

The Prevalence of Ophthalmic Diagnoses and Exam Findings in Emergency Department Consults at Two Academic Hospitals

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Purpose: To report the prevalence of abnormal ophthalmic exam findings in Emergency Department (ED) ophthalmology consultations and provide foundational data for assessing ancillary diagnostic tools' effectiveness in an acute care setting.

Patients and Methods: We reviewed ophthalmic exam findings from consultations at Harborview Medical Center and University of Washington Medical Center EDs (Seattle, WA) between January 1, 2022, and December 31, 2022. Data included visual acuity (VA), intraocular pressure (IOP), visual field by confrontation (CVF), extraocular motility (EOM), pupil exam, slit lamp, and dilated exam findings. Descriptive statistics were calculated for continuous and categorical variables.

Results: A total of 2087 consults for 1946 patients were included. VA was 20/40 or better in 61.9% of right eyes and 62.4% of left eyes. Afferent pupillary defect (APD) was present in 12.6% eyes. The average IOP was 16.1 mmHg for the right eye and 16.1 mmHg for the left eye. Abnormal EOM in either eye or both eyes were reported in 17.5% and 2.5%, respectively, while abnormal CVF were reported in 16.9%; with homonymous defects in 0.8%. The most common slit lamp exam findings included cataract (31.94%), conjunctival injection (31.2%), and superficial punctate epithelial erosions (29.6%). The most common fundusoscopic findings were retinal hemorrhage (14.0% peripheral and 6.3% macular), posterior vitreous detachment (9.7%), and retinal vascular attenuation (6.7%).

Conclusion: This comprehensive report of findings of ED ophthalmic consultations can be used as a foundational pretest measure for guiding the implementation of appropriate ancillary diagnostic tools for emergency ophthalmic care.

Keywords: tele-ophthalmology, ophthalmic emergencies, examination findings, ophthalmic screening

Introduction

In recent years, hospital Emergency Departments (EDs) have faced decreasing access to in-person ophthalmology consultants for patients with vision and eye symptoms.¹ A variety of instruments, including fundus cameras, posterior segment optical coherence tomography (OCT), and anterior segment photography, are becoming available to help ED personnel collect ophthalmic data for remote specialist screening and evaluation via tele-ophthalmology or via machine learning.²⁻⁴ However, the prevalence of pathologic findings targeted by these instruments have not been well studied, which creates a challenge in accurately assessing the true utility of any ancillary ophthalmic testing in an ED setting. While most common ophthalmic conditions in EDs have been reported to be primarily lower acuity conditions,^{5,6} those that require ophthalmology consultation may have higher rate of ocular pathology with greater potential benefit of ancillary ophthalmic testing and tele-ophthalmology screening. Prevalence data for ophthalmic findings and diagnoses from ophthalmology consultations may guide the utilization and interpretation of ED ancillary testing.

The purpose of this study is to report the prevalence of ophthalmic exam findings among ophthalmology consults at two tertiary, university-based medical center EDs, including a level one trauma center. The findings of this study can be

used as a foundational pretest measure to guide the implementation of appropriate diagnostic tests and assess their predictive value in an emergency care setting among patients requiring ophthalmology consultation.

Materials and Methods

This retrospective study was approved by the Institutional Review Board (IRB) of the University of Washington (STUDY00018734). The IRB determined that patient consent was not required due to retrospective nature of the study. All research was performed in accordance with the principles stated in the Declaration of Helsinki and patient data remained confidential. This cross-sectional study included patients who received ophthalmic consultations at Harborview Medical Center and University of Washington Medical Center EDs (Seattle, WA) between January 1, 2022, and December 31, 2022. The study included patients who presented directly to the ED or were transferred from another ED facility with in-person consultations performed by an ophthalmology resident physician during ED encounter. Ophthalmology exam findings were initially recorded into the Epic Electronic Medical Records (EMR) system using the Kaleidoscope module by ophthalmology resident consultants at the time of the exam. Intraocular pressure was measured using the Tonopen Avia[®] electronic handheld tonometers (Reichert Inc., Depew, NY). All patients in 2022 with a consultation note by ophthalmology resident physicians in the Emergency Department setting were included in this study. Patients for whom ophthalmic consultation was requested but not complete at the time of the ED visit were not included.

Demographic data including sex, race/ethnicity, and age were extracted from the EMR. The primary final ophthalmic diagnosis for each encounter was obtained from the electronic medical records and sorted into major categories to identify the most frequent diagnoses. Ophthalmic exam findings collected from EMR included visual acuity, intraocular pressure (IOP), visual field by confrontation, extraocular motility, pupil exam, slit lamp exam findings, and fundoscopic findings. All abnormal ocular exam findings were reviewed and findings with a prevalence greater than 1% are listed in the results for a report of most common findings.

The data was analyzed with Excel and Power BI (Microsoft 6.85 (24051214), Redmond, WA). Descriptive statistics were calculated with means and standard deviations (SD) for continuous variables and proportions for categorical variables. Prevalence of findings are reported for the presence in either eye and in both eyes.

Results

A total of 2,087 ophthalmology consults for 1,946 patients, of whom 141 (6.8%) had more than one ED consult visit, were included. Sixty percent of patients were male; the most common self-reported race/ethnicity were White (68.7%), Black (13.3%), and Asian (8.9%). The mean $\pm$ SD age was 47.7 ± 19.3 years (range 0–102).

The ten most common primary visit diagnoses are reported in [Table 1](#), with the most frequent diagnoses being orbital wall fracture (7.3%), infectious keratitis (4.9%), and open globe injury (4.1%). Baseline eye exam characteristics are reported in [Table 2](#), including the percentages of patients with eye findings out of all patients receiving each component of the eye exam. The number of patients receiving each component of the eye exam varied; visual acuity visual field

Table 1 Ten Most Common Primary Diagnoses in Emergency Department Consults

Diagnosis	N (%)
Orbital Wall Fracture	153 (7.3%)
Infectious Keratitis	103 (4.9%)
Open Globe Injury	85 (4.1%)
Glaucoma or Ocular Hypertension	81 (3.9%)
Retinal Detachment	73 (3.5%)
Corneal Abrasion	72 (3.4%)
Periocular Infection (including preseptal cellulitis, orbital cellulitis, dacryocystitis)	67 (3.2%)

(Continued)

Table 1 (Continued).

Diagnosis	N (%)
Eyelid or Facial Laceration	65 (3.1%)
Vitreous Hemorrhage	62 (3.0%)
Uveitis (Anterior and Posterior)	61 (2.9%)
Posterior Vitreous Detachment	58 (2.8%)

Table 2 Ophthalmic Basic Eye Exam From Ophthalmic ED Consultations Between January 1, 2022 and December 31, 2022, Including Visual Acuity, Afferent Pupillary Defect, Average Intraocular Pressure, Extraocular Movement, and Confrontation Visual Field Exam

Visual Acuity, N (%)	Right Eye	Left Eye
20/40 or Better	1170 (61.9%)	1180 (62.4%)
20/50-20/150	304 (16.1%)	279 (14.8%)
20/200 - Count Fingers (CF)	208 (11%)	216 (11.4%)
Hand Motion (HM)	92 (4.9%)	89 (4.7%)
Light Perception (LP)	74 (3.9%)	59 (3.1%)
No Light Perception (NLP)	42 (2.2%)	68 (3.6%)
Total Exams	1890	1891
Afferent Pupillary Defect, N (%)		
Present		235 (12.6%)
Not Present		1425 (76.5%)
Questionable		53 (2.8%)
Not Reported		150 (8.1%)
Total Exams		1863
Non-Reactive Pupils		313 (15.7%)
Average (SD) Intraocular Pressure		
Right Eye (N=1901)	16.1 (6.6) mmHg	
Greater than 21mmHg	203 (10.7%)	
Total Exams		1901
Left Eye (N=1899)	16.1 (6.3) mmHg	
Greater than 21mmHg	191 (10.1%)	
Total Exams		1899
Extraocular Movement Exams, N (%)		
Deficits in Either Eye		302 (17.5%)
Deficits in Both Eyes		44 (2.5%)
Total Exams		1726
Visual Field Exams, N (%)		
Deficit Present		202 (16.9%)
Right Eye		107 (8.9%)
Left Eye		95 (7.9%)
Homonymous Defects		9 (0.8%)
Total Exams		1197

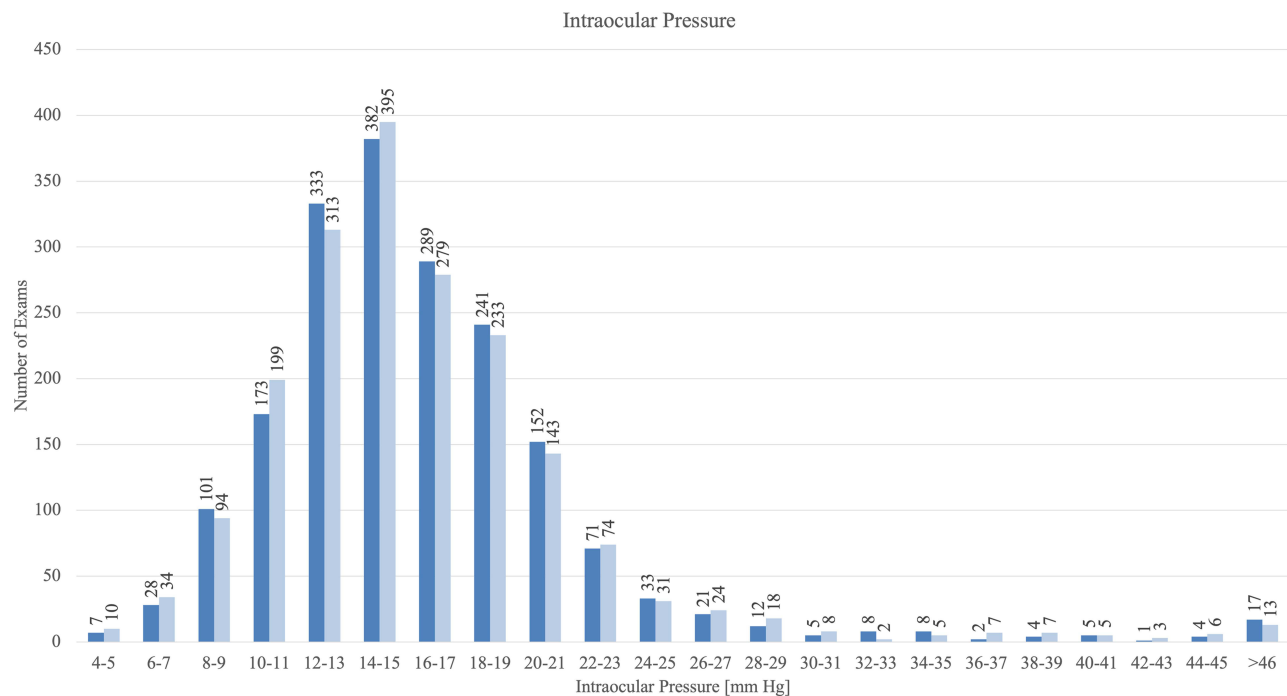


Figure 1 Histogram Intraocular pressure measurements from ophthalmic ED consultations between January and December in 2022. Dark blue bars indicate the right eye and light blue bars indicate the left eye.

testing were not obtained when patients were unable to participate in a subjective exam, intraocular pressure measurements were deferred in cases of suspected open globe injury or in cases where patients declined or had prior enucleation. Afferent pupillary defect was present in 12.6% of all consults. Intraocular pressure was greater than 21 mmHg in approximately 10% of patients for each eye, ranging from 2 to 87 mmHg. A histogram of the distribution of intraocular pressure is shown in Figure 1. Visual field deficits were present on confrontation for 16.9% of documented exams.

Slit lamp and funduscopy findings are reported in Table 3. Most common location of abnormal findings was conjunctiva, with 56.5% of eyes showing at least one abnormal finding, followed by cornea (47.2%), lens (41.8%), and retina periphery (34.3%). The most common conjunctival finding was injection (31.2%), followed by chemosis (14.8%) and subconjunctival hemorrhage (14.7%). The most common corneal findings included superficial punctate epithelial erosions (29.6%), epithelial defects (10.92%), Descemet folds (5.5%), and corneal infiltrate or ulcer (4.9%). Among lens findings, most frequent findings included cataract (31.9%) and intraocular lens (13.5%). Of 1813 patients

Table 3 Slit Lamp and Funduscopy Findings Present in >1% of Ophthalmic ED Consultations in 2022, Including External Eye, Lid/Lashes, Conjunctiva, Cornea, Anterior Chamber, Iris, Lens, Vitreous, Nerve, Macula, Vessel, and Periphery

External Eye	Either Eye, N (%)	Both, N (%)
Edema	173 (8.65%)	29 (1.45%)
Laceration	114 (5.69%)	26 (1.30%)
Ecchymosis	114 (5.69%)	20 (1.00%)
Abrasion	89 (4.45%)	11 (0.55%)
Proptosis	27 (1.35%)	3 (0.15%)
Vesicle	22 (1.10%)	1 (0.05%)
Any External Eye Findings	394 (19.69%)	
Total Exams		2001

(Continued)

Table 3 (Continued).

Lid/Lashes	Either Eye, N (%)	Both, N (%)
Edema	534 (25.76%)	98 (4.73%)
Ecchymosis	282 (13.60%)	47 (2.27%)
Meibomian Gland Dysfunction/Blepharitis	199 (9.60%)	171 (8.25%)
Laceration	172 (8.30%)	5 (0.24%)
Ptosis	145 (6.99%)	32 (1.54%)
Dermatochalasis	37 (1.78%)	32 (1.54%)
Lesion	24 (1.16%)	4 (0.19%)
Any Lid/Lash Findings	563 (27.16%)	
Total Exams		2073
Conjunctiva	Either Eye, N (%)	Both, N (%)
Injection	647 (31.21%)	106 (5.11%)
Chemosis	306 (14.76%)	54 (2.60%)
Subconjunctival Hemorrhage	305 (14.71%)	26 (1.25%)
Laceration	91 (4.39%)	2 (0.10%)
Papillae / Follicles	31 (1.50%)	16 (0.77%)
Any Conjunctiva Findings	1171 (56.49%)	
Total Exams		2073
Cornea	Either Eye, N (%)	Both, N (%)
Superficial Punctate Epithelial Erosions	612 (29.57%)	390 (18.84%)
Epithelial Defect	226 (10.92%)	24 (1.16%)
Descemet's Fold	114 (5.51%)	6 (0.29%)
Infiltrate/Ulcer	101 (4.88%)	6 (0.29%)
Edema	90 (4.35%)	4 (0.19%)
Keratic Precipitate	69 (3.33%)	17 (0.82%)
Laceration	65 (3.14%)	1 (0.05%)
Endothelial pigment	63 (3.04%)	16 (0.77%)
Neovascularization	59 (2.85%)	7 (0.34%)
Corneal Thinning	46 (2.22%)	7 (0.34%)
Pterygium	39 (1.88%)	21 (1.01%)
Foreign Body	23 (1.11%)	1 (0.05%)
Any Cornea Findings	977 (47.20%)	
Total Exams		2070
Anterior Chamber	Either Eye, N (%)	Both, N (%)
Cell/Hypopyon	166 (8.03%)	55 (2.66%)
Hypopyon	57 (2.77%)	2 (0.10%)
Flare	223 (10.78%)	23 (1.11%)
Hyphema	132 (6.38%)	3 (0.15%)
Shallow	69 (3.34%)	20 (0.97%)
Any Anterior Chamber Findings	500 (24.18%)	
Total Exams		2068

(Continued)

Table 3 (Continued).

Iris	Either Eye, N (%)	Both, N (%)
Posterior Synechiae	53 (2.56%)	12 (0.58%)
Neovascularization	49 (2.37%)	9 (0.43%)
Misshapen pupil	39 (1.88%)	0 (0.00%)
Iris Transillumination Defect	24 (1.16%)	4 (0.19%)
Any Iris Findings	146 (7.06%)	
<i>Total Exams</i>		2069
Lens	Either Eye, N (%)	Both, N (%)
Cataract	656 (31.94%)	493 (24.00%)
White/Traumatic Cataract	24 (1.17%)	1 (0.05%)
Intraocular Lens	278 (13.53%)	163 (7.94%)
Any Lens Findings	859 (41.82%)	
<i>Total Exams</i>		2054
Vitreous	Either Eye, N (%)	Both, N (%)
Posterior Vitreous Detachment	144 (9.68%)	45 (3.03%)
Vitreous Cell	133 (8.94%)	31 (2.08%)
Vitreous Hemorrhage	50 (3.36%)	5 (0.34%)
Vitreous Haze	23 (1.55%)	1 (0.07%)
Any Vitreous Findings	283 (19.03%)	
<i>Total Exams</i>		1487
Nerve	Either Eye, N (%)	Both, N (%)
Cup to Disc Ratio ≥ 0.6	144 (12.77%)	65 (5.76%)
<i>Total Exams</i>		1128
Pallor	122 (6.61%)	38 (2.06%)
Edema	56 (3.03%)	34 (1.84%)
Cupped, Enlarged, Notch	49 (2.65%)	16 (0.87%)
Hemorrhage, Disc Heme	45 (2.44%)	6 (0.32%)
Neovascularization of the Disc	39 (2.11%)	10 (0.54%)
Any Nerve Findings	243 (13.16%)	
<i>Total Exams</i>		1847
Macula	Either Eye, N (%)	Both, N (%)
No View	236 (13.02%)	28 (1.54%)
Heme (Dot Blot Hemorrhages, Flame, Intraretinal, Preretinal)	114 (6.29%)	26 (1.43%)
Drusen	64 (3.53%)	27 (1.49%)
Exudate	51 (2.81%)	15 (0.83%)
Microaneurysms	47 (2.59%)	16 (0.88%)
Detachment	37 (2.04%)	5 (0.28%)
Traction or Tractional Retinal Detachment	12 (0.66%)	5 (0.28%)
Commotio or Berlin's Edema	35 (1.93%)	3 (0.17%)
Geographic Atrophy / Macular Scar	33 (1.82%)	10 (0.55%)
Cotton Wool Spots	24 (1.32%)	2 (0.11%)
Other Retinal Abnormalities (Thickening, Hole, Lesions)	24 (1.32%)	0 (0.00%)
Any Macula Findings	301 (16.60%)	
<i>Total Exams</i>		1813

(Continued)

Table 3 (Continued).

Vessel	Either Eye, N (%)	Both, N (%)
Attenuation	119 (6.63%)	52 (2.90%)
Tortuosity	50 (2.79%)	33 (1.84%)
Any Vessel Findings	161 (8.97%)	
<i>Total Exams</i>		1794
Periphery	Either Eye, N (%)	Both, N (%)
Hemorrhage	245 (14.04%)	81 (4.64%)
Laser Scars / Panretinal Photocoagulation	117 (6.70%)	32 (1.83%)
Retinal Tear, Hole, or Operculum	77 (4.41%)	13 (0.74%)
Lattice Degeneration	66 (3.78%)	25 (1.43%)
Retinal Detachment	51 (2.92%)	1 (0.06%)
Comotio	48 (2.75%)	3 (0.17%)
Exudates	30 (1.72%)	7 (0.40%)
Neovascularization	21 (1.20%)	4 (0.23%)
Any Periphery Findings	599 (34.33%)	
<i>Total Exams</i>		1745

with a retinal exam documented, 13% were reported to have no view of the macula. Among peripheral retinal findings, most frequent findings included hemorrhage (14.0%), laser scars (6.7%), retinal tear (4.4%), and lattice degeneration (3.8%). The least common location of abnormal findings was the iris, with 7.1% of patients having an abnormal finding in either eye.

Discussion

Prior studies have focused on common ophthalmic conditions encountered in the ED⁵⁻⁷ and the need for advanced diagnostic tools for remote screening to alleviate issues of ED overcrowding, high costs, and shortage of ophthalmologists in rural areas, and to expedite the diagnosis of time-sensitive conditions.⁸⁻¹¹ The current literature still lacks a comprehensive analysis of the frequency of ophthalmic exam findings among patients, a necessary step to accurately determine the effectiveness and prognostic value of any diagnostic tool. We report the prevalence of ophthalmic examination findings from over 2,000 ED ophthalmology consults, highlighting the most frequently observed abnormal eye findings among ophthalmology consults in an ED of an academic tertiary center and level 1 trauma center.

Other authors have reported that the most common ophthalmic conditions in the ED tend to be lower acuity diagnoses such as conjunctivitis, corneal abrasions, dry eye, posterior vitreous detachments, and chalazions,^{1,7} the evaluation of which may lead to delay of care for higher priority cases in which vision loss is of greater risk. In contrast to these prior studies of all eye-related presentations to the ED, this study focuses on those receiving ophthalmic consultation, for which the acuity of findings is higher than previously reported. Our study demonstrates higher percentages of ophthalmic consults involving diagnoses that require urgent intervention, including infectious keratitis, open globe injury, and retinal detachment.

Additionally, the rate of abnormal eye vitals was high, with the prevalence of a visual acuity of 20/200 or worse in any eye greater than 20%, and the prevalence of afferent pupillary defects, extraocular movement deficits, visual field deficits, and ocular hypertension greater than 10%. This high prevalence of pathology supports the utility of ancillary ophthalmic testing in emergency ophthalmic consults, especially in the setting of difficulty obtaining in-person ophthalmology evaluation.¹ Additionally, the high rate of abnormalities on ophthalmic exam suggests that access to in-person ophthalmic consultation is important for appropriate treatment of potentially vision threatening conditions. That there is a high prevalence of abnormal ophthalmic findings among ophthalmic consultations may reflect the high volume of trauma-related consults at a level 1 trauma center. Additionally, the higher rate of more urgent diagnoses may reflect the efficacy of ED triage for ophthalmic complaints, in which less acute problems do not receive ophthalmic consultation.

ED physicians are often the first to triage ophthalmic conditions, but often have limited training and comfort in ocular examinations,^{12,13} translating into low rate of acquisition and accuracy of ED evaluation of ophthalmic vitals and examination findings.^{14,15} Automated technologies such as smartphone visual acuity testing,^{16,17} virtual reality-based automated pupillometry,¹⁸ and virtual reality or screen-based visual field testing^{19–21} have potential in ED settings to improve assessment of eye vitals. Additionally, when an in-person evaluation is not available, the use of diagnostic and screening ophthalmic imaging tools to collect data for a remote ophthalmologist or machine deep learning interpretation has been considered for use in the triage and evaluation of emergency ophthalmic conditions. Video and photograph assessments for evaluation of the lids and adnexa, smartphone photography of corneal pathology^{2,4,22} and anterior segment optical coherence tomography (OCT) for corneal pathology,²³ angle closure, and cell and flare²⁴ have potential use for ED evaluation of anterior segment anterior diagnoses. Furthermore, OCT and fundus photography have become essential components in the remote or automated evaluation of papilledema,²⁵ new onset visual field/visual acuity defect,²⁶ retinal detachment/tear, and the ophthalmology trauma work up.²⁷

The implementation of these tools allows ED providers and ophthalmologists to capture and transmit essential ophthalmic exam data and high-quality images for ophthalmology evaluation. However, prevalence data in the ED setting is critical to determine the utility of such tools. For example, fundus photography and OCT testing would not be expected to be a valid screening tool for 13% patients with no view to the macula on clinical exam. Fundus imaging of the posterior pole without peripheral imaging may miss peripheral fundus findings in over 30% of patients. Additionally, prevalence data is critical to the interpretation of testing; it allows for the determination of positive and negative predictive values of testing results, which is paramount for screening of rare conditions or time-sensitive pathologies.²⁸ The prevalence data from our study can be used for interpretation of diagnostic tools to determine predictive values for abnormal results.

Our study has several limitations. The study was conducted at two tertiary, university-based medical center EDs that serve as major referral centers for a large geographic region, and our findings may not be generalizable to all ED settings with different referral patterns and consultation practices. The findings also only represent those receiving ophthalmic consultation and does not include less severe ophthalmic pathology that the general ED provider may treat without ophthalmic consultation. The accuracy of ophthalmic exam findings documented may vary, affecting the reliability of the study's findings. Additionally, not all patients had documentation of all exam findings, either due to the clinical scenario (ie, no visual acuity documented on a sedated patient) or due to documentation error.

Conclusion

Our study provides a comprehensive report of ophthalmic findings of patients receiving ophthalmic consults in the EDs of an academic tertiary care hospital and level 1 trauma center. There is a high prevalence of decreased visual acuity, pupillary abnormalities, ocular hypertension, and anterior segment and posterior segment slit lamp exam findings among ophthalmic consults in the ED, representing the high acuity of ophthalmic consults in academic EDs.

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