiagnosed CVD. Some clinicians have only found out about their deficiency years after qualifying [3], and it is not unreasonable to suggest that there may still be those who never realise. In the UK, local education authority screening for CVD has been phased out, nor is it tested for as standard as part of an NHS eye examination [15]. As a result, <20% of children arriving into year 7 will have had a colour vision test [15]. 40% of children do not know they have CVD upon leaving school [16]. Whilst the

undiagnosed are more likely to have a mild deficiency, there is still the potential for harm. Even those that have a diagnosis of CVD, are often unaware of the extent of their deficiency [3, 6, 7]. There are also those practitioners with CVD who do not see it as a problem and believe they are working effectively [14], with little auditable data to prove this either way.

Apart from the responsibility of the individual clinician, the weight of responsibility falls onto medical schools and occupational health departments [17]. Medical schools seem vastly more aware of the problem when compared to hospital trusts, but 83.3% still do not screen for CVD. One school commented that “*it is now some years since we requested that the Medical School Council considered providing formal guidance to schools regarding this issue and we are aware that City University [who have an optometry department specialising in CVD] were willing to help. Disappointingly, though, there was no response*”. However, half of medical schools do offer adaptations to examinations. Practice varies significantly in how to adapt examinations, including more than one medical school giving extra time to students with CVD to do colour-related tasks. This shows a fundamental misunderstanding into how CVD affects practice, as no amount of extra time will allow someone with CVD to see a colour they cannot see [16]. Attempts to match examinations to real-life situations, where you can ask a colleague for assistance, seems sensible.

However, the downfall in the medical school approach is that it is very exam-centric. Advice and support for medical students with CVD is tailored to passing exams and graduating medical school, rather than life as a practicing doctor. There was very little mention of advice on which specialties are appropriate, or useful advice for clinical situations. This could mean students are graduating without a true appreciation of what they are going to struggle with when they start working on the wards. Research has shown that medical students with CVD feel generally unsupported, with 74% claiming it would be useful to have a full colour vision assessment so they knew their type of deficiency and severity [5].

Acute trusts showed a general lack of understanding that there was even an issue, with a negligible amount holding screening or offering advice and guidance of any real substance. An example of trusts not taking this issue seriously is Trust 123’s response (see Table 3), suggesting doctors “*use all their senses*” to compensate for abnormal colour vision, which shows a fundamental lack of understanding in how CVD works. This is likely a combination of lack of awareness and lack of doctors reporting the problem. Hospitals need to take as much responsibility as medical schools for screening and support. One trust commented that “*it would be expected*

that any colour vision deficiency would be picked up during training and/or by medical school”, however the latest figures show that 37% of doctors practicing in the UK gained their primary medical qualification outside of the UK [18]. Trusts are also likely to be the ones to deal with any negative consequences as a result of misdiagnosis by a doctor with CVD, giving them a vested interest into making sure their staff are properly screened and supported.

## Recommendations

The evidence is clear that there is a problem, yet still no solution. As a result, this paper proposes a number of recommendations.

### Counselling for prospective medical school applicants

Those applying to medical school with CVD should be counselled as to the possible impact it will have on their training and career to ensure they are making an informed decision to pursue a career in medicine. Prospective students should be informed that having CVD could affect their performance, and given advice in how/where to be tested.

### Screening and testing

Medical students should be screened within their first year of medical school. Many medical schools require students to visit local occupational health departments for work-related vaccine and testing could be implemented into this system. Anyone highlighted as potentially having CVD should then be offered formal testing for type of deficiency and severity. Their details should be stored on a database so that they can be supported throughout training, and also offered the opportunity to participate in research.

### Examinations

The medical school council should agree reasonable adjustments to be made to examinations because of CVD, after discussion with appropriate stakeholders. These should be equal across all UK medical schools to ensure no student is disadvantaged over another. With further research, these could be type and severity specific. Current adjustment procedures should be reviewed to provide an adjustment that would be most relevant in a clinical setting, for example giving students more time is neither appropriate nor clinically relevant.

## Integration of CVD status into occupational health record

In a similar fashion to how immunisation status is tracked and required when registering with a new occupational health department, proof of colour vision status should also be integrated into this. When a doctor is not up-to-date with immunisations, occupational health will arrange for this to be done. The same can be done for CVD screening. As like the medical schools, occupational health departments should hold records on which of their doctors has CVD, so that support and reasonable adjustments can be offered.

## National guidance

A working group of experts and key stakeholders is needed to form national guidelines for medical students and doctors with CVD. Guidance should focus on types of clinical scenarios that may be difficult for doctors with CVD, and advice on how to cope with these. With further research, higher quality, evidence-based, deficiency-specific advice can be given.

Separate guidance should be offered to medical schools and occupational health departments as to how to manage medical students and doctors with CVD, similar to advice that already exists for school teachers [15, 16].

## Further research

High-quality research is lacking due to a lack of participants to make findings statistically significant, especially around deficiency-specific problems. Screening may help identify potential participants. Deficiency-specific advice would be invaluable, e.g. knowing that those with deuteranopia always struggle with a certain task, whereas someone with tritanopia may not struggle with that task. This would help to tailor advice and support to an individual.

Research into whether technologies assist those with CVD is important as it will allow medical schools and trusts to make reasonable adjustments to support doctors. Examples include correctional glasses (e.g. EnChroma) or otoscopes/ophthalmoscopes that plug into smart phones, allowing for capture of images and easy second opinions from colleagues.

## Summary of recommendations

1. Pre-application counselling for prospective medical school applicants.
2. Screening of all medical students at an early stage.
3. Formal testing of type and severity in those with CVD, followed by counselling.

4. Medical school consensus into adaptations made to examinations.
5. Integration of CVD screening/certification of colour vision status into occupational health screening.
6. National consensus guidelines for medical students and doctors with CVD on the types of problems they may encounter, coping strategies, and specialty guidance.
7. Urgent, high-quality research into which type and severity of CVD will struggle with which problems, valid coping strategies, and an integration of this into national guidelines.
8. Research into the use of technology into assisting those with CVD.

## Conclusion

Abnormal colour vision is a prevalent, yet largely unrecognised, problem in medicine. Doctors and medical students with CVD are generally left to develop their own coping mechanisms, with little support. Due to a reduction in routine screening of school children, numbers of undiagnosed doctors with CVD could be rising. Failure to address the problem and support doctors with CVD could lead to negative outcomes for patients. Research recommending screening and counselling over the last 25 years has failed to implement any significant change, with little awareness about the problem seen at hospital level. National guidance, including screening programmes, deficiency-specific testing, and counselling, need to be implemented to ensure doctors with CVD are supported and patients receive the best care possible.

## Disclaimer

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## Summary

### What was known before

- Doctors with CVD have an increased chance of making error in clinical practice due to their condition.

- Medical staff feel that they have not been offered advice or screening

### What this study adds

- Almost all medical schools and NHS trust have no protocols in place screening for CVD.
- NHS trusts have no policies or advice in place to assist staff with CVD and are unaware of the effect it could have on their clinical practice.

### Data availability

Full dataset available from the corresponding author.

**Author contributions** NJR initiated and designed the project, reviewed collected literature, designed the data collection tools, monitored data collection, drafted and revised the paper. He is the guarantor. BTM assisted with the project design, collected literature, implemented data collection, analysed the quantitative data and revised the draft paper. NKH assisted with the project design, collected literature, implemented and analysed data collection, and revised that draft paper. GH assisted with the project design, collected literature, implemented data collection, analysed the qualitative data and revised the draft paper.

### Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

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