

## Original Investigation

## Epidemiology of Eye-Related Emergency Department Visits

Roomasa Channa, MD; Syed Nabeel Zafar, MBBS, MPH; Joseph K. Canner, MHS; R. Sterling Haring, DO, MPH; Eric B. Schneider, PhD; David S. Friedman, MD, MPH, PhD

**IMPORTANCE** Determining the epidemiology of eye-related emergency department (ED) visits on a national level can assist policymakers in appropriate allocation of resources.

**OBJECTIVE** To study ED visits related to ocular conditions for all age groups across the United States.

**DESIGN, SETTING, AND PARTICIPANTS** Nationally representative data from the US Nationwide Emergency Department Sample (NEDS) were used to analyze ED visits from January 1, 2006, to December 31, 2011 (6 years). All patients with eye problems presenting to EDs across the United States were eligible for inclusion. A weighted count of 11 929 955 ED visits were categorized as possibly emergent (emergent), unlikely to be emergent (nonemergent), or could not be determined. Data were analyzed from March 1 to May 30, 2015.

**MAIN OUTCOMES AND MEASURES** Population-based incidence rates of eye-related ED visits, incidence rates of eye injuries, relative proportions of emergent vs nonemergent eye-related ED visits among different age groups, and independent factors associated with emergent vs nonemergent visits.

**RESULTS** From 2006 to 2011, 11 929 955 ED visits (male patients, 54.2%; mean [SD] age, 31 [22] years) for ocular problems across the United States were categorized as emergent (41.2%), nonemergent (44.3%), or could not determine (14.5%). Corneal abrasions (13.7%) and foreign body in the external eye (7.5%) were the leading diagnoses in the emergent category. More than 4 million visits were for conjunctivitis (28.0%), subconjunctival hemorrhages (3.0%), and styes (3.8%). Emergent visits were significantly more likely to occur among males (odds ratio [OR], 2.00; 95% CI, 2.00-2.01), patients in the highest income quartile (OR, 1.47; 95% CI, 1.46-1.49), older patients (OR, 2.38; 95% CI, 2.38-2.44), and patients with private insurance (OR, 1.29; 95% CI, 1.28-1.30). Mean annual inflation-adjusted charges for all eye-related ED visits totaled \$2.0 billion.

**CONCLUSIONS AND RELEVANCE** Across the United States, nonemergent conditions accounted for almost half of all eye-related ED visits. Interventions to facilitate management of these cases outside the ED could make ED resources more available for truly emergent ophthalmic and medical issues.

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**Author Affiliations:** Author affiliations are listed at the end of this article.

**Corresponding Author:** Roomasa Channa, MD, Dana Center for Preventive Ophthalmology, Wilmer Eye Institute, Johns Hopkins Hospital, 600 N Wolfe St, Woods 267, Baltimore, MD 21287 (rchanna3@jhmi.edu).

**E**mergency departments (EDs) face an ever-increasing demand to provide effective clinical care despite limited resources.<sup>1</sup> The National Hospital Ambulatory Medical Care Survey reported that, in 2002, 56.5% of all visits to the ED were emergent or urgent.<sup>2</sup> Few studies have assessed the role that EDs play in delivering eye care in the United States. Ophthalmic care is routinely provided on an outpatient basis, and trained eye care professionals are rarely available in most EDs across the United States. Nevertheless, many patients present to the ED for eye problems.<sup>3,4</sup> A statistical brief published in 2011 used data from the Nationwide Emergency Department Sample (NEDS) and stated that, in 2008, more than 636 000 ED visits for eye injuries occurred.<sup>3</sup> Our study uses 6-year data (2006-2011) from the NEDS database to determine changes in ED visits for all ophthalmic problems, including injury- and non-injury-related visits. The largest nationally representative study on this topic,<sup>5</sup> to our knowledge, was published in 1998 and reported that, from December 1992 through December 1993, 2.3 million estimated ED visits were for conditions related to the eye and its adnexa, and a large proportion of the visits (51%) were for eye conditions other than trauma. A thorough understanding of the burden of emergent and non-emergent eye care is crucial for policymakers to design efficient, patient-oriented, systemic interventions relating to ED use, reimbursement mechanisms, and ophthalmic care. The objectives of this study were to assess the national burden of eye care in the ED for all ages, assess factors associated with ED visits for eye care, and determine changes over time.

## Methods

### Data Source

NEDS is the largest all-payer ED database in the United States, developed for the Healthcare Cost and Utilization Project, which is a federal-state-industry partnership sponsored by the US Agency for Healthcare Research and Quality. NEDS provides national estimates of ED visits for all ages and allows analyses of patterns in the use of ED services. NEDS contains data from the billing records of 25 to 30 million ED visits per year from more than 950 hospitals and approximates a 20% stratified sample of hospital-based EDs across the United States. We analyzed the data available from January 1, 2006, to December 31, 2011. The database is constructed using stratified sampling based on hospital characteristics that include geographic region, trauma center designation, urban or rural location, teaching status, and hospital ownership. Application of poststratification weights allows calculation of US population-based estimates. Additional details on the methods used by the Agency for Healthcare Research and Quality are publicly available.<sup>6</sup> The institutional review board of Johns Hopkins Hospital approved the study. No patient identifiers are available in the database, and therefore individual patient consent was not required and not possible.

### Study Population

We queried NEDS to identify patient visits from 2006 through 2011 associated with a principal diagnosis related to the eye

### Key Points

**Question:** What is the epidemiology of eye-related emergency department (ED) visits across the United States?

**Findings:** Of 11.9 million ED visits for eye problems in the United States from 2006 to 2011, 44.3% were for nonemergent problems. Lower income, Medicaid, female sex, and younger age were significantly associated with ED visits for nonemergent problems.

**Meaning:** The ED visits for nonemergent eye-related problems may be more appropriately managed at facilities outside the ED and spare ED resources for truly emergent conditions.

and its adnexa using codes from the *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)*. The principal diagnosis represents the primary reason for the patient presenting to the ED based on the best judgment of the physician caring for the patient at that visit. The specific *ICD-9-CM* codes included for ocular problems unrelated to injuries were 360.0 through 379.9. The codes for eye injury were 802.6 to 802.7, 870.0 to 870.9, 871.0 to 871.9, 918.0 to 918.9, 921.0 to 921.9, 930.0 to 930.9, 940.0 to 940.9, 950.0 to 950.9, and 951.0 to 951.3. Codes for external causes of injury (*ICD-9-CM* e-codes) were used to determine mechanisms of injury.

### Measures

In addition to primary diagnoses, demographic variables studied included age, sex, primary payer information, and household income quartile of patients seen in the ED based on the residential zip code. Facility and visit variables examined included geographic location, teaching status of the hospital, timing of the visit, and total charges. Emergency department-related patient outcomes were classified as treated and released, transferred to another facility, or admitted to the same hospital.

### Data Analysis

Data were analyzed from March 1 to May 30, 2015. We applied weights, provided by the Healthcare Cost and Utilization Project in the data files, to obtain national estimates of the incidence of eye conditions. Individuals included in the study were categorized by age into the following groups: 0 to 5 years, 6 to 12 years, 13 to 18 years, 19 to 64 years, and 65 years or older. We used summary statistics to compare population characteristics across these groups. We calculated a separate incidence for annual ED visits related to eye problems and for eye injuries. Census data from each year studied were used as the denominator to determine incidence.<sup>7,8</sup>

Ophthalmic diagnoses categorized as *likely to be emergent* were labeled as *emergent*, and those categorized as *unlikely to be emergent* as *nonemergent* or *could not be determined*. Categorization was made after consensus among ourselves and based on whether the diagnosis code was suggestive of an immediate threat to vision and whether the condition could be managed in an eye clinic or urgent care center (eTable 1 in the [Supplement](#) gives a list of all diagnoses, with

frequency and categorization). NEDS includes as many as 15 diagnoses for each ED visit. Additional diagnoses were reviewed to identify the most common comorbid diagnoses among patients with one of the primary diagnoses listed above to ensure that a potentially emergent diagnosis was not associated with a nonemergent diagnosis.

We used multivariate logistic regression analysis to determine demographic and facility-level factors associated with presenting to the ED with an emergent vs a nonemergent diagnosis. Covariates included age, sex, year of presentation, day and month of presentation, insurance status, median household income, hospital location (urban or rural), and teaching status of the hospital. A separate model was used to determine whether hospital admission (as an outcome) was associated with an emergent vs a nonemergent diagnosis. The model was adjusted for the same covariates as listed above. The variables in both models were considered for inclusion based on clinical importance and were only included in the final model if the likelihood ratio was significant. All variables mentioned above were significant on likelihood ratio testing and kept in both final models.

We also studied the total charges associated with these ED visits. Total charges were corrected for inflation based on the 2011 US dollar value using the hospital services Consumer Price Index from the US Bureau of Labor Statistics (Jonathon Church, email communication, April 10, 2015). A generalized linear model with a gamma distribution was used to determine the change in inflation-adjusted charges over time.

## Results

From 2006 to 2011, an estimated 11 929 955 visits to EDs occurred in the United States for ophthalmic conditions, a mean of nearly 2 million visits per year. The estimated incidence of ED visits declined from 722 per 100 000 persons in 2006 to 636 per 100 000 persons in 2011. The mean (SD) age at presentation was 31 (22) years, and 54.2% of the patients were male. With the exception of those 65 years and older, the proportion of males presenting with eye problems was higher than that of females ( $P < .001$ ). Visits occurred more frequently during April through June than other quarters of the year ( $P < .001$ ) (Table 1).

### Insurance Rates

Overall, 19.0% of patients presenting with eye problems to the ED were uninsured and 33.9% had public insurance (Medicare or Medicaid). This proportion varied by age category and year (Table 1). In 2006, 18.4% of patients were uninsured, rising to 19.7% in 2007 and 19.5% in 2010 before declining to 18.3% in 2011. Similarly, the proportion of uninsured patients among all eye-related ED visits increased from 17.2% in 2006 to 18.4% in 2007 before declining to 16.3% in 2011. The proportion of patients presenting with eye problems to the ED who were insured by Medicaid increased steadily from 21.7% in 2006 to 29.7% in 2011, which paralleled the overall increase in the proportion of Medicaid coverage among patients presenting to EDs for all causes.

### Emergent vs Nonemergent Visits

From a total of 11 929 955 ED visits, 44.3% were categorized as nonemergent and 41.2% as emergent. For 14.5% of the ED visits, the diagnosis codes were too nonspecific for classification as emergent or otherwise. A total of 747 unique diagnosis codes were associated with primary ophthalmic disorders. Eighteen of these codes accounted for 72.1% of the visits, whereas the remaining 27.9% of the visits were distributed among 729 diagnoses. Figure 1 shows the leading diagnoses in each of the 3 categories. The diagnoses in each category and the number and proportion of these visits among age categories are summarized in Table 2.

The results of a multivariate logistic regression model (Table 3) showed that emergent visits were most likely among males (odds ratio [OR], 2.00; 95% CI, 2.00-2.01), patients in the highest income quartile (OR, 1.47; 95% CI, 1.46-1.49), older patients (OR, 2.38; 95% CI, 2.38-2.44), and patients with private insurance (OR, 1.29; 95% CI, 1.28-1.30). Charges were adjusted for inflation based on the 2011 US dollar value. Mean annual charges for eye-related ED visits were \$2.0 billion compared with \$48.6 billion for all ED visits. Figure 2 shows the changes in inflation-adjusted charges per visit for emergent and nonemergent diagnoses from 2006 to 2011. Charges increased by a mean of \$36/visit per year ( $P < .001$ ). Mean (SD) inflation-adjusted charges were \$1266 (\$2328) for emergent visits and \$631 (\$878) for nonemergent visits ( $P < .001$ ).

### Disposition From the ED

More than 90% of patients were discharged home from the ED. From 2006 to 2011, a total of 200 604 hospital admissions occurred among patients presenting to the ED with eye problems. Comparison among age categories showed that patients 65 years or older were most likely to be admitted (6.0% of all visits among patients 65 years and older vs  $\leq 1.7%$  for all other age categories) and accounted for 27.3% of all admissions, although they constituted 7.8% of the total patient population studied. Leading diagnoses that resulted in hospital admission included orbital cellulitis (15.5% of all admissions), orbital floor fractures (12.5% of all admissions), and eyelid abscess (6.9% of all admissions). Diagnoses and proportions by age categories for patients who were admitted to the hospital with a primary diagnosis of an ophthalmic problem are shown in eTable 2 in the Supplement. Patients with emergent diagnoses were much more likely to be admitted as inpatients (OR, 10.17; 95% CI, 9.82-10.54) compared with patients presenting with nonemergent diagnoses.

### Eye Injuries

From 2006 to 2011, an estimated 4 327 336 patients with eye injuries (36.3% of all ED visits for ophthalmic conditions) presented to the ED. The population-specific rate of eye injury-related ED visits declined 24.2% from 280 to 212 per 100 000 persons during this period. However, the change in incidence varied by injury type. Mean annual rates of superficial injuries, ruptured globes, and burns declined by 3.4%, 5.1%, and 6.6%, respectively, during the 6-year study period, whereas rates of other vision-threatening injuries such as blow-out orbital fractures increased by 2.5% (eTable 3 in the Supplement).

Table 1. Sociodemographic and Visit Characteristics by Age of Patients Presenting to US EDs With Ophthalmic Conditions<sup>a</sup>

Characteristic	Total (N = 11 929 955 [100%])	Patient Age Range, y				
		0-5 (n = 1 874 387 [15.8%])	6-12 (n = 949 431 [8.0%])	13-18 (n = 882 313 [7.4%])	19-64 (n = 7 291 067 [61.1%])	≥65 (n = 932 757 [7.8%])
Age, mean (SD), y	31 (21.7)	2.1 (1.6)	8.7 (2.0)	15.8 (1.7)	37.7 (12.6)	75.2 (7.8)
Sex, weighted count (%)						
Male	6 460 185 (54.2)	1 033 896 (55.2)	544 533 (57.4)	471 455 (53.3)	4 009 194 (54.8)	401 107 (42.9)
Female	5 465 152 (45.8)	839 941 (44.8)	404 532 (42.6)	410 606 (46.7)	3 278 732 (45.1)	531 341 (57.1)
Discharge quarter, weighted count (%)						
January to March	2 684 957 (22.6)	458 049 (24.4)	212 258 (22.5)	202 640 (23.0)	1 603 105 (22.1)	208 905 (22.7)
April to June	3 364 184 (28.1)	553 997 (29.5)	304 023 (31.9)	251 407 (28.4)	2 005 025 (27.4)	249 732 (26.5)
July to September	3 135 450 (26.2)	434 267 (23.2)	232 705 (24.5)	229 693 (26.0)	1 990 461 (27.2)	248 325 (26.3)
October to December	2 738 687 (23.1)	427 774 (22.8)	200 347 (21.2)	198 472 (22.6)	1 686 514 (23.3)	225 580 (24.4)
Weekend visit, weighted count (%)						
No	7 933 729 (66.5)	1 206 995 (64.4)	640 717 (67.5)	602 708 (68.4)	4 888 146 (67.1)	595 164 (63.8)
Yes	3 989 912 (33.5)	667 087 (35.6)	308 608 (32.5)	279 501 (31.6)	2 397 370 (32.8)	337 346 (36.2)
Disposition if discharged alive, weighted count (%)						
Home	11 274 722 (94.5)	1 798 486 (96.0)	907 722 (95.6)	839 353 (95.1)	6 901 782 (94.7)	827 379 (88.7)
Inpatient admission	200 604 (1.7)	19 106 (1.0)	10 747 (1.1)	9358 (1.0)	106 605 (1.5)	54 789 (6.0)
Admission to another facility <sup>b</sup>	164 296 (1.4)	18 201 (1.0)	11 649 (1.2)	12 453 (1.4)	92 706 (1.3)	29 286 (3.2)
Miscellaneous <sup>c</sup>	289 926 (2.4)	38 563 (2.1)	19 288 (2.0)	21 126 (2.4)	189 683 (2.6)	21 266 (2.3)
Primary payer, weighted count (%)						
Public	4 022 440 (33.9)	1 061 195 (56.8)	427 783 (45.3)	317 677 (36.2)	1 444 022 (20.0)	771 689 (83.2)
Private	4 565 095 (38.5)	571 906 (30.6)	389 158 (41.2)	404 994 (46.2)	3 082 286 (42.6)	116 669 (12.6)
Self-pay	2 248 846 (19.0)	164 139 (8.8)	90 246 (9.5)	107 124 (12.2)	1 863 818 (25.8)	23 412 (2.5)
No charge	84 526 (0.7)	3399 (0.2)	2121 (0.2)	2878 (0.3)	75 305 (1.0)	824 (0.1)
Other <sup>d</sup>	934 550 (7.9)	67 771 (3.6)	35 963 (3.8)	44 820 (5.1)	771 197 (10.7)	14 776 (1.6)
Hospital region, weighted count (%)						
Northeast	2 714 237 (22.8)	360 659 (18.8)	205 860 (21.0)	193 898 (21.2)	1 743 473 (22.9)	210 331 (21.3)
Midwest	2 894 215 (24.3)	484 729 (23.8)	238 438 (23.2)	225 421 (23.7)	1 741 330 (22.3)	204 133 (20.4)
South	4 307 387 (36.1)	699 380 (40.2)	351 202 (39.9)	314 267 (38.6)	2 612 488 (38.9)	329 960 (38.6)
West	2 014 469 (16.9)	329 619 (17.2)	153 931 (15.9)	148 727 (16.5)	1 193 777 (16.0)	188 333 (19.7)
Income quartile, weighted count (%)						
Lowest	3 661 925 (30.7)	656 263 (34.7)	308 269 (32.2)	273 379 (30.9)	2 189 900 (30.1)	234 056 (25.1)
Level 2	3 179 925 (26.7)	539 132 (28.7)	256 347 (26.9)	232 682 (26.2)	1 922 780 (26.3)	228 916 (24.5)
Level 3	2 655 441 (22.3)	394 557 (21.4)	202 949 (21.6)	192 593 (22.0)	1 641 626 (22.6)	223 670 (24.2)
Highest	2 160 745 (18.1)	256 996 (13.8)	166 289 (17.6)	166 430 (18.9)	1 349 442 (18.4)	221 559 (23.6)

Abbreviation: ED, emergency department.

<sup>a</sup> Based on the Nationwide Emergency Department Sample, 2006 to 2011. Counts may not add up to the totals owing to missing data; percentages have been rounded and may not total 100.

<sup>b</sup> Includes skilled nursing facilities, intermediate care facilities, and home health care programs.

<sup>c</sup> Includes against medical advice, transferred to court or law enforcement, and discharged alive with unknown destination.

<sup>d</sup> Includes worker's compensation, Civilian Health and Medical Program of the Uniformed Services (CHAMPUS), Civilian Health and Medical Program of the Veterans Administration (CHAMPVA), Title V, and other government programs.

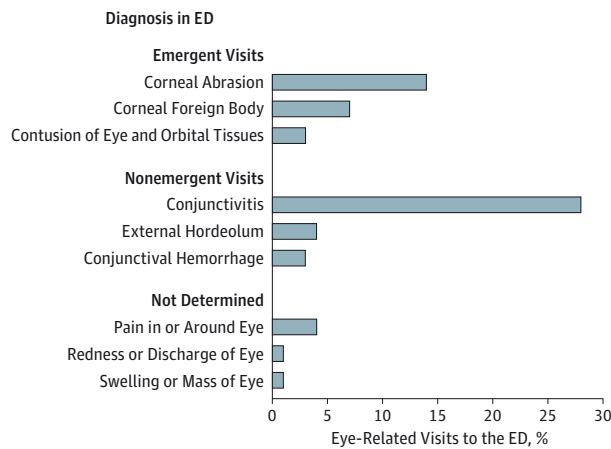
The mean (SD) age of patients with eye injuries was 32 (20) years. Two-thirds (67.4%) of all injuries occurred in the age category of 19 to 64 years, which is more than the proportion of the US population represented by this age group in 2011 (61.6%). Although males constituted 49.2% of the US population in 2011, 66.1% of all injuries occurred in males. Eye injuries accounted for less than one-quarter of all eye-related visits among children 5 years or younger, whereas

injury accounted for 40.4% of such visits among adolescents aged 13 to 18 years. The leading mechanism of injury, accounting for 29.8% of all injuries, was accidental entry of a foreign body to the eye and adnexa. The second most common cause was being struck by or against objects or persons (18.4%). Corneal abrasion and superficial laceration of the eye or its adnexal structures were the most common injuries, accounting for 37.8% of all eye injuries.

## Discussion

From 2006 to 2011, more than 4 million ED visits occurred for conjunctivitis, subconjunctival hemorrhages, and styes. All 3 conditions pose no threat to vision and can be managed at eye

**Figure 1. Leading Diagnoses in the Emergency Department (ED), 2006-2011**



Visits and diagnoses were categorized as emergent, nonemergent, and not determined by diagnostic codes. Weights provided by the Healthcare Cost and Utilization Project were applied to obtain national estimates.

clinics or urgent care, walk-in medical facilities across the country. Identifying strategies to shift these visits to eye clinics offers several important advantages. First, ED resources could be better focused on patients who truly need emergent care. Second, the patient would likely have a more expert evaluation by an eye care professional (most EDs do not have one). Third, those patients seen in an eye clinic likely would receive screening for potentially blinding conditions such as glaucoma, diabetic retinopathy, and macular degeneration. Fourth, national health care costs would be greatly reduced.

Nonurgent care costs 2 to 3 times more when provided in the ED compared with similar visits in other settings, and ophthalmic care is no exception to the rule.<sup>9</sup> The cost of care for conjunctivitis, for example, is estimated to be \$390 in the ED in our institution vs \$101 in an urgent care center and \$136 in an ophthalmologist's office.<sup>10</sup> Even in an after-hours setting, when ophthalmology offices are more likely to be closed, care provided at walk-in urgent care clinics is estimated to be far less costly than similar care provided in an ED setting.<sup>10</sup> The cost burden of ED visits for eye conditions could be reduced if patients with the top 3 nonemergent conditions were seen at eye clinics during working hours or at urgent care centers after hours. However, the trend noted in our study has been otherwise: the proportion of emergent ED visits has decreased and that of nonemergent ED visits has increased from 2006 to 2011.

Being in the highest income quartile was independently associated with a lower likelihood of presenting to the ED for nonemergent diagnoses. Studies have shown a correlation be-

**Table 2. Most Common Ophthalmic Conditions by Age at Presentation to the ED<sup>a</sup>**

Diagnosis	Patient Age Range, y					Total
	0-5	6-12	13-18	19-64	≥65	
<b>Possibly emergent, No. (%)</b>						
Contusion of eye and orbital tissues	36 383 (1.9)	44 702 (4.7)	48 555 (5.5)	172 027 (2.4)	31 329 (3.4)	332 996 (2.8)
Corneal abrasion	114 521 (6.1)	108 067 (11.4)	109 350 (12.4)	1 208 335 (16.6)	90 233 (10.0)	1 630 506 (13.7)
Foreign body on external eye <sup>b</sup>	34 228 (1.8)	36 560 (3.9)	44 493 (5.0)	740 702 (10.2)	37 414 (4.0)	893 397 (7.5)
Laceration of skin of eyelid and periocular area	83 113 (4.4)	37 956 (4.0)	33 590 (3.8)	101 073 (1.4)	15 713 (1.7)	271 445 (2.3)
Open wounds of ocular adnexa	54 339 (2.9)	24 777 (2.6)	22 667 (2.6)	71 454 (1.0)	11 032 (1.2)	184 269 (1.5)
Orbital floor fracture, closed	1377 (0.1)	4588 (0.5)	15 783 (1.8)	112 439 (1.5)	22 755 (2.4)	156 942 (1.3)
Other <sup>c</sup>	186 508 (10.0)	114 342 (12.0)	118 833 (13.5)	889 125 (12.2)	136 987 (14.7)	1 445 795 (12.1)
<b>Unlikely to be emergent, No. (%)</b>						
Conjunctivitis <sup>d</sup>	1 027 142 (54.8)	363 638 (38.3)	240 495 (27.3)	1 591 464 (21.8)	121 161 (13.0)	3 343 900 (28.0)
Conjunctival hemorrhage	21 782 (1.2)	16 415 (1.7)	19 967 (2.3)	201 211 (2.8)	94 062 (10.1)	353 437 (3.0)
External hordeolum	54 469 (2.9)	44 980 (4.7)	47 008 (5.3)	292 757 (4.0)	11 617 (1.2)	450 831 (3.8)
Other <sup>c</sup>	130 622 (7.0)	66 176 (7.0)	79 965 (9.1)	742 153 (10.2)	120 800 (13.0)	1 139 716 (9.6)
<b>Not determined, No. (%)</b>						
Pain in or around eye	22 503 (1.2)	28 371 (3.0)	36 767 (4.2)	373 811 (5.1)	48 477 (5.2)	509 929 (4.3)
Swelling or mass of eye	34 614 (1.8)	15 027 (1.6)	9805 (1.1)	59 285 (0.8)	6556 (0.7)	125 287 (1.1)
Redness or discharge of eye	39 551 (2.1)	12 336 (1.3)	8902 (1.0)	69 967 (1.0)	8921 (1.0)	139 677 (1.2)
Other specified visual disturbances	606 (0.03)	5781 (0.6)	8365 (0.9)	144 673 (2.0)	45 808 (4.9)	205 233 (1.7)
Other <sup>c</sup>	32 629 (1.7)	25 715 (2.7)	37 769 (4.3)	520 590 (7.1)	129 892 (13.9)	746 595 (6.2)
<b>Total No.</b>	<b>1 874 387</b>	<b>949 431</b>	<b>882 314</b>	<b>7 291 066</b>	<b>932 757</b>	<b>11 929 955</b>

Abbreviation: ED, emergency department.

<sup>a</sup> Based on the Nationwide Emergency Department Sample, 2006 to 2011.

<sup>b</sup> Includes corneal foreign body.

<sup>c</sup> Includes diagnoses that individually occurred less than 1% of the time in the database.

<sup>d</sup> Includes acute, chronic, allergic, or unspecified conjunctivitis.



**Table 3. Multivariate Logistic Regression Analysis of Factors Associated With ED Visits That Were Likely Emergent**

Variable Name and Category	No. (%)		OR (95% CI)
	Nonemergent Visit	Emergent Visit	
Age groups, y (reference, 19-64 y)			
0-5	1 234 015 (70.7)	510 469 (29.3)	0.42 (0.41-0.42)
6-12	491 209 (57.0)	370 992 (43.0)	0.71 (0.71-0.72)
13-18	387 435 (49.6)	393 271 (50.4)	0.94 (0.93-0.95)
≥65	347 640 (50.2)	345 463 (49.8)	0.99 (0.98-1.01)
Study year (reference, 2006)			
2007	898 783 (50.7)	874 287 (49.3)	0.98 (0.97-0.99)
2008	835 726 (51.1)	798 824 (48.9)	0.98 (0.97-0.99)
2009	824 529 (52.4)	747 872 (47.6)	0.96 (0.95-0.97)
2010	890 507 (53.2)	783 959 (46.8)	0.92 (0.92-0.93)
2011	910 001 (54.1)	772 678 (45.9)	0.91 (0.91-0.92)
Sex (reference, male)			
Female	2 812 406 (61.5)	1 762 115 (38.5)	0.50 (0.50-0.51)
Insurance (reference, uninsured)			
Medicare	434 086 (50.7)	421 969 (49.3)	1.05 (1.03-1.06)
Medicaid	1 706 270 (66.2)	869 787 (33.8)	0.79 (0.78-0.80)
Private	1 807 715 (46.6)	2 069 085 (53.4)	1.29 (1.28-1.30)
No charge	37 419 (53.3)	32 763 (46.7)	0.92 (0.89-0.96)
Other <sup>a</sup>	275 638 (33.4)	548 306 (66.5)	1.95 (1.93-1.98)
Teaching status of hospital (reference, metropolitan nonteaching)			
Metropolitan teaching	2 175 043 (53.0)	1 932 579 (47.0)	1.08 (1.07-1.08)
Nonmetropolitan	971 539 (50.6)	946 943 (49.4)	0.89 (0.88-0.91)
Region of hospital (reference, northeast)			
Midwest	1 269 919 (51.0)	1 219 775 (49.0)	1.08 (1.07-1.09)
South	1 994 773 (53.8)	1 712 636 (46.2)	1.04 (1.04-1.05)
West	849 023 (50.1)	845 577 (49.9)	1.14 (1.12-1.15)
Estimated median household income of residents in the patient's zip code (reference, 0-25th percentile)			
26th to 50th percentile (median)	1 441 817 (52.6)	1 297 934 (47.4)	1.13 (1.12-1.14)
51st to 75th percentile	1 116 061 (49.2)	1 151 070 (50.8)	1.27 (1.26-1.28)
76th to 100th percentile	808 053 (44.6)	1 004 298 (55.4)	1.47 (1.46-1.49)
Patient address, NCHS urban-rural code in 2006 (reference, central counties of metropolitan areas with population ≥1 million)			
Counties			
Fringe <sup>b</sup>	1 153 715 (49.4)	1 181 701 (50.6)	1.16 (1.15-1.17)
Metropolitan areas (larger population) <sup>c</sup>	1 089 166 (51.5)	1 026 388 (48.5)	1.21 (1.20-1.22)
Metropolitan areas (smaller population) <sup>d</sup>	473 139 (50.7)	460 251 (49.3)	1.25 (1.23-1.26)
Micropolitan	603 735 (50.9)	583 350 (49.1)	1.43 (1.41-1.45)
Not metropolitan or micropolitan	368 916 (48.2)	397 195 (51.8)	1.60 (1.58-1.63)
Admission day (reference, Monday-Friday)			
Weekend	1 790 417 (51.8)	1 669 017 (48.2)	1.01 (1.00-1.01)
Discharge quarter (reference, January-March)			
April-June	1 543 298 (53.2)	1 358 480 (46.8)	1.00 (0.99-1.01)
July-September	1 322 074 (49.6)	1 343 473 (50.4)	1.13 (1.12-1.14)
October-December	1 189 462 (50.9)	1 145 467 (49.1)	1.10 (1.09-1.11)

Abbreviations: ED, emergency department; NCHS, National Center for Health Statistics; OR, odds ratio.

<sup>a</sup> Includes worker's compensation, Civilian Health and Medical Program of the Uniformed Services (CHAMPUS), Civilian Health and Medical Program of the Veterans Administration (CHAMPVA), Title V, and other government programs.

<sup>b</sup> Indicates metropolitan areas with a population of at least 1 million.

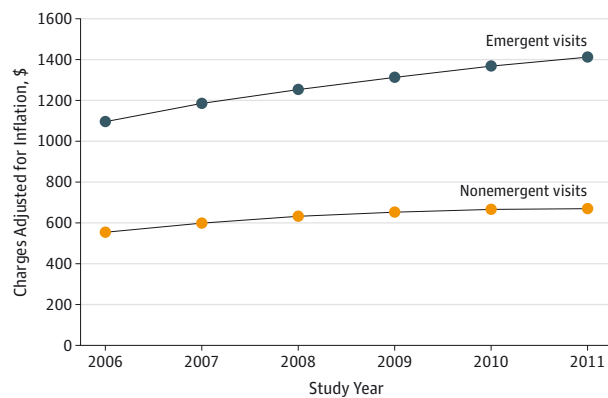
<sup>c</sup> Indicates population of 250 000 to 999 999.

<sup>d</sup> Indicates population of 50 000 to 249 999.

tween higher income and better overall health.<sup>11,12</sup> Results from the National Health Interview Survey<sup>13</sup> in 2002 identified lower income as significantly associated with visual impairment. In addition, patients with higher income have been shown to have

a higher likelihood of having an eye examination,<sup>14</sup> suggesting that they may already have an established eye care professional for nonemergent problems, leading to ED use only for emergent conditions. When compared with patients with

Figure 2. Mean Charges per Emergency Department (ED) Visit



The change over time is given in mean inflation-adjusted charges (US dollars) per visit for emergent and nonemergent eye-related ED visits.

private insurance, uninsured patients and patients with Medicaid were more likely to be seen in the ED for nonemergent conditions. This finding is not specific to eye problems alone. Cunningham et al<sup>15</sup> reported a higher use of the ED for non-urgent health problems among patients with Medicaid compared with all other groups, including the uninsured. Possible reasons include the fact that Medicaid patients are less likely to have access to a primary care physician.<sup>16,17</sup> In a study of more than 57 000 patients assigned to 353 primary care practices affiliated with a Medicaid health maintenance organization, increased access to primary care physicians was associated with lower rates of ED use.<sup>18</sup> The proportion of patients with Medicaid increased over time in our patient cohort and also among all patients presenting to the ED during this time period. The rising proportion of patients with Medicaid underscores the need to increase access to primary care and improve education among Medicaid recipients regarding availability of urgent care clinics after hours. These changes could help reduce costs for eye problems in this population.

Our study found eye injury rates that were lower than previous estimates.<sup>5,19-21</sup> Although methodologic differences likely also play a role in this discrepancy, we believe that the difference can be attributed largely to 2 factors. First, our results represent an estimate of the ED burden of eye injury, whereas some estimates,<sup>20,21</sup> including a 2001 National Hospital Ambulatory Medical Care Survey reporting an injury incidence rate of 698 per 100 000 persons,<sup>20</sup> have attempted to characterize this burden in urgent care offices, outpatient clinics, and private physicians' offices in addition to the ED. Second, the lower rate we report may reflect actual changes in injury incidence over time. This trend has been pronounced across the existing lit-

erature; ED-based studies reported eye injury incidence rates of 447 per 100 000 persons in 1993 and 315 per 100 000 persons in 2000.<sup>5,21</sup> We report a rate of 212 per 100 000 persons in 2011, suggesting continued, although slowed, reduction in the incidence of ED treatment of eye injuries over time. This trend may be explained in part by policy and behavioral interventions, including awareness campaigns such as Eyesmart<sup>22</sup>; strengthened requirements by the Occupational Safety and Health Administration regarding eye protection in the workplace<sup>23</sup>; and a steady increase in the use of seatbelts,<sup>24</sup> which has been associated with reduction of serious eye injury.<sup>25</sup>

Although eye injuries overall have declined, orbital blow-out fractures have increased. The leading cause of orbital fractures was an unarmed fight or brawl, followed by falls, both situations in which one is unlikely to be wearing protective eye wear. Falls are a potentially preventable problem. However, despite falls being identified as a leading cause of injury in older adults<sup>26</sup> and being a leading contributor to morbidity and mortality in that age group,<sup>27-29</sup> the rates of falls among the elderly have increased<sup>30</sup> and the total number of falls will continue to increase as the population ages.<sup>31</sup> The rates of orbital fractures per 100 000 persons among those 65 years and older increased by 30.0% during the 6-year study period. Given the extent to which falls contribute to orbital blow-out fractures in this population, policies and interventions aimed at reducing the frequency and severity of falls in older adults will likely be key to reducing the burden of these severe ocular injuries in future years.

One of the limitations of our study is in the assessment of the cost of ED visits. NEDS provides hospital charges with no charge-to-cost conversion for ED visits. Thus, the hospital charges described in our study reflect the total ED-related charges but not the final cost to the patient, physician, or hospital for these visits.

## Conclusions

Our study provides national estimates of the annual incidence of ED presentation for eye-specific problems across the United States, describes trends in ED-treated ophthalmic disorders across a 6-year period, and identifies patient factors, such as younger age, female sex, lower income quartile, and Medicaid insurance, associated with ED use for nonemergent problems. These data suggest that expanded use of urgent care centers and improved access to eye care professionals' offices, especially among these groups of patients, could provide more cost-effective care for nearly half of those who visit EDs for ocular problems.

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**Author Affiliations:** Dana Center for Preventive Ophthalmology, Wilmer Eye Institute, Johns Hopkins Hospital, Baltimore, Maryland (Channa, Friedman); Department of Surgery, Howard University Hospital, Washington, DC (Zafar); Johns Hopkins Surgery Center for Outcomes Research, Department of Surgery, Johns Hopkins School of Medicine, Baltimore, Maryland (Canner, Schneider);

Center for Surgery and Public Health, Brigham and Women's Hospital, Boston, Massachusetts (Haring, Schneider); Department of Epidemiology, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland (Schneider, Friedman); Harvard Medical School, Boston, Massachusetts (Schneider).

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**Study concept and design:** Channa, Zafar, Haring, Schneider, Friedman.

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