Incidence of Emergency Department–Treated Eye Injury in the United States

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Objective: To present the descriptive epidemiology of emergency department–treated eye injury in the United States.

Methods: Data from the Consumer Product Safety Commission’s National Electronic Injury Surveillance System All Injury Program was used to estimate the number of patients treated in US emergency departments for eye injuries. Eye injury rates were calculated according to age, sex, and race, and characteristics of the injury event were determined.

Results: The rate of emergency department–treated eye injury in the United States is 3.15 per 1000 population (95% confidence interval, 2.66-3.63). Rates were highest among those in their 20s and 30s, among males, and among American Indians and African Americans. The majority of injuries occurred in the home, and contusions and abrasions were the most common types of injury.

Conclusion: This study documents the burden of eye injury in the United States and identifies areas wherein future research activities should be directed.


Eye injury is a leading cause of monocular blindness in the United States and is second only to cataract as the most common cause of visual impairment. Injury is the most common reason for eye-related emergency department (ED) visits. Most eye injuries are preventable with the appropriate use of protective eyewear, yet the use of such equipment is often infrequent. The majority of eye injuries occur in the home and workplace, and young males are the most frequent victims. Most eye injuries are minor (eg, corneal abrasions and periorbital contusions and lacerations) and likely result in no permanent visual impairment. For severe eye injuries, a substantial proportion of patients experience poor visual outcomes.

The reported incidence of eye injury in the United States varies widely (Table). Tielsch et al10 and Klopfer et al11 report an incidence of 27.3 and 29.1 per 100 000 population, based on hospital admissions in Maryland and the United States, respectively. The incidence of eye injuries requiring medical attention in New England was estimated to be 975 per 100 000 population,12 which was approximately twice the rate reported for adults in Baltimore, Md (490 per 100 000 population).13 Karlson and Klein8 and Nash and Margo2 report rates of 423 and 447 per 100 000 population, based on data from Wisconsin and the United States, respectively. There are several reasons for this variability in injury rates. Perhaps the most significant factor is the choice of study population. Some studies have focused on eye injuries that require hospital admission, which are rare, while others have focused on both inpatients and outpatients.

To understand the impact of eye injury in the United States and to plan preventive strategies, it is important to depict the complete magnitude of the problem with regard to true population-based data and standard, reproducible definitions. Herein we report the incidence of eye injury treated in US EDs overall and according to age, sex, and race, as well as characteristics of these injuries, using data from the National Electronic Injury Surveillance System (NEISS).

METHODS

DATA SOURCE AND STUDY POPULATION

In July 2000, the Centers for Disease Control and Prevention’s National Center for Injury Prevention and Control, in collaboration with the Consumer Product Safety Commission, expanded the Consumer Product Safety Com-
mission's NEISS to include all types and external causes of nonfatal injuries treated in US hospital EDs. This ongoing surveillance system is called the NEISS All Injury Program (NEISS-AIP). Normally, the NEISS collects data only on nonfatal injuries treated in US hospital EDs that resulted from consumer products. Data from the NEISS-AIP can be used to calculate national, standardized, weighted estimates for nonfatal injuries treated in US hospital EDs. Data for the year 2000 was used in the present study.

The NEISS-AIP includes data from 66 of the 100 NEISS hospitals, which are a nationally representative, stratified probability sample of the approximately 5000 hospitals in the United States and its territories with a minimum of 6 beds and a 24-hour ED. The sample includes separate strata for very large, large, medium, and small hospitals (defined by the number of annual ED visits per hospital) and children's hospitals. There are 31 hospitals in the small stratum, 9 in the medium, 6 in the large, and 13 in the very large, and there are 5 hospitals in the children's stratum. The NEISS-AIP provides data on approximately 500,000 injury- and consumer product–related ED cases each year. Data from these cases are weighted by the inverse of the probability of selection to provide national estimates.

The NEISS-AIP defines nonfatal injuries and poisonings as bodily harm resulting from acute exposure to an external force or substance (ie, mechanical, thermal, electrical, chemical, or radiant) and near drowning, including unintentional and violence-related causes. Cases were excluded if (1) the principal diagnosis was an illness, pain only, psychological harm (eg, anxiety and depression) only, contact dermatitis associated with exposure to consumer products (eg, body lotions, detergents, and diapers) and plants (eg, poison ivy), or unknown; or (2) the ED visit was for adverse effects of therapeutic drugs or of surgical and medical care.

Data obtained for each NEISS-AIP case include age, race/ethnicity, sex, principal diagnosis, primary body part affected, consumer products involved, disposition at ED discharge (ie, hospitalized, transferred, treated and released, observed, or died), locale where the injury occurred, relation of the injury to the person's employment, and a narrative description of the injury circumstances. Mechanisms of injury were classified by trained coders into recommended major external cause-of-injury groupings by using definitions consistent with *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) external cause coding guidelines. For the purposes of this study, cases wherein the primary body part affected was identified as "eyeball" were selected. Injuries to the orbit and soft tissue around the eye were not included in this definition of eye injury; only injuries to the globe were included.

**STATISTICAL ANALYSIS**

Rates of eye injury according to age, sex, and race were calculated by using weighted counts from the NEISS-AIP as the numerator and population estimates from the 2000 US Census Bureau as the denominator. Injury rates were calculated along with their associated 95% confidence intervals (CIs); appropriate standard errors for these calculations were obtained using SUDAAN, version 8.0 (Research Triangle Institute, Research Triangle Park, NC), which is able to account for the sampling used by the NEISS-AIP. Information pertaining to type and mechanism of eye injury is also presented.

In the year 2000, there were an estimated 884,829 patients treated for eye injuries in US EDs, which is a rate of 3.15 per 1000 population (95% CI, 3.04-3.26). The rate of eye injury according to age is presented in Figure 1; rates are highest for persons in their 20s and 30s and lowest among those 60 years and older. The injury rate among males was 4.52 per 1000 population (95% CI, 3.77-5.20) compared with 1.82 per 1000 population (95% CI, 1.55-2.10) for females. Injury rates were highest among American Indians and African Americans, followed by white, Hispanic, and Asian subjects (Figure 2).

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Table. Summary of Existing Literature Reporting Population-Based Rates of Eye Injury

<table>
<thead>
<tr>
<th>Resource</th>
<th>Study Period</th>
<th>Study Population</th>
<th>Patient Type</th>
<th>Injury Definition</th>
<th>Eye Injury Rate*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karlson and Klein</td>
<td>1979</td>
<td>Dane County, Wisconsin</td>
<td>Inpatient/outpatient</td>
<td>Nonstandard</td>
<td>423.0</td>
</tr>
<tr>
<td>Tielsch et al</td>
<td>1979-1986</td>
<td>Maryland</td>
<td>Inpatient</td>
<td>ICD-9 codes</td>
<td>27.3</td>
</tr>
<tr>
<td>Klopper et al</td>
<td>1984-1987</td>
<td>United States</td>
<td>Inpatient</td>
<td>ICD-9 codes</td>
<td>29.1</td>
</tr>
<tr>
<td>Glynn et al</td>
<td>1985</td>
<td>New England states</td>
<td>Inpatient/outpatient</td>
<td>Self-report</td>
<td>975.0</td>
</tr>
<tr>
<td>Katz and Tielsch</td>
<td>1985-1988</td>
<td>Baltimore, Md</td>
<td>Inpatient</td>
<td>ICD-9 codes</td>
<td>490.0</td>
</tr>
<tr>
<td>Wong et al</td>
<td>1985-1994</td>
<td>US military personnel</td>
<td>Inpatient</td>
<td>ICD-9 codes</td>
<td>77.1</td>
</tr>
<tr>
<td>Hsieh et al</td>
<td>1989</td>
<td>US military personnel</td>
<td>Inpatient/outpatient</td>
<td>Nonstandard</td>
<td>1420.0</td>
</tr>
<tr>
<td>Fong</td>
<td>1989-1990</td>
<td>Victoria, Australia</td>
<td>Inpatient</td>
<td>ICD-9 codes</td>
<td>15.2</td>
</tr>
<tr>
<td>Desai et al</td>
<td>1991</td>
<td>Scotland</td>
<td>Inpatient</td>
<td>ICD-9 codes</td>
<td>8.1</td>
</tr>
<tr>
<td>Wong and Tielsch</td>
<td>1991-1996</td>
<td>Singapore</td>
<td>Inpatient</td>
<td>ICD-9 codes</td>
<td>12.6</td>
</tr>
<tr>
<td>Nash and Margo</td>
<td>1993</td>
<td>United States</td>
<td>Outpatient</td>
<td>ICD-9 codes</td>
<td>447.1</td>
</tr>
<tr>
<td>Andreotti et al</td>
<td>1998</td>
<td>US military personnel</td>
<td>Inpatient/outpatient</td>
<td>ICD-9 codes</td>
<td>983.0</td>
</tr>
<tr>
<td>McCarty et al</td>
<td>NR</td>
<td>Victoria, Australia</td>
<td>Inpatient/outpatient</td>
<td>Self-report</td>
<td>1140.0</td>
</tr>
</tbody>
</table>

*Abbreviations: ICD-9, International Classification of Diseases, Ninth Revision; NR, not reported.
*Injury rate per 100,000 population.
The most common injury to the eye was a contusion or abrasion (44.4%), followed by foreign bodies (30.8%), burns (10.2%), and conjunctivitis (9.9%) (Figure 3). Other, less common injuries included lacerations (1.8%) and punctures (0.5%). The majority of injuries occurred in the home (44.6%). Public places (eg, office buildings, restaurants) (23.6%) and industrial locales (20.3%) were also common places of occurrence. Smaller proportions of injuries occurred on highways (5.6%), in schools (3.0%), or in athletic facilities (2.9%). The most common cause of eye injury was a foreign body (44.6%), followed by being struck against or by an object (33.0%) and burns (12.0%) (Figure 4). Machinery (3.1%), motor vehicle crashes (2.3%), and falls (1.8%) were less frequent causes of eye injury.

According to the results of our study, the rate of ED-treated eye injury in the United States in 2000 was 3.15 per 1000 population. Numerous studies have presented population-based rates of eye injury; however, those studies differ according to their definitions of eye injury and the populations studied (Table). Some studies relied on self-report of eye injury, while others used administrative (eg, International Classification of Diseases, Ninth Revision) codes. Moreover, many studies have focused on eye injuries that were serious enough to require hospital admission; although those injuries are the most likely to be visually disabling, they are also rare and therefore represent only a small part of the problem. Finally, 3 studies were conducted among military populations. Thus, it is difficult to compare our rate with those reported in the existing literature.

Studies that have focused exclusively on hospitalized injuries have generally reported low rates of eye injury relative to those studies that have included both ED-treated and hospitalized injuries. With respect to the former, eye injury rates ranged from a low of 8.1 per 100,000 to a high of 77.1 per 100,000. Exclusion of studies from outside the United States and those involving military personnel resulted in a more consistent rate (27.3 and 29.1 per 100,000). For combined inpatient and outpatient injuries, eye injury rates from US population-
based studies were 423, 490, and 975 per 100 000 population. It should be noted that 2 of those studies relied on self-report of eye injury, and 1 estimated incidence on the basis of lifetime prevalence estimates.

Only 1 study has provided incidence estimates that were based solely on ED visits, as was the case in the present study. The rate in that study was higher (447.1 per 100 000 population) than that reported herein (315 per 100 000 population). Differences in the definition of eye injury could account for this difference, because the earlier study included injuries other than those involving the eye itself (eg, orbital floor fracture and wounds of the ocular adnexa). Assuming that between two thirds and three quarters of all eye injuries (including orbital fractures and injury to the ocular adnexa) involve the globe, the rates from that study and ours may be similar.

We found that the eye injury rate is elevated in children, but reaches a peak in the third decade of life and then steadily declines. The rate appears to plateau in the oldest age groups. This pattern has been reported elsewhere, although some studies have also noted a more dramatic increase among older adults. The high rate among young adults is not surprising and likely reflects greater exposure to potentially injury-producing hazards. This is also a likely explanation for the higher rate among males. One potential explanation for some studies reporting an elevation among older adults is that of sample size. This discrepancy between studies may be real. Tielsch et al and Hsieh et al reported generally similar rates of eye injury for white and black subjects. However, others reported elevated rates for black subjects, although these rates were often based on small sample sizes. Two other studies could not report rates by racial group because there was little racial heterogeneity in the study population. From the existing evidence, little can be concluded regarding an association between race and eye injury.

Approximately 1 million eye injury–related ED visits occur each year in the United States, representing less than 2% of all ED visits; most of these injuries do not require hospitalization and likely result in no visual impairment. However, despite their minimal long-term morbidity, less serious eye injuries may result in lost productivity and sharp reductions in quality of life. Although research regarding the latter is sparse, at least 1 study has suggested that ocular trauma is associated with psychomorbidity and problems of adjustment. Among serious eye injuries that require hospitalization, the risk of poor visual outcome is significant. Thus, it is important to consider the full spectrum of eye injuries to gain the proper perspective on the significance of this public health problem.

Research has consistently shown that, despite the severity of the resulting injury, most eye injuries are preventable with the use of protective eyewear; however, use of such devices is not universal. Moreover, a large proportion of eye injuries occur in the workplace, where the use of eye protection is mandated. Whether eye injuries in this setting result from failure to comply with such regulations or ineffective eye protection requires additional attention. The majority of injuries occurred in the home, where regulations regarding protective eyewear do not exist. To the extent that these injuries resulted from the use of consumer products, it would be important to determine which products encourage the use of protective eyewear and the actual frequency of use. Such information, along with the high-risk groups identified in the present study, could then be used to develop interventions targeted toward specific consumer products and the particular risk of eye injury associated with their use. The true benefit of protective eyewear remains largely unknown because few studies have empirically tested the protection offered by these devices. The introduction of face protection in ice hockey has been shown to reduce the risk and severity of eye injury. However, empirical evidence of the effectiveness of protective eyewear in other settings remains unknown. Moreover, the role of other potential risk factors for eye injury also remains unknown because little research has been conducted.

The results of the present study should be interpreted in light of several strengths and limitations. First, compared with the existing literature, this study was able to provide a more complete picture of eye injuries because of our focus on ED-treated cases rather than on less common, more serious hospitalized cases. Of course, more serious injuries are associated with the greatest morbidity, and thus an understanding of the nature and circumstances of these injuries is important. Unfortunately, because such injuries are rare, the NEISS-AIP contains few such events; therefore, this study cannot address issues of injury severity. Excluded from our estimates are those injuries that are seen directly by ophthalmologists and optometrists. It is unknown what proportion of all eye injuries are seen directly by ophthalmologists and optometrists vs EDs; however, it would not be surprising if the number is low. If that is the case, the eye injury incidence reported in this article will be lower than the true incidence but perhaps only slightly lower. However, the existing literature provides ample detail on serious eye injuries and complements the findings from the present study. Second, because the NEISS-AIP samples data from across the United States, the results of this study are not likely to be affected by regional differences in eye injury risk and characteristics. The disadvantage associated with this breadth is a lack of depth. Fairly limited information on the nature and circumstances of each injury is available in the NEISS-AIP. Additional information pertaining to the specific activities at the time of in-
jury and use of eye protection would have provided a more detailed picture of the high-risk activities associated with the occurrence of eye injuries. Third, information on the occurrence of eye injuries is obtained directly from medical records and not via self-report, as was the case with several other studies. Unfortunately, in the present study detailed diagnosis information was not available. Thus, while we were able to present rates for globe injury, we were unable to present rates specific to or including injury to associated structures.

Our study has presented the epidemiology of ED-treated eye injuries in the United States. In contrast to existing studies that provide estimates of the rate of severe eye injury only, our study provides a more comprehensive estimate by including a preponderance of such injuries, that is, those not requiring hospitalization. Such information is important for documenting the full public health impact of eye injury and identifying potential avenues for education initiatives and future research. Finally, given the large number of eye injuries seen in US EDs, ophthalmologists should train their emergency medicine colleagues to recognize, treat, and refer, when appropriate, the most common injuries seen in the ED.

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REFERENCES