

# Acute Primary Angle Closure Glaucoma Prognostic Factors



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## Abstract

**Background:** Acute primary angle closure glaucoma (APACG) is one of the most significant ocular emergencies presenting to emergency departments. This form of glaucoma is generally perceived as an acute ocular emergency which requires prompt ophthalmic referral for definitive treatment, which is almost universally surgical. At present however, prognostic factors on presentation are not well established and physicians do not have the ability to predict patient's visual outcomes on presentation with reliable data.

**Methods:** In this retrospective case study, we analyze one hundred cases of acute primary angle closure glaucoma referred to our practice from four emergency departments (EDs) between 2008 and 2020 to statistically assess the characteristics, demographics, treatments, and clinical findings that affect outcomes.

**Result & Conclusion:** In our patient population emergent surgical intervention broke the acute attack in all patients, but only cured 27% of patients long term, leaving 73% of the patients requiring chronic treatment. This underscores the fact that acute angle closure glaucoma more often represents an exacerbation of a chronic disease requiring long-term treatment. We found that a presenting visual acuity (VA) of 20/200 or worse was the most significant prognostic factor in determining final VA. Other prognostic factors associated with poor visual outcomes included Black race, a need for continued intraocular pressure (IOP) lowering medications at one month of follow up, and a lack of health insurance. Asian race and a higher presenting IOP greater than 46 mmHg were suggestive of poor outcomes but were not statistically significant.

**Keywords:** Primary acute angle closure glaucoma; Emergency department; Eye; Vision; Treatment

**Abbreviations:** APACG: Acute Primary Angle Closure Glaucoma; ED: Emergency Department; VA: Visual Acuity; IOP: Intraocular Pressure; PACG: Primary Angle Closure Glaucoma; OD: Right Eye, OS: Left Eye; LPI: Laser Peripheral Iridotomy; NLP: No Light Perception

## Introduction

Acute primary angle closure glaucoma (APACG) is one of the most important true ocular emergencies that a physician may encounter. Angle closure glaucoma results from a narrowing of the iridocorneal angle, causing obstruction of aqueous humor outflow and a rapidly elevated intraocular pressure. This process occurs in response to one of two mechanisms. In primary angle closure glaucoma (PACG), the flow of aqueous humor through the pupil is blocked. Conversely, secondary angle closure occurs when the iris is either pushed from behind or pulled anteriorly to narrow the angle. Both forms may present in an acute or chronic form. PACG tends to occur more acutely and patients with this etiology will frequently present to the emergency department (ED).

Patients with angle closure glaucoma often present to the emergency department complaining of severe ocular pain, headache, blurry vision, nausea, and vomiting, classically after transitioning from a light to dark environment. These symptoms are believed to be caused by a rapid increase in intraocular pressure (IOP). Nausea and vomiting generally occurs as a result of autonomic stimulation, while blurred vision and colored halos around lights are caused by corneal edema from the increased IOP pushing fluid into the cornea.

Physical exam may show a red eye with an elevated IOP (normal 10-20 mmHg), a fixed and mid-dilated pupil with poor reactivity to light, corneal edema, marked limbal conjunctival injection, and

a shallow anterior chamber. Unfortunately, the gold standard for diagnosis involves evaluation of the anterior chamber angle with gonioscopy, [1,2] which is generally not available in an emergency department setting. However, assessing the anterior chamber can be done at bedside by shining a penlight perpendicularly to the direction of gaze and assessing for a shadow on the nasal iris. This test has been reported to have a sensitivity of 76% and a specificity of 81% [3].

There are several established risk factors for APACG including female sex, [4,5] Asian [6-9] or Inuit race, [10,11] older age [4,7] and certain drugs. [2] Anatomic predispositions include hyperopia, [12] a thick lens, [13] and an anatomically narrow anterior chamber. [12,14] Acute attacks have also been associated, albeit with less evidence, with emotional stress, [15,16] increased self-reported depression and anxiety, autonomic dysfunction, Valsalva maneuver, winter months, inflammation, [6] a larger iris area or thin iris [17].

In the emergency setting, patients presenting with APACG should be treated with IOP lowering agents, which may include pilocarpine, beta-blockers, alpha-agonists, carbonic anhydrase inhibitors, or hyperosmotic agents [1]. Urgent referral to an ophthalmologist should be made for definitive treatment, which is surgical in nature, and may include laser peripheral iridoplasty, [18,19] lens removal via phacoemulsification, [20-22] and/or peripheral iridotomy (PI) [23].

At present, there is no definitive data published to allow emergency department physicians to accurately determine or convey prognosis and likely necessary treatment modalities to their patients. Prognostic signs have been classically attributed to the duration of the attack and time to abate symptoms. [6,24] Peak IOP has been reported to not be predictive of long-term outcomes. [24-26] However, it has also been reported that increased IOP is associated with progression to chronic form, [6] requiring future lens extraction [27]. Additionally, the development of PACG after APACG in fellow eyes has been reported at 53%, even after prophylactic PI was completed. These authors reported that 21% of patients with an acute attack had progressive loss of visual fields on follow up, [28] with reports in populations of Asian individuals ranging from 33-72% [29].

With limited data on factors that affect long-term outcomes, our research aims to help provide prognostic clues into final visual acuity, the need for ocular surgery, and the likelihood of a patient requiring long-term treatment after the initial attack to control IOP. To our knowledge this is the first study to assess prognostic clues for long-term VA after APACG. This data can be used by the emergency department physician to help prognosticate the course of the disease and the expected outcomes.

**Materials & Methods**

We completed a retrospective case series of 100 patients referred for treatment of acute angle closure glaucoma from four

local emergency departments for presumed APACG between 2008 and 2020. The study protocol was approved by the local Institutional Review Board of the California Northstate University, and the study was conducted in accordance with the Declaration of Helsinki. Data was obtained through retrospective chart review and included patient demographics, presenting symptoms, duration of symptoms, exam findings, initial and final VA, initial and final IOP, nature and duration of treatment and insurance status for measures of significance. T-tests and Pearson’s Chi squared tests were used to determine statistical significance for quantitative and categorical data respectively. A P-value of less than 0.05 was statistically significant.

**Results**

Patient age, sex, and ethnicity are presented in Table 1. Reported ethnicity breakdown was like the demographics of the surrounding area with a notable exception that the prevalence of Asian patients in our study was near double that of the community (25% vs. 14.3%). We also observed a lower-than-expected number of Hispanic (12% vs. 21.6%) and Black patients (8% vs. 15.4%). The eyes were split at 47% right eye (OD) and 53% left eye (OS). Insured patients comprised 92%, and 8% were uninsured at the time of presentation. Average initial IOP was recorded at 44.8 mmHg (SD 11.7). All patients underwent a same day initial laser peripheral iridotomy (LPI) with a post-treatment average IOP of 18.6 (SD 10.6). A total of 31 patients required a repeated iridotomy for IOP control; patients requiring a second LPI had an average IOP of 29.1mmHg (SD 16.6) prior to the repeat procedure. Repeat LPI was completed 36 days after the initial intervention on average. Mean follow up time was 1.6 years with a maximum of 11.7 years.

**Table 1:** Patient age, sex, and ethnicity.

Patient Demographics	Patients	Mean Age, Years
Males	25 (25.0%)	64.5 (range 19-85)
Females	75 (75.0%)	61.4 (range 41-89)
Total	100 (100.0%)	63.7 (range 19-89)
Affected eye	Right	Left
	47%	53%
<b>Ethnicity</b>		
White/Caucasian	48%	
Asian	25%	
Hispanic	12%	
African American	8%	
Native Hawaiian/	1%	
<b>Pacific Islander</b>		
American Indian/	1%	
Alaskan Native		
Unknown Race	5%	

Presenting symptoms varied greatly. The most common presenting symptom was pain (70%). Additionally, 43% had blurry vision, 34% had headache, 34% complained of redness, and 25% experienced photophobia. Other less common symptoms included 20% with watering of the affected eye, 16% reported a sensation of pressure, 13% had burning, 13% had dryness, 11% complained of ocular discharge. 7% described their symptoms as an ocular discomfort, 6% had vomiting, 3% had swelling, 3% had double vision, 3% had a foreign body sensation, and 2% had dizziness (Table 2).

**Table 2:** Presenting symptoms.

Presenting symptoms	
Pain	70%
Blurry Vision	43%
Headache	34%
Redness	34%
Photophobia	25%
Watering of Affected Eye	16%
Burning	13%
Dryness	13%
Ocular Discharge	11%
Ocular Discomfort	7%
Vomiting	6%
Swelling	3%
Double Vision	3%
Foreign Body Sensation	3%
Dizziness	2%

To determine the prognostic value of initial VA on presentation, we analyzed patients with a VA of better than 20/200 compared to those with VA of 20/200 or worse. Patients with an initial VA of 20/200 or worse were more likely to have a final VA of 20/200 or worse (44% vs. 2%  $p=6.9E-7$ ), have a final VA of NLP (9% vs. 0%,  $p=0.042$ ), and have higher initial IOP (48.2 +/- 12.0 vs. 40.5 +/-10.1,  $p=0.001$ ). This occurred even though patients with an initial VA of 20/200 or worse were treated more aggressively with a greater number of medications (3.5 +/- 1.2 vs. 2.6 +/- 1.3 medications,  $p=0.002$ ). To assess what factors were prognostic of blindness in the affected eye (defined as vision 20/200 or worse), we first stratified patients by their final visual outcome based on their most recent visit. The final VA on record showed 74 patients with a final VA of better than 20/200 and 26 patients with a final VA 20/200 or worse. Additionally, 6 of these patients had no light perception (NLP) (Table 3). Of the final VA patients with NLP, one of these six had a VA of NLP on presentation. Patients who ended up blind were more likely to seek medical attention sooner (2.3 +/-1.95 days vs. 4.2 +/- 6.19 days,  $p=0.044$ ) and more likely to be on IOP medications long term (88% vs. 34%,  $p=0.016$ ), defined as needing medications longer than one month after the initial attack.

**Table 3:** Final visual acuity.

Final Visual Acuity	
VA 20/200 or better	74
VA 20/200 or worse (NLP)	26 (6)

Comparing patients with a final VA of NLP to those with final VA better than 20/200, NLP patients were significantly more likely to lack insurance (33% vs. 5%,  $p=0.012$ ). Additionally, NLP patients had a higher, though not statistically significant, IOP following LPI (27.8 +/- 16.4 vs. 18.4 +/- 9.6  $p=0.25$ ). When analyzing final VA there was no significant difference in age, sex, need for a repeat PI, IOP after PI, number of medications used to treat the initial attack, or need for surgical lens removal between the groups. Presenting symptoms not specified above were not significantly different between groups and had no prognostic value. To address racial discrepancies and to better understand how race plays into prognosis we analyzed our data by patient-reported race. Black patients were more likely to have final VA of 20/200 or worse when compared to White patients ( $p=0.02$ ), while Asian patients were suggestive of similar outcomes relative to White patients ( $p=0.054$ ). No other significant differences existed between racial groups including age, sex, insurance status, and need for long-term medication. Since length of symptoms is classically associated with prognosis, we looked at patients who presented with differing duration of symptoms. Surprisingly, there was no difference in age, sex, initial or final VA, insurance status, initial IOP, or need for cataract surgery when groups were split up by patients who presented within one day versus greater than one day and additionally when the groups were split at two or less days versus three or more days. This suggests that some patients clearly tolerated or experienced symptoms to different degrees.

Finally, since there have been discussions about the relevance of quantitative IOP level on presentation, we analyzed data based on the patient's initial IOP on presentation. When broken up by initial IOP greater or less than or equal to 46 mm Hg, patients with higher IOP were more likely to have an initial VA of 20/200 or worse (70% vs. 40%  $p=0.003$ ), but this was not significantly associated with final VA (30% vs. 19%  $p=0.19$ ). With a higher cutoff value of 49 mmHg the association with final VA is slightly more predictive of final VA, but still not significant ( $p=0.11$ ), indicating that initial IOP likely does not have prognostic value in determining final VA.

**Discussion**

In our study, 26% of patients ended up with final legal blindness, defined as a vision of 20/200 or worse and 6% with total loss of vision and no light perception. This is like other studies that report this data (range 5.6-24%) [26,30,31]. Additional studies report lower levels of blindness (6-11.4%) but use a higher cutoff value of blindness (20/400 or worse) [6,32]. Values from these studies with higher cutoffs are like our study's incidence of a final visual acuity of NLP (6%). This grim prognosis of legal blindness

in roughly one of four patients underscores the significance of the emergency department physician recognizing and properly managing this disease. Our results strongly suggest that initial VA 20/200 or worse can be used as a prognostic sign for final VA of 20/200 or worse. Additionally, Asian, or Black race, need for continued IOP lowering medications at one month follow up, and a presenting IOP of greater than 46 mmHg are all associated with eventual blindness in the affected eye. Unsurprisingly, a lack of insurance also correlated with worse visual outcomes, and this may be tied to a larger socioeconomic factor or access to care, which we were unable to analyze further with available data. To our surprise we were unable to find a correlation between duration of symptoms and final VA. This may be since there is a variation in the tolerance of symptoms early on by patients, subjective reporting, and the often subacute on chronic nature of the disease. Duration of the attack in APACG has previously been associated with poorer visual outcomes [33] and developing PACG [6,30]. However, this is not a definitive conclusion at present within the literature. In addition to our data, two other studies have failed to show a temporal correlation between time to treatment and final visual acuity. The first showed that there was minimal evidence that the duration of the attack influenced vision retained or recovered [34]. The second reported that a significant delay in treatment was not associated with poorer visual outcomes [35]. We agree with the conclusions that Hillman et al make in their paper; that is, that in addition to what we classically diagnose as APACG, there is likely a less devastating, subacute form of the disease, which can present similarly.

Evidence of a chronic process is supported by our data showing patients with a VA better than 20/200 presented after the onset of symptoms on average 1.9 days later than patients with an initial VA worse than 20/200. In addition, although numbers are too low to have high statistical power, of the six patients that presented after a week of symptoms, none had a final VA 20/200 or worse, but 83% required medication long term. This suggests that these patients may have a presentation more consistent with a subacute on chronic process. It should also be noted that although we did not find a statistically significant difference in time to presentation, we believe there is still benefit to early diagnosis and treatment. This is evidenced by the fact that of those patients who were free of symptoms and medications long term (i.e., those who truly were cured by LPI shortly after presentation), 67% of them presented within two days, and 80% presented within four days. As these cases do have better outcomes with a quicker time to LPI, we believe that early treatment to lower IOP does maximize the chance of a cure and is still the standard of care and treatment for these cases should not be delayed.

We recognize that there are limitations in our study, mainly due to its retrospective nature. Additionally, the subjective nature of reporting of symptoms and their duration may have introduces bias. Finally, small sample sizes in specific ethnic patient groups and in NLP patients may make specific conclusions about these groups less reliable.

## Conclusion

Our results demonstrate that the strongest predictive factor for poor final visual outcome is a presenting VA of 20/200 or worse. Additionally, our work supports previous data suggesting that IOP on presentation is unrelated to final visual outcomes [24]. This may be since the mean ocular perfusion pressure is still typically higher than the average presenting IOP as observed in our patient population [36,37]. However, there still may be some prognostic value in the initial IOP, with higher values correlating, albeit insignificantly, with poorer final VA. Finally, we recommend that APACG should be approached as an acute presentation of a chronic disease, which requires long-term treatment and follow up after the initial frequently surgical intervention.

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