• Brief Report •

Effect of glaucoma on identification of bottle cap color in ophthalmic medications

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Abstract

• A prospective, nonrandomized, observational trial of 60 glaucoma patients to correlate visual acuity and visual field with ability to distinguish bottle cap color of commonly used ophthalmic medications was conducted. A total of 103 eyes from 60 patients (30 women) were evaluated. The mean logMAR acuity was 0.34±0.54 (approximately 20/45 Snellen acuity), average Humphrey Visual Field (HVF) mean deviation was -8.58±8.69 dB, mean Ishihara plates (out of 14) were 11.78±4.15, and bottle cap color score (out of 10) was 8.56±2.51. Multiple linear regression analysis revealed an independent correlation of visual acuity (*P*=0.0137) and Ishihara score (*P*<0.001) with cap color score, but no significant effect with visual field mean deviation (*P*>0.05). Glaucoma patients with poor visual acuity, but not necessarily advanced visual field loss, are likely to have difficultly identifying the color of their bottle caps. Physicians should be cognizant of this potential issue when reviewing medications with patients.

• KEYWORDS: glaucoma; color vision; compliance; medication; patient communication

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INTRODUCTION

It is well known that pharmacotherapy for the treatment of glaucoma lowers intraocular pressure and delays disease progression[1]. Likewise and confounding, patient compliance with medications remains limited, with the literature suggesting rates of 70% or less[2-3].

Multiple reasons have been explored, including some related to the bottle itself[4-5]. Recently, two articles have highlighted potential issues when relying on the systematically color labeled bottle caps to differentiate and communicate about medications. Marando *et al*[6] surveyed glaucoma patients at a tertiary care office and found that 65% utilized bottle cap color to differentiate between medications, significantly more than medication name itself (19%). A concurrent study by Dave *et al*[7] found that a sampling of 100 patients used 102 unique descriptions for the colors of 11 bottle caps. Three physicians independently attempted to identify the medications based on the patient description, and among individual patients the mean number of medications demonstrating agreement was only 6 of 11 (55%).

Collectively, these data raise concern for utilizing bottle cap color to identify and discuss ophthalmic medications, particularly in glaucoma patients prone to impaired visual acuity, contrast sensitivity and color vision[8]. This study was designed to determine how frequently patients were able to correctly identify the bottle cap color of ten commonly used ophthalmic medications in each eye independently and correlate this information with visual acuity, automated visual field and clinical testing of color vision.

SUBJECTS AND METHODS

Ethical Approval The study was performed according to the Declaration of Helsinki, with approval from the Institutional Review Board at the University of Kentucky. Informed consent was obtained for all patients.

Patients were prospectively recruited to participate in the study from the glaucoma clinics at the University of Kentucky between June 2014 and September 2016. Inclusion criteria included: age 18 years or greater, diagnosis of glaucoma on stable topical medication regimen, self-administered eyedrops, measurable Snellen visual acuity, Humphrey Visual Field (HVF) testing within 6mo of enrollment, familiarity with the 10 test colors and willingness to participate. Patients with hereditary or acquired color vision deficiencies were excluded.

Snellen visual acuity was tested in a standard 6 foot exam room. HVF testing was performed using the 24-2 SITA FAST algorithm (Carl Zeiss Meditec Inc., Dublin, CA, USA). Color

vision was assessed for each eye using standard Ishihara color plates. Each eye was also tested independently for the ability to correctly identify the bottle cap color of ten commonly used ophthalmic medications presented against a white background in a standardized fashion and sequence. Cap colors included yellow, purple, orange, blue, green, red, teal, pink, gray and tan.

Statistical analysis was conducted on the data using JMP 12.2 Pro (SAS Institute Inc., Cary, NC, USA) to correlate these results with the most recent measurements of visual acuity (Snellen visual acuity converted to logMAR)[9] and glaucoma severity (visual field mean deviation using a *t* ratio test). Statistical analysis of individual cap colors was completed with logistic regression analysis using a Chi-square test. Multivariate analysis of linear regression was performed using an *F*-test.

RESULTS

Totally 103 eyes from 60 patients (30 women) were evaluated. The mean logMAR acuity was 0.34±0.54 (approximately 20/45 Snellen acuity), average HVF mean deviation was -8.58±8.69 dB, mean Ishihara plates (out of 14) were 11.78±4.15, and bottle cap color score (out of 10) was 8.56±2.51. A lower visual acuity (higher logMAR) demonstrated a statistically significant relationship with lower cap score overall (P<0.0001), and in seven of ten colors individually (all P<0.01; Table 1). A lower visual field mean deviation was correlated with lower cap color score (P=0.0019), Ishihara plate score (P<0.0001), and decreased likelihood for correctly identifying green (P=0.0071) and orange (P=0.0037) caps. Multiple linear regression analysis revealed an independent correlation of visual acuity (P=0.0137) and Ishihara score (P<0.001) with cap color score, but no significant effect with visual field mean deviation (P>0.05).

Table 1 Individual cap colors *vs* logMAR visual acuity and visual field mean deviation

Cap color	*vs* logMAR	*vs* mean deviation
Orange	0.0072[a]	0.0037[a]
Yellow	0.0037[a]	>0.05
Purple	0.0005[a]	>0.05
Blue	0.0042[a]	>0.05
Pink	0.0043[a]	>0.05
Gray	0.0006[a]	>0.05
Tan	0.0006[a]	>0.05
Green	>0.05	0.0071[a]
Red	>0.05	>0.05
Teal	>0.05	>0.05

logMAR: logMAR visual acuity. [a]P<0.05.

DISCUSSION

In 1983, the American Academy of Ophthalmology successfully advocated to the US Food and Drug Administration to enter an informal and voluntary agreement with pharmaceutical companies to create a uniform color for bottle caps of different classes of medications, which has largely been in practice ever since[10]. As a result, recognition of bottle cap color has become a common method for patients to distinguish medications and for providers and patients to discuss medication use and compliance[5]. This study attempted to measure the effect of glaucoma on discrimination of these colored caps and found that patients were less likely to correctly identify the color of caps as visual acuity and visual field mean deviation worsened. Multiple linear regression analysis suggested that the visual field effect may be more related to visual acuity, and decreased bottle cap color recognition could not be independently attributed to this marker of glaucoma severity.

A recent study highlighted the concerns when relying upon bottle cap color for communication of medications, with poor agreement between patients and physicians when describing 11 distinct medication bottle caps[6]. The authors further found in single, but not multi-variate analysis, that severity of better-eye visual field loss and extent of color vision loss were associated with poor patient-physician agreement. Our study expands on and confirms these findings by demonstrating difficulty discriminating bottle cap color in patients who claim to have the capacity to recognize these colors, and confirms the link between visual field and color vision loss and increased error in distinguishing medications. In addition, we found that visual acuity was a stronger predictor of difficulty identifying bottle cap color than visual field.

This study has several limitations. It was a relatively small sample size conducted at a single institution. Color vision was determined by Ishihara color plates and each eye was tested individually. The second eye tested may have been biased by prior immediate testing of the first eye.

In summary, worsening visual acuity and color vision are independently associated with difficulty distinguishing bottle cap color in this glaucoma patient population. Increasing severity of glaucoma on the basis of visual field mean deviation are not similarly correlated, and our data suggest that many patients maintain the ability to distinguish bottle cap color, provided visual acuity remains adequate. These results support the need for circumspection when discussing medications with patients. Additional changes in bottle manufacturing to aid our most vulnerable patients are long overdue.

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