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ORIGINAL ARTICLE

FLASH: A Novel Tool to Identify Vision-Threating Eye Emergencies

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ABSTRACT

BACKGROUND: Two million patients visit emergency departments due to eye complaints annually in the United States, yet nearly one-quarter of these visits are for non-urgent ocular problems. Other patients often present a significant length of time after the onset of their symptoms, which may cause progression to irreversible vision loss. A major reason for this discrepancy is that many patients are unsure what symptoms constitute eye emergencies. The challenge is helping patients understand what constitutes a vision-threatening eye emergency, as well as the risks and complications that are associated with delaying their visit to the ophthalmologist or Emergency Department.

OBJECTIVES: To describe relevant literature on incidence, prevalence, presentation times, associated prognoses, risks, and complications of individual vision-threating eye emergencies, and present a novel acronym, FLASH (Floaters and flashes, Loss of vision, Aching pain, Second Image, Help), to better educate patients at risk for these conditions, fostering better symptom recognition and timely care. This manuscript is aimed at reaching public health departments, educational institutions, primary care offices and eye care centers as part of a dedicated patient education effort for vision-threatening eye emergencies.

DESIGN / METHODS: Narrative overview of the available literature on specific eye conditions presenting with the aforementioned symptoms, synthesizing findings retrieved from searches of computerized databases and authoritative texts.

CONCLUSIONS: In each condition presented in this article, symptom interval significantly impacts treatment prognoses. The cited literature demonstrates that patients often present late in emergent eye conditions resulting in vision loss.

Key words: Delayed presentation, eye emergencies, vision complications, blindness, patient education, endophthalmitis, retinal detachment

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INTRODUCTION

Two million people present every year to emergency departments (ED) for eye complaints in the United States[1]. If medical care is not initiated promptly, emergent ophthalmic disease can progress to irreversible vison loss and blindness. However, many of these visits are for non-urgent conditions. A recent study out of the University of Michigan demonstrated that a quarter of eye-related emergency department visits by adults with private insurance over a 14-year period were for non-urgent conditions[2]. It is difficult for patients to predict what is and what is not an eye emergency, judging by their ED visits and associated urgency (Table 1). Patients spend nearly $580 more per visit by presenting to the ED for their ophthalmic concerns compared to an office visit[2]. Notably, patients were less likely to seek immediate care for their non-urgent conditions if there were already seeing an eye specialist regularly[3]. Public education on vision-threatening entities could foster earlier presentation to eye specialists, cost savings, and maximization of visual prognosis, as well as allowing EDs to serve patients with more appropriate, urgent conditions[4,5].

Many triage tools currently exist and are employed by various eye-care centers around the world. Our team has developed an acronym, described in Figure 1, FLASH (Floaters, Loss of Vision, Aching Pain, Second Vision, Help), that covers the several conditions assessed in these triage tools. Several authors describe examples of triage forms that ask many of the questions FLASH would ask; specifically about double vision, floaters, decreased vision, and pain[6,7]. Many academic centers, including the Wills Eye Hospital, include the symptoms listed in FLASH, notably Flashes, Floaters, Sudden Vision Loss, Double Vision, and Pain as causes for concern for a medical emergency[7,8].

In the future, an increasing number of ophthalmic consultations will likely be performed remotely as telemedicine plays a larger role in our care of patients, causing requests for ophthalmologic consultations to rise rapidly, thus improving eye access for people with emergency conditions[9]. With a tool like FLASH, patients would be able to quickly identify and address eye emergencies through such services.

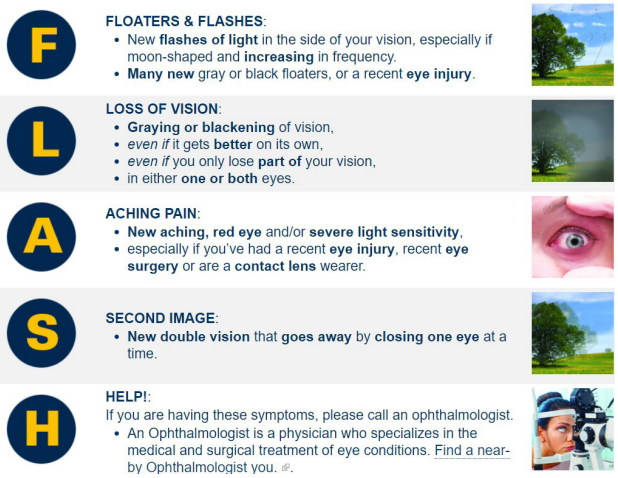

Figure 1 This figure displays the FLASH acronym and its associated symptoms.

Table 1 This table represents number of people presenting to the emergency department with eye conditions relative to total ED visits, along with demographic breakdown.

	ED visits related to eye injuries*	Treat and release ED visits related to eye injuries*	ED visits resulting in admission related to eye injuries*	ED visits for all other injuries
Number of Visits	636,619	616,766	19,853	29,482,454
ED visits per day	1,744	1,690	54	80,774
Rate per 100,000 population	209	203	7	9,696
Males, rate per 100,000 population	262	254	8	10,400
Females, rate per 100,000 population	158	153	5	9,007
Utilization characteristics				
Percentage treated and released	96.90%			
Percentage admitted to the hospital	3.10%			8.10%
Percentage of visits primarily/principally for eye injuries	80.80%	82.50%	27.60%	n/a
Percentage of visits with a secondary diagnosis of eye injuries only	19.20%	17.50%	72.40%	n/a
Patient Characteristics				
Mean age, years	31.50	30.80	51.20	35.40
Percentage by age group				
0 to 17 years	28.30%	28.80%	12.70%	25.80%
18 to 44 years	45.30%	45.90%	29.10%	41.50%
45 to 64 years	18.70%	18.70%	20.70%	19.20%
65 years and older	7.60%	6.70%	37.60%	13.50%
Percentage of male patients	61.70%	61.80%	59.10%	52.90%
Patient residence, rate per 100,000 population1				
Urban areas (large central, large fringe, and small and medium metropolitan), rate per 100,000 population	120	116	5	5,317
Rural areas (micropolitan and noncore), rate per 100,000 population	646	630	16	31,229

1Missing patient's residence on 250,418 (<1%) injury records and income information on 751,631 (2.5%) injury records. *Based on all-listed diagnoses. Source: Agency for Healthcare Research and Quality, Healthcare Cost and Utilization Project, Nationwide Emergency Department Sample, 2008. Denominator data for rates were based on Annual Estimates of Resident Population for the United States, Regions, States and Puerto Rico: April 1, 2000 to July 1, 2009 (NST_EST2009-01, NC-EST2009-02). U.S. Census Bureau, Population Division.

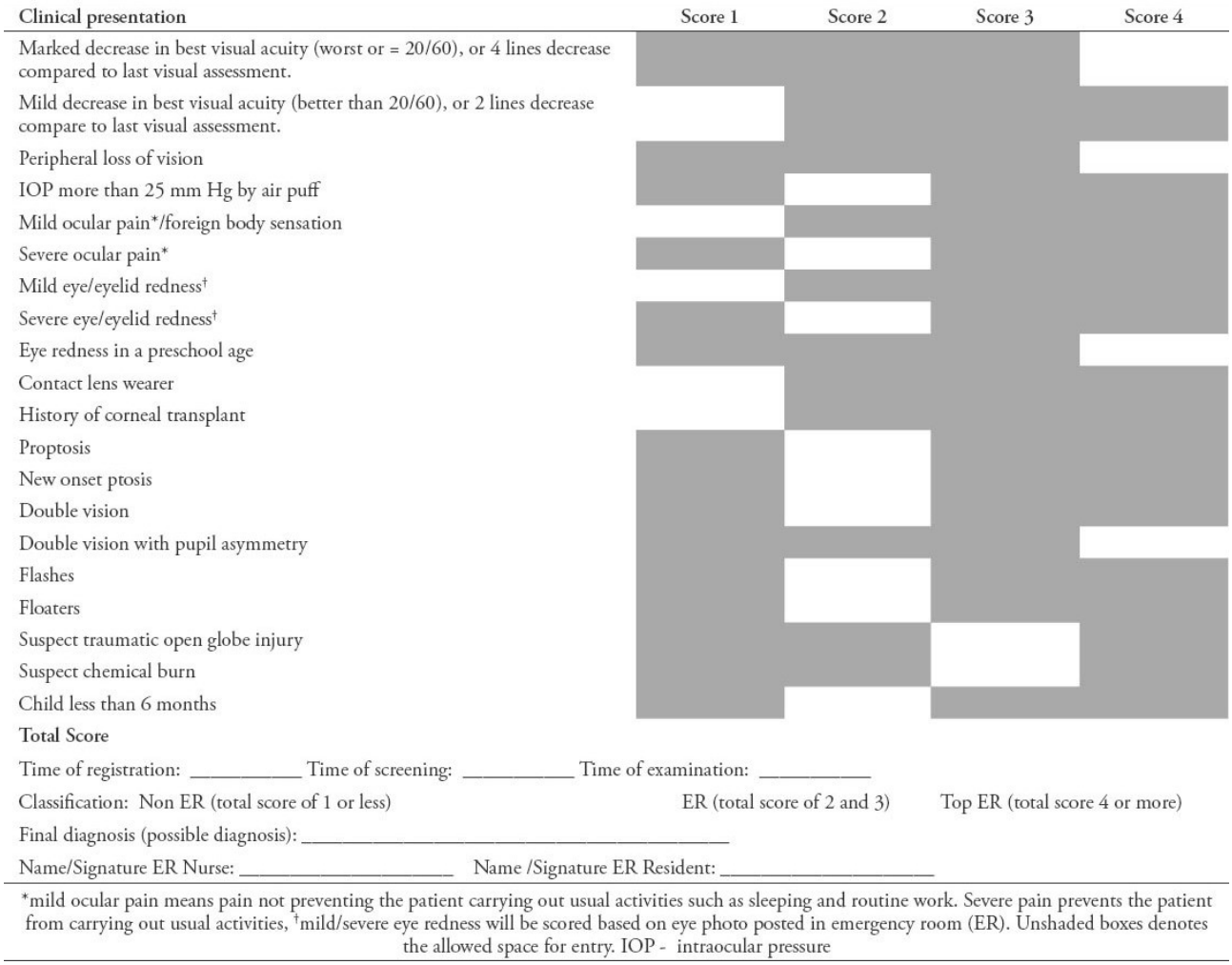

Figure 2 This figure is obtained from reference [6] and represents the clinical presentation of emergency ophthalmic patients. The score delineates the urgency of the condition: non-urgent (0 to 1), semi-urgent (2 or 3), and urgent (4 or more). The FLASH acronym includes most of the symptoms that would be recognizable to a patient experiencing them. Copyright: © Saudi Medical Journal.

In this manuscript, we have undertaken a review of the relevant literature on incidence, prevalence, presentation times, associated prognoses, risks, and complications of individual vision-threating eye emergencies that present with the symptoms outlined in FLASH. We hope to demonstrate the need for patient education on these emergencies, as far too many patients are currently suffering from preventable complications.

2.1: Retinal detachment (Floaters / Flashes, Loss of Vision)

Macula-sparing rhegmatogenous retinal detachments (RRD) are urgent eye conditions in which the neurosensory retina is detached from the underlying retinal pigment epithelium and choroid, which if left untreated, can result in permanent blindness. RRD has an incidence of about 5 cases in 100,000 persons per year (for otherwise normal eyes), but 20 in 100,000 when including only middle-age or elderly populations[10,11]. Lifetime risk for RRD is approximately 1 in 300, and notably shows a strong correlation with affluence, indicating that RRD may become more prevalent as populations age in more affluent countries[12,13].

In the case of retinal detachment, patients often present once vision declines and the macula is off, leading to a worse visual prognosis and an average visual acuity outcome of 20/80. If caught earlier when the macula is on, the prognosis is much better[14]. Estimates have determined that between 50% to 70% of patients (regardless of their level of education) present after the macula is detached, due to their not being able to recognize the symptoms of detachment[15,16], but those who present with macula still on are more sensitive to the presence of floaters and seem to be more informed about signs and symptoms of eye conditions. This awareness is essential to achieving earlier presentation times and can become more widespread with promotion strategies such as educating patients about warning signs (especially in high risk patients, such as high myopes and the elderly)[17,18].

One study showed that length of delay in surgical intervention from onset of symptoms correlated strongly with a decline in visual acuity, with 53% achieving 20/20 to 20/50 acuity within 9 days, 34% between 10-19 days, and 29% after 19 days. Patients who presented within 9 days were significantly more likely to obtain a final acuity of 20/50 or better ($p < 0.05$)[19]. Another study demonstrated that after detachment, the best mean preoperative vision, the most significant predictor of postoperative visual acuity[20], is seen in patients with detachment of less than 1 week duration. If the macula has been off for longer than 6 weeks, visual prognosis postoperatively is significantly poorer[21,22]. In order to prevent the complication of blindness from this treatable condition, early diagnosis and prompt referral for diagnosis and surgery are of paramount importance.

2.2 Acute angle closure glaucoma (Loss of vision, Acute pain)

Acute angle closure glaucoma (AACG) is an eye emergency in which closure of the drainage system of the eye, the angle, causes an

acute elevation in intraocular pressure (IOP) and can lead to ischemia and permanent vision loss if untreated. Awareness and knowledge of glaucoma is low in patients suffering from AACG. This lack of awareness, leading to delayed presentation times, is correlated with many factors, including older age, education, and unemployment[23]. Most symptomatic angle closure events stand a high chance of recovery without any short-term optic disc or visual field damage if promptly treated (60-75% success rate)[24].

Development of primary angle closure glaucoma after AACG was noted in two studies of Caucasian and Asian populations to correlate with length of symptoms before presentation ($p = 0.001$) and time taken to abort the acute attack ($p = 0.01$)[25,26]. In a Scottish population, delayed presentation (≥3 days) was associated with higher rate of glaucoma at follow-up (22.6% vs 60.8%, $p < 0.001$), worse visual acuity (20/44 vs 20/110 Snellen, $p < 0.0001$) and need for more topical medication (RR 0.52 vs 1.2, $p = 0.003$) to control IOP[27].

Visual field loss has been shown to be directly correlated to delayed presentation after an AACG attack, with one study demonstrating loss of vision in 38% of eyes after nerve fiber loss six months after the attack[28]. Another study demonstrated that changes in optic disc morphology were documented as soon as 2-16 weeks after the attack, preferentially targeting inferotemporal and superotemporal regions[28]. Although IOP measurement is an important predictor of outcome, if an attack persists for a longer duration and becomes more difficult to manage, the visual outcome for the eye worsens, regardless of initial IOP measurement[29,30]. One study assessed the risk of chronic glaucoma in patients who presented with a delay as well as patients with poor IOP control, and found that the relative risk of patients presenting with a 24 to 72-hour delay was 2.78, while patients requiring iridotomy or trabeculectomy for control of IOP had relative risks of 3.63 and 4.83, respectively[30].

2.3 Corneal Ulcer (**L**oss of vision, **A**cute Pain)

Corneal ulcers are infections, most commonly bacterial, in the cornea which can lead to permanent scarring and visual loss. The surge in use of contact lenses has led to an increasing prevalence of corneal ulcers in recent years.[31] Incidence of microbial keratitis in the population varies based on type of contact lens used, but is clearly correlated to length of time in the eye, with yearly rates of 2 cases per 10,000 people for rigid contact lens wearers, 2.2-4.4 per 10,000 for daily-wear soft contact lens users, and 13.3-20.9 per 10,000 for extended-wear soft contact lenses[32]. A known complication of corneal ulcers is permanent blindness, and a delay in diagnosis and treatment can lead to this unfortunate result[33]. For this reason, immediate referral to the ophthalmologist, leading to prompt initiation of antimicrobial therapy, is paramount to preventing loss of vision in these patients.

Increased rates of recurrence and necessity for invasive operations are seen in patients with delayed presentation[34]. The average time before a hospital visit after onset of symptoms in Nadu, India, was 6.2 days, and 10.6% of cases either required therapeutic penetrating keratoplasty (8.5%) or progressed to endophthalmitis and required evisceration (2.1%)[34]. In studies out of Iran and Britain, the average delay between onset of symptoms and the first examination was 48 hours, and complications requiring intervention beyond a topical approach were noted in 6% of eyes[35,36]. In one study, the mean delay in referral to the corneal specialist for patients that had to undergo penetrating keratoplasty was 8 days, versus 1.3 days in the patients that did not ($p < 0.03$)[37].

Delayed presentation may negate the efficacy of medical treatment, according to authors who found that when *Fusiarium* keratitis has progressed to an advanced stage, combination antibiotic therapies, including fluconazole, ketoconazole, topical natamycin, and amphotericin B failed to elicit a response in 9 of 10 patient cases[38]. A symptom interval of more than 2 weeks in patients with fungal keratitis has also been shown to statistically increase the chances that they will require surgery later[39]. However, if diagnostic delay and initiation of antibiotic therapy can be held to under 18 days from the start of symptoms, the odds of a better final visual acuity are increased[40]. For these reasons, early presentation and diagnosis are important factors in determining prognosis for visual outcome in patients with corneal ulcers.

2.4 Herpes Keratitis (**L**oss of vision, **A**cute pain)

Herpes can cause a particularly devastating corneal infection which can lead to scarring, vision loss, and blindness. The incidence of ocular herpes simplex virus (HSV) infection in the USA is about 0.15%, with about 20,000 new cases and 28,000 reactivations annually. In the United States, ocular HSV is widely known to be a frequent cause of blindness[41]. Some estimations predict that nearly 500,000 people are afflicted with ocular HSV in the US[42]. Necrotizing stromal keratitis (NSK), a result of the progression of ocular HSV, is a condition that can lead to corneal perforation and vision loss. The diagnosis of NSK is often delayed, leading to increased incidence of visual morbidity[43].

In most cases, ocular HSV will resolve on its own without permanently damaging vision, with mean times to resolution after symptom onset ranging from 17.6 days in the first episode to 28.4 days in recurrent episodes[41]. Notably, there is no current method that will predict which infections may progress, so prompt recognition and treatment is important in preventing progression, and alleviating symptoms[44]. Despite its often self-limited nature, reducing viral replication is imperative to reduce symptoms, shorten the course of disease, and prevent further complications[45].

2.5 Scleritis (**L**oss of vision, **A**cute pain)

Scleritis is a painful inflammation of the sclera and scleral vessels that is associated with systemic autoimmune conditions in up to 50% of patients. Scleritis is highly variable in its presentation, with time from an initial identifiable event to presentation ranging anywhere from 0-36 years. Postsurgical patients tend to fall on the longer end of the spectrum compared to post-nonsurgical trauma patients[46]. Autoimmune disease processes are the most common etiology for scleritis and can be progressively destructive if treatment is not initiated, potentially leading to loss of vision or loss of the eye[47]. Fungal etiologies tend to have worse prognosis, likely secondary to delays in diagnosis[48]. Infectious scleritis can be viral, bacterial, fungal, and parasitic. It is uncommon, particularly in the absence of infectious keratitis; however, possibly because of the diagnostic delay that is reported to be associated with infectious scleritis, visual prognosis is poorer in these patients than in those with an autoimmune manifestation[49]. One study reported that there is a gap of nearly 46 days between commencing treatment and resolution of scleritis, which can be exacerbated by a delayed diagnosis: Hodson *et al.* report 50% of eyes losing function vision, emphasizing the point that delayed diagnosis can result in progression of the disease that can result in eventual vision loss[46].

2.6 Giant cell arteritis (**L**oss of vision)

Giant cell arteritis is the most common vasculitis in adults aged 50 years and older and can often present with eye complaints. The overall prevalence of giant cell arteritis (GCA), adjusted for age and sex, has been reported to be nearly 204 (95% CI: 161-254) per 100,000

population greater than or equal to 50 years of age, with a predilection for men[50]. Nearly 15-20% of patients with GCA have reported experiencing permanent vision loss as a complication of this condition, which makes early and correct diagnosis critical[51,52]. During the course of disease progression, nearly 50% of patients experience visual symptoms, including painless unilateral vision blurring or vision loss and diplopia. What initially seems like an innocuous partial field defect can progress to blindness over the course of a few days. Although transient episodes of blurred vision are generally treatable, if treatment for GCA is not started urgently, sudden irreversible vision loss can result. One of the most important considerations in treatment of the GCA is the potential for bilateral vision loss. If GCA remains untreated in patients with unilateral vision loss, the second eye may become affected within 1-2 weeks in up to 50% of patients[53].

In the classic disease progression of GCA, it tends to involve the aorta and collateral branches, which can lead to a host of complications. Besides a permanent loss of visual function, untreated GCA, potentially due to late diagnosis, can cause serious systemic complications[52]. And delay in diagnosis is not uncommon, with a reported mean delay of 9 weeks, and even longer when patients displayed an absence of cranial symptoms[54]. In one study, the mean time from symptom onset to diagnosis of GCA was 35 days due to slow recognition of ischemic symptoms. In the 65-patient cohort, 24.6% experienced visual loss at presentation, 15.4% presented with neuro-ophthalmological vascular complications (NOC), 70% of whom developed permanent visual impairment, and 7.7% suffered cerebrovascular complications. A delay in diagnosis and/or treatment has been found to partially contribute to the ischemic manifestations that result from GCA, most of which are not reversible[55].

2.7 Endophthalmitis (**L**oss of vision, **A**cute pain)

Endophthalmitis is a severe inflammation of the intraocular tissues, most commonly due to infection. It is particularly devastating since the eye, like the brain, is an immune-privileged site, and thus inflammation can lead to permanent, severe vision loss. Because symptoms of endophthalmitis (both systemic and ocular) are generally non-specific, diagnosis is reliant on patients contacting clinicians with their symptoms. With continuing progress and advancement in surgical technology, as well as vitreoretinal pharmacology, prompt intervention with intravitreal pharmacotherapy or surgery (in more severe cases) is the prevailing trend in endophthalmitis management[56]. Endophthalmitis may progress into permanent vision loss, and this can happen in a relatively short time window[57].

Endophthalmitis generally presents within a few hours to a few days after the onset of symptoms. Cases of endophthalmitis are considered medical emergencies. Despite the risk of blindness, vision may be preserved if prompt therapy is initiated, even in the most severe cases[58]. Most patients suffering from postoperative endophthalmitis present within seven days of the surgery with an acute onset[59]. Acute bacterial endophthalmitis is an especially emergent condition, as even a short treatment delay can lead to loss of vision[60]. A 19-year-long study out of the Bascolm Palmer Eye Institute found that for cases occurring within six weeks of clear corneal cataract surgery, time to diagnosis ranged from 1-39 days, with a median of 9 days and a mean of 13.8[61]. It has been widely reported that longer delay from infection to treatment correlates directly to a poorer visual prognosis[62-64]. One study examining retinal changes in the setting of *Bacillus* endophthalmitis demonstrated structural and electrophysiologic changes, PMN infiltration into the vitreous, Glial fibrillary acidic protein (GFAP) detection in the retina, and an increase in ophthalmic TNF- α, all within 4 to 6 hours. The changes in retinal architecture correlated to a functional deficit in these eyes. The study suggests that prompt intervention in endophthalmitis is strongly indicated, due to the rapid detrimental changes that can occur to the eye, potentially leading to vision loss, in patients with endophthalmitis[65].

2.8 New-onset diplopia (**L**oss of vision, **S**econd vision)

Although this manuscript has been organized by condition, rather than symptom, the eye emergencies associated with new-onset diplopia are specific and severe enough to be presented as a symptom with associated causes. Specific associated emergency conditions include cranial nerve (CN) III, IV, or VI palsy, cavernous sinus syndrome (CSS), or CNS lesions.

CN palsy, according to a study out of Moorfields Eye Hospital, is the most common condition affecting patients who present to the clinic complaining of diplopia in both eyes, with a prevalence of 67%[66]. One cause of a CN palsy may be Cavernous Sinus Syndrome (CSS). Prompt diagnosis and treatment within 100 days of onset of CSS plays an important role in improved visual prognosis[67,68].

Diplopia is also known to present as a symptom of CNS lesions, such as aneurysm rupture or brain tumor. One of the most worrisome complications that can arise from aneurysms that have not yet ruptured is subarachnoid hemorrhage, occurring at a rate of nearly 6-10/100,000 person-years. Rupture of these unruptured intracranial aneurysms (UIAs) are responsible for nearly 85% of all SAH cases, with a fatality rate of 30%-40%[69,70]. Visual difficulties (including diplopia) accounted for 38% of symptoms occurring at any time and for 10% of the first presenting symptoms of brain tumor. The average symptom interval, correlated with a negative impact on treatment outcome, for patients presenting with brain tumors was 471 days with a median of 120 days[71]. Diplopia was present in 43% of these cases, while blurred vision was present in 39%. Photophobia was present in 6% of cases[72].

In one study out of the UK that examined the records of 139 children with brain tumors, it was found that a delay in diagnosis was related to many complications including reduced visual acuity, growth abnormalities, cranial nerve palsy, and head tilt. The median time to diagnosis from the onset of symptoms was 3.3 months, by which time patients usually had around six signs and/or symptoms[73]. Separate studies have corroborated this timeframe, with a reported lag time from symptom onset to diagnosis of at least 12.5 weeks[74-77].

CONCLUSION

Patients have a limited understanding about what constitutes vision-threatening eye emergencies, and what symptoms to look for when they feel like they may be experiencing one. This lack of information may result in devastating side effects, including progression to irreversible vision loss and blindness. In addition, patients not presenting in a timely fashion to ophthalmic emergencies and seeking emergency department treatment for non-urgent conditions incur significant cost to the healthcare system (estimated $392.9 million every year)[3,78].

Currently, it is apparent that clinical management of vision-threatening eye emergencies can most effectively help those who seek clinical help for appropriate conditions in a timely fashion. In every condition presented in this article, time to presentation after onset of symptoms was an important factor in determining treatment prognoses. The current challenge, however, is helping patients to understand what constitutes a vision-threatening eye emergency, as well as the risks and complications that are associated with delaying their visit to the ophthalmologist.

Through a narrative review of the literature discussing the delayed presentation of several serious ophthalmic emergencies and the decreased outcomes associated with time to presentation, including symptom recurrence, irreversible vision loss, and blindness, we hope to have demonstrated the need for a public health education initiative that would prompt patients to present to their clinicians earlier after the onset of symptoms and before permanent damage is done. Although in some cases, the literature is sparse, this speaks to the relative obscurity of the subject, and the need to shed light on vision-threatening, and in some cases, life-threatening emergencies. We recognize this as a potential limitation to the study. We propose one step toward a solution in the form of an acronym, much like the widely successful FAST acronym for stroke used as a mnemonic to help detect and enhance responsiveness to stroke victim needs. Through demonstration of the need for a dedicated public health effort to serve this problem, and the introduction of a potentially useful acronym to help achieve this goal, patients will be encouraged to present earlier to physicians if they are experiencing vision-threatening eye emergencies.

The acronym we propose is **FLASH**: **F** stands for Floaters and Flashes, **L** stands for Loss of Vision, **A** stands for Acute Pain, **S** stands for Second Image (double-vision), and **H** stands for Help (contact your ophthalmologist). The medical community has already seen massive success in the implementation of the FAST / BEFAST acronyms for stroke, as patients at risk are more informed about the signs to look for and possess an acronym that is relevant and easy to remember. By introducing FLASH, we hope to implement the same model into primary care offices and eye care centers, with the aim of improving patient outcomes for these emergencies.

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