

Eye Injuries, Active Component, U.S. Armed Forces, 2000-2010

The structure of the face and eye offer natural protection against eye injury. The bony orbit and quickly closing eyelids protect the eyeball from minor impacts and harmful substances. As a result, most eye injuries spare the eyeball and are not serious. However, even minor eye injuries can result in lost duty time and reduced military operational effectiveness. More significant eye injuries can cause blindness or other permanent loss of visual function in one or both eyes. The U.S. military has aggressively countered eye injury threats, especially those related to combat; in 2004, ballistic protective eyewear became standard issue for deploying forces.

Several recent reports have reviewed the numbers and natures of eye injuries among U.S. service members.¹⁻³ In an effort to improve eye injury surveillance in the U.S. Armed Forces, the Tri-Service Vision Conservation and Readiness Program (TSVCRP) at the US Army Public Health Command (USAPHC) and the Armed Forces Health Surveillance Center (AFHSC) have recently developed a quarterly surveillance report designed to monitor rates and trends of eye injuries among active component service members by cause and by specific military, occupational and demographic characteristics. This article summarizes selected results from the most recent of these reports.

Methods:

The surveillance period was January 2000 to December 2010. The surveillance population included all members of the U.S. Armed Forces who served in the active component at any time during the surveillance period. Eye injury diagnoses were derived from standardized records of medical encounters that occurred in (a) fixed military and non-military medical facilities in the U.S. and overseas and (b) deployed military medical facilities (primarily in Iraq and Afghanistan). Eye injuries diagnosed in deployed settings were summarized for the period January 2005 to December 2010 only.

Eye injuries were defined by eye injury-specific diagnostic codes (Table 1) coded in any diagnostic position during a medical visit. For surveillance purposes, if an individual had the same eye injury documented in different clinical settings, diagnoses reported during hospitalizations in fixed medical facilities were prioritized over those reported during medical encounters in deployed settings which, in turn, were prioritized over diagnoses reported during outpatient encounters in fixed medical facilities.

Seventy-three eye injury-related diagnostic codes (ICD-9-CM) were separated into nine clinically relevant categories (Table 1). The “high risk of blindness” category reflected the

findings of a 2006 study of United States Eye Injury Registry data; in that study, injuries with the highest risk of blindness were perforating trauma (64% of such injuries caused blindness), globe rupture (60%), intraocular foreign body (25%), and penetrating trauma (23%).⁴

To estimate the number of individuals affected by “superficial injuries” of the eye, each individual could be considered an “incident case” only once per 60-day period. For all non-superficial eye injury categories, individuals could be incident cases of each type of injury only once during the surveillance period. Rates of eye injuries in fixed medical facilities were calculated as incident medical encounters per 1,000 person-years of service in the active component. Rates of injuries diagnosed in deployed settings were not calculated because of incomplete ascertainment of all medical encounters and all service time during deployments throughout the surveillance period. Finally, causes of injuries were assessed using external cause of injury codes (ICD-9-CM “E codes”) for eye injuries treated in ambulatory settings and STANAG (NATO Standardization Agreement No. 2050) codes for hospitalized eye injuries.

Table 1. Defining diagnostic codes (ICD-9-CM) of nine clinical categories of eye injury

Injury category	Description	Diagnosis codes
High risk blindness ^a	Perforating/penetrating trauma, globe rupture, intraocular foreign body	871.0-871.9
Anterior segment	Hyphema, traumatic cataract	364.41, 366.22, 364.76
Burns	Chemical and thermal burns of eye/adnexa	940.0-940.5, 940.9, 941.02, 941.12, 941.22, 941.32, 941.42, 941.52
Contusion	Black eye, contusion of globe	921.0-921.3, 921.9
Lid/adnexa	Lacerations of lid and adjacent structures	870.0-870.2, 870.8-870.9
Optical/cranial nerve	Optic nerve, eye movements	950.0-950.3, 950.9, 951.0, 951.1, 951.3
Orbit	Orbital fractures and orbital penetrating wounds	802.6-802.8, 870.3-870.4, 367.32
Posterior segment	Retinal and choroidal hemorrhage, retinal detachment	362.81, 361.0, 361.00-361.07, 363.61, 363.63, 379.23, 360.00-360.01
Superficial	Abrasions and external foreign bodies	918.0-918.2, 918.9, 930.0-930.2, 930.8-930.9

^aHigh risk of blindness category based on a 2006 study of United States Eye Injury Registry data.⁴

Results:

Eye injuries treated in fixed medical facilities:

During the 11-year surveillance period, there were 186,555 eye injuries diagnosed in fixed (e.g., not deployed, at sea) medical facilities. Of these, approximately 3 percent (n=4,030) required hospitalization; most by far (n=182,525) were treated during ambulatory visits only (Table 2).

During the period, the overall rate of eye injury hospitalizations was 0.26 per 1,000 person-years (p-yrs). Rates of eye injury hospitalizations were stable during 2000 through 2002 (0.21 per 1,000 p-yrs), increased sharply in 2003 and 2004 (0.29 and 0.34 per 1,000 p-yrs respectively),

Table 2. Incident diagnoses and rates of eye injury, by clinical setting and demographic and military characteristics, active component, U.S. Armed Forces, 2000-2010

	2000-2010			
	Ambulatory		Hospitalization	
	No.	Rate ^a	No.	Rate ^a
Total	182,525	11.65	4,030	0.26
Gender				
Male	156,092	11.66	3,787	0.28
Female	26,433	11.63	243	0.11
Age group				
<20	12,828	8.45	380	0.25
20-24	62,902	11.88	2,005	0.38
25-29	39,891	12.29	812	0.25
30-34	25,265	11.25	419	0.19
35-39	22,265	11.45	229	0.12
>=40	19,374	13.68	185	0.13
Service				
Army	64,479	11.64	1,920	0.35
Navy	45,207	11.67	723	0.19
Air Force	44,769	11.73	455	0.12
Marine Corps	21,572	10.75	870	0.43
Coast Guard	6,498	15.16	62	0.14
Rank				
Enlisted, junior (E1-E4)	83,602	12.19	2,570	0.37
Enlisted, senior (E5-E9)	71,090	11.37	1,159	0.19
Officer, junior (O1-O3,W1-W3)	16,350	10.54	214	0.14
Officer, senior (O4-O10,W4-W5)	11,483	11.52	87	0.09
Occupation				
Enlisted occupations				
Infantry, guncrew, seamen	25,691	11.27	1,351	0.59
Electronic equipment repair	12,966	11.36	199	0.17
Communications & intelligence	12,132	10.06	295	0.24
Healthcare	12,667	14.32	205	0.23
Technical & other professional	4,886	11.90	99	0.24
Functional support & admin	21,363	10.51	307	0.15
Electrical/mechanical repair	35,152	13.17	606	0.23
Craftwork & Construction	8,585	16.88	146	0.29
Service, transport & supply	13,736	11.00	372	0.30
Students, trainees & unknown	7,514	10.26	149	0.20
Officer occupations				
General/flag ofc & executives	290	13.09	2	0.09
Tactical operations	9,355	10.29	141	0.16
Intelligence	1,304	9.53	14	0.10
Engineering & maintenance	4,022	11.36	22	0.06
Healthcare	4,819	12.08	42	0.11
Scientists & professional	1,472	11.03	15	0.11
Administrative	1,815	10.91	12	0.07
Supply & logistics	2,250	10.65	27	0.13
Students, trainees & unknown	2,506	11.60	26	0.12

^aRate per 1,000 person-years

generally declined during 2005 through 2008 (0.23 per 1,000 p-yrs) and remained stable in 2009 and 2010 (Figure 1a). Rates of incident eye injury-related ambulatory visits were relatively stable throughout the period (Figure 1b); the overall rate during the surveillance period was 11.65 per 1,000 p-yrs.

Demographic and military characteristics:

During the 11-year period, the highest incidence rates (unadjusted) of eye injury-related hospitalizations affected service members in enlisted combat-specific occupations (0.59 per 1,000 p-yrs) and in the Marine Corps (0.43 per 1,000 p-yrs). The highest rates of eye-injury-related ambulatory visits affected service members in enlisted craftwork and construction occupations (rate: 16.88 per 1,000 p-yrs), in the Coast Guard (rate: 15.16 per 1,000 p-yrs), in enlisted health care occupations (14.32 per 1,000 p-yrs) and over 40 years of age (13.68 per 1,000 p-yrs) (Table 2).

The overall rate of eye injury-related hospitalizations was more than twice as high among males as females (Figure 1a). However, rates of eye injury-related ambulatory visits (overall) were similar among males and females throughout the period (Table 2, Figure 1b).

The rate of eye injury-related hospitalizations was nearly two times higher among 20-24-year olds (0.38 per 1,000 p-yrs) than those 40 and older (0.13 per 1,000 p-yrs) (Table 2, Figure 2a). Conversely, rates of eye injuries diagnosed during ambulatory visits were highest among the oldest (40 and over: 13.68 per 1,000 p-yrs) and lowest among the youngest (<20 years: 8.45 per 1,000 p-yrs) service members (Figure 2b). Service members in their 20s and 30s had similar outpatient eye injury rates throughout the period.

Among the Services, the overall rate of eye injury-related hospitalizations was highest in the Marine Corps (0.43 per 1,000 p-yrs), intermediate in the Army (0.35 per 1,000 p-yrs) and relatively low in the other Services (Table 2). Among Marines, there was a sharp peak in the eye injury-related hospitalization rate in 2004; in the Army, eye injury-related hospitalization rates were higher from 2004 through 2007 than earlier or later years of the period (Figure 3a). In the Navy and Air Force, annual hospitalization rates for eye injuries remained relatively low and stable throughout the period (Figure 3a). In the Coast Guard, there were fewer than six eye injury-related hospitalizations per year on average during the period.

In contrast to hospitalization experiences among the Services, rates of eye injury-related ambulatory visits were highest in the Coast Guard (15.16 per 1,000 p-yrs), lowest in the Marine Corps (10.75 per 1,000 p-yrs) and intermediate among soldiers, sailors and airmen (Table 2). In the Coast Guard and Navy, annual rates of ambulatory visits for eye injuries increased each year from 2000 to 2004. From 2003 to the end of the period, rates in the Coast Guard were markedly higher than in the other Services (Figure 3b).

Figure 1a. Incidence rates of eye injury hospitalizations, active component, U.S. Armed Forces, 2000-2010

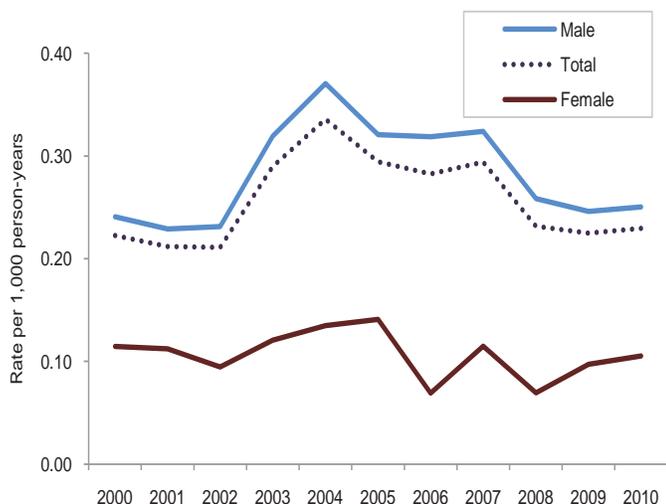
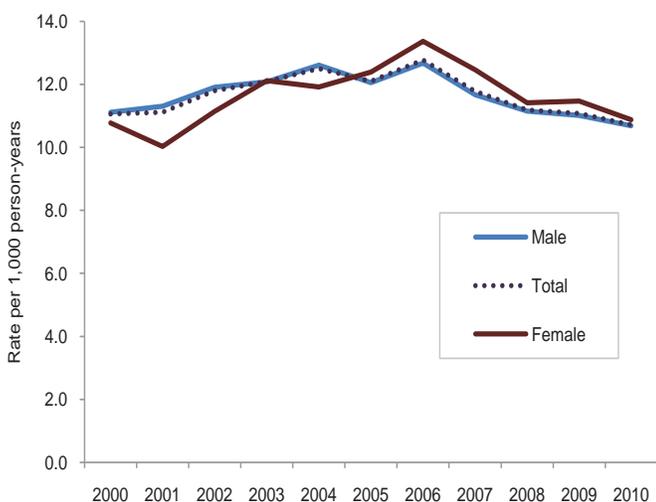


Figure 1b. Incidence rates of eye injury-related ambulatory visits, active component, U.S. Armed Forces, 2000-2010



The rate of eye injury-related hospitalizations (overall) was more than three times higher among junior enlisted service members (E1-4: 0.37 per 1,000 p-yrs) than senior commissioned/warrant officers (O4-10, W4-5: 0.09 per 1,000 p-yrs) – and approximately twice as high among junior than senior (E5-9: 0.19 per 1,000 p-yrs) enlisted members. In contrast, ambulatory visit rates were only slightly higher among junior enlisted service members than other enlisted and officer groups (Table 2).

Among enlisted service members, the highest rates of eye injury-specific ambulatory visits affected those in military occupations related to “craftwork and construction”, “health care” and “electrical/mechanical repair”. The rate of eye injury-related ambulatory visits (overall) was 50 percent higher among enlisted members in “craftwork and construction” (16.88 per 1,000 p-yrs) than in combat-specific (infantry, guncrew, seamen: 11.27 per 1,000 p-yrs)

occupations; however, the rate of hospitalizations for eye injuries was more than twice as high among those in combat-specific than in “craftwork and construction” occupations (Table 2). Among officers, “general/flag officers and executives” (13.09 per 1,000 p-yrs) and “intelligence officers” (9.53 per 1,000 p-yrs) had the relatively highest and lowest rates of eye injury-related ambulatory encounters, respectively. Eye injury-related hospitalization rates were higher in all but one of the occupational groups of enlisted members than in any occupational group of officers (Table 2).

Clinical categories of injury:

Orbit injuries accounted for more hospitalizations than any other injury type. During the period, orbit injuries accounted for 52 percent of all eye injury-related hospitalizations (n=2,115, rate: 0.14 per 1,000 p-yrs). The rate of orbit injury-related hospitalizations markedly increased from 2002 to 2004 and then remained fairly stable.

Contusions were the next most frequent cause of eye injury hospitalizations (n=1,031, rate: 0.07 per 1,000 p-yrs). The rate of contusion-related hospitalizations remained relatively stable throughout the period (Table 3, Figure 4a).

Hospitalizations for injuries with “high risk of blindness” increased sharply from 2002 (rate: 0.03 per 1,000 p-yrs) to 2004 (rate: 0.09 per 1,000 p-yrs) and then declined to near 2002 levels by the end of the period (Figure 4a). There was a small peak of hospitalized cases of lid/adenxa injuries in 2006; rates of other eye injury types were generally low and stable throughout the period (Figure 4a).

Table 3. Incident eye injuries diagnosed in fixed medical facilities (2000-2010) and deployed medical facilities (2005-2010), by clinical category of injury, active component, U.S. Armed Forces

	2000-2010				2005 - 2010	
	Fixed medical facilities		Hospitalizations		Deployed medical facilities	
	Ambulatory visits					
	No.	Rate ^a	No.	Rate ^a	No.	% total
Total	182,525	11.65	4,030	0.26	8,323	100
Superficial injuries	133,274	8.51	532	0.03	6,505	73.98
High risk of blindness	4,154	0.27	698	0.04	229	2.98
Contusion	24,223	1.56	1,031	0.07	822	9.38
Orbit	9,571	0.61	2,115	0.14	207	2.38
Lid/adnexa	9,758	0.62	718	0.05	328	4.26
Posterior segment	7,539	0.48	292	0.02	71	0.80
Burns	4,843	0.31	138	0.01	406	4.86
Anterior segment	2,572	0.16	51	0.00	91	1.12
Optic/cranial nerve	798	0.05	138	0.01	21	0.23

^aRate per 1,000 person-years

Figure 2a. Incidence rates of hospitalizations for eye injuries, by age group, active component, U.S. Armed Forces, 2000-2010

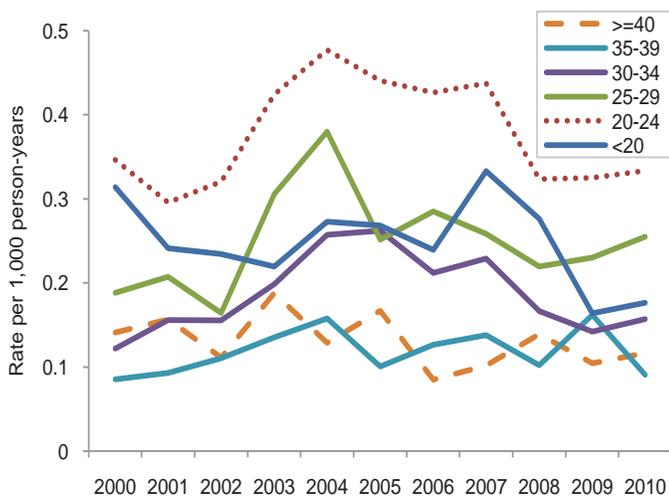
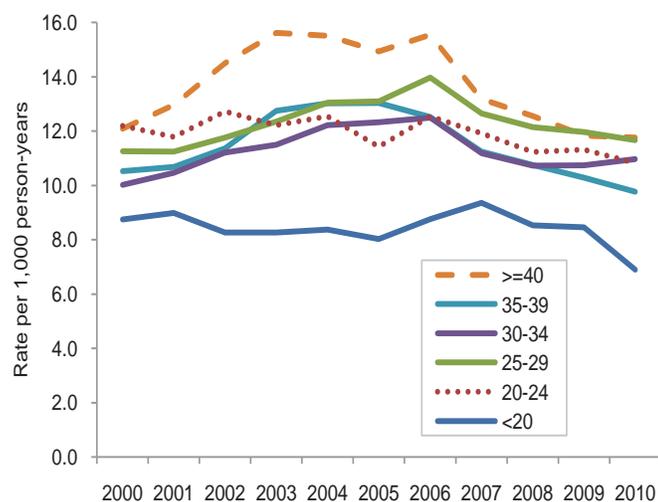


Figure 2b. Incidence rates of eye injury-related ambulatory visits, by age group, active component, U.S. Armed Forces, 2000-2010



Superficial injuries (n=133,274, overall rate: 8.51 per 1,000 p-yrs) and contusions (n=24,223, overall rate: 1.56 per 1,000 p-yrs) accounted for 73 percent and 13 percent of all eye injuries treated during ambulatory visits, respectively (Table 3, Figure 4b). Two percent of all eye injury-related outpatient encounters were considered “high risk of blindness” injuries (n=4,154, overall rate: 0.27 per 1,000 p-yrs).

During the period, annual rates of ambulatory visits for contusions and orbit injuries generally increased, rates of high risk of blindness injuries decreased, rates of lid/adnexa injuries decreased from 2004 to 2010, and rates of other injury types were relatively low and stable (Figure 4b).

Cause of injury codes were reported during 57 percent (n=2,311) of all eye injury-related hospitalizations. “Guns and explosives”, transportation-related accidents and fights, brawls, assaults were the most frequently reported causes of hospitalized eye injury cases, among those with a reported

Figure 3a. Incidence rates of hospitalizations for eye injuries, by service, active component, U.S. Armed Forces, 2000-2010

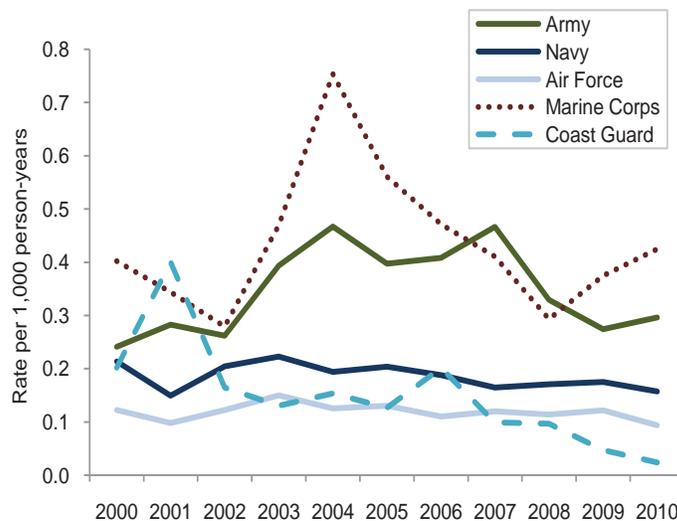
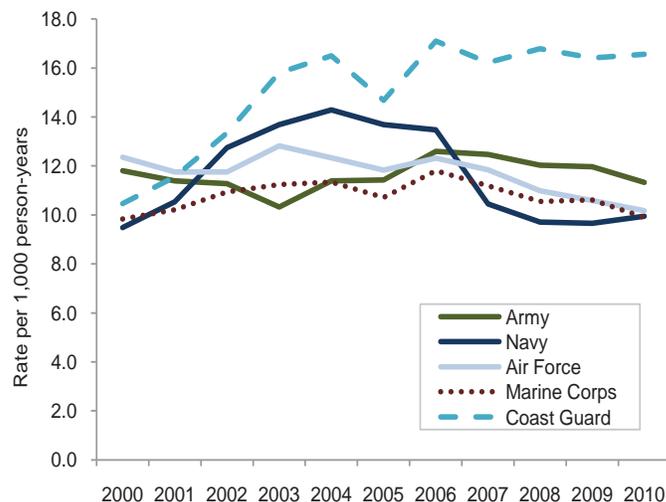


Figure 3b. Incidence rates of eye injury-related ambulatory visits, by service, active component, U.S. Armed Forces, 2000-2010

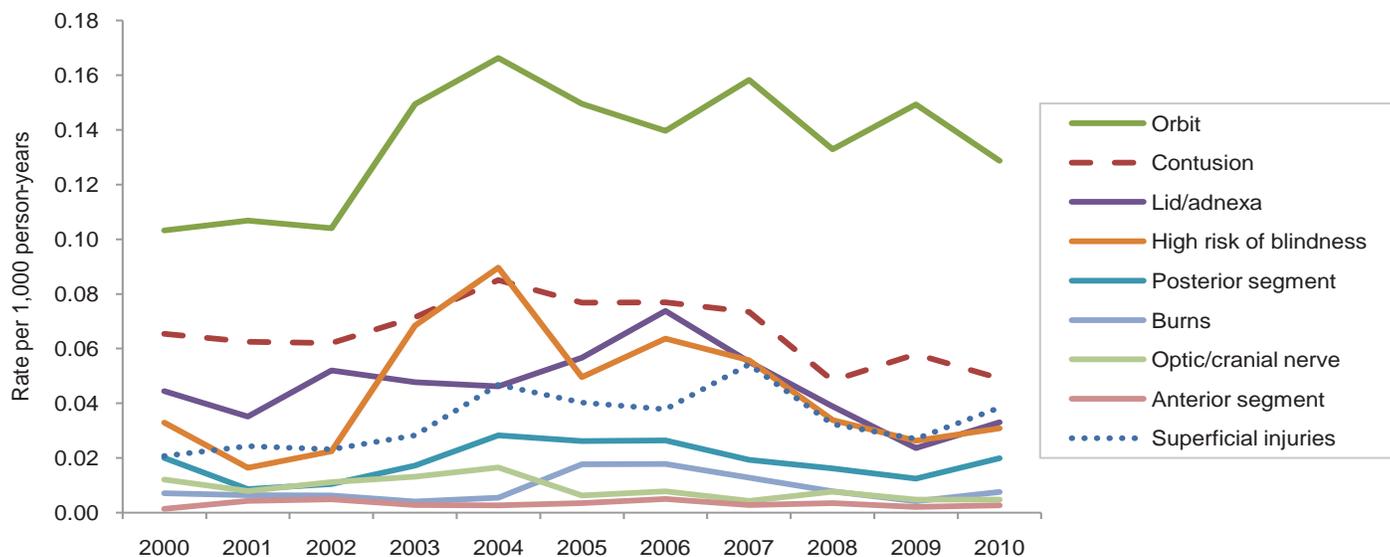
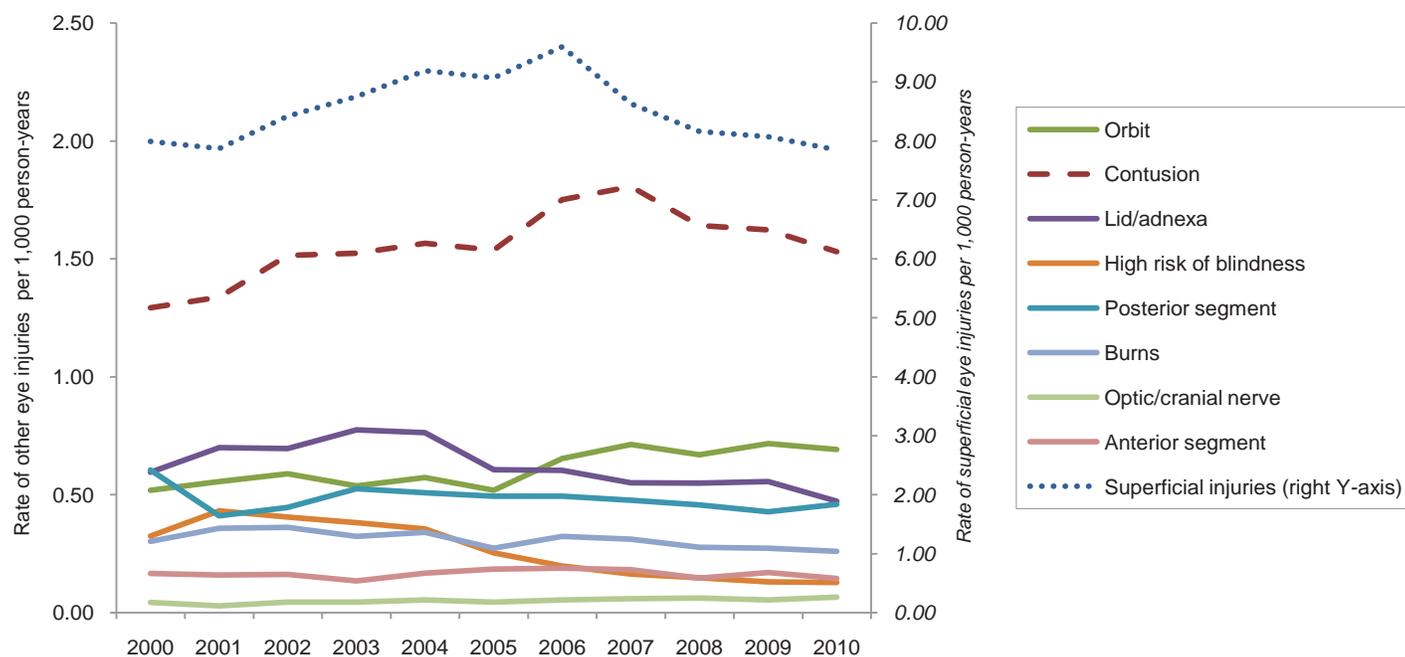


cause (Table 4). Approximately 8 percent of all hospitalized eye injuries were reported as “battle-related.”

Cause of injury codes were reported for fewer than 13 percent (n=23,402) of all eye injury-related ambulatory encounters. The most frequently reported causes of eye injuries treated in outpatient settings were “machinery and tools”, “slips, trips and falls” and fighting/assault (Table 4).

Eye injuries treated in deployed settings (2005-2010):

Between 2005 and 2010, 8,323 incident eye injuries were reported from deployed medical treatment facilities (Table 3). Most injuries affected service members who were enlisted (89%), male (86%), aged 20-29 (67%) and in the Army (59%) (data not shown). Nearly three-fourths of the injuries were considered “superficial” (Table 3). Of all eye injuries treated in deployed and fixed ambulatory clinics, the distributions by

Figure 4a. Incidence rates of eye injury hospitalizations by clinical category of injury, active component, U.S. Armed Forces, 2000-2010**Figure 4b.** Incidence rates of ambulatory visits for superficial (right Y-axis) and other eye injuries (left Y-axis), active component, U.S. Armed Forces, 2000-2010

clinical categories were generally similar. Of note, however, there were relatively more burns, and relatively fewer orbital injuries and contusions, treated in deployed than in fixed ambulatory clinics.

Editorial comment:

This report documents that most by far (98 percent) of eye injuries of active component U.S. military members are treated in ambulatory settings. Of note, however, there are marked differences in epidemiologic and clinical characteristics of eye injuries treated during hospitalizations and outpatient clinics. For example, service members who

sustain eye injuries that require hospital treatment are relatively likely to be 20-24 years old, males, in combat-specific occupations, and in the Army or Marine Corps. The majority of all hospital-treated eye injuries are fractures or penetrating wounds of the orbit; they are most frequently caused by guns/explosives, motor vehicle accidents, and fights or assaults. In contrast, service members who sustain eye injuries that are treated in outpatient settings are relatively likely to be in craftwork or construction occupations and aged 40 and older. Nearly three-quarters of all outpatient treated eye injuries are superficial injuries; they are most frequently caused by accidents with machinery and tools, and slips, trips, and falls.

Table 4. Eye injuries by cause^a, active component, U.S. Armed Forces, 2000-2010

Cause	Ambulatory visits		Hospitalizations	
	No.	%	No.	%
Battle casualty ^b	84	0.0	311	7.7
Guns and explosives	965	0.5	706	17.5
Sports	2,024	1.1	103	2.6
Machinery and tools	10,895	6.0	149	3.7
Transport	802	0.4	469	11.6
Slips, trips and falls	6,012	3.3	203	5.0
Fights, assault, horseplay	2,620	1.4	370	9.2
Other or unknown cause	159,123	87.2	1,719	42.7

^aCauses determined by "E-codes" and by codes specified in NATO Standardization Agreement (STANAG) No. 2050

^bIncludes accidents with guns and explosives during war

There are several limitations of this report that should be considered when interpreting the results. For example, for more than 40 percent of hospitalized and nearly 90 percent of ambulatory treated injuries, the causes of the injuries were not reported. The relatively few causes that were reported may not reliably indicate the causes of eye injuries among U.S. military members overall.

Also, the report summarizes injuries to members of the active component of the U.S. military services if they were treated in "fixed" (e.g., U.S. military and contracted/reimbursed civilian) or deployed (from 2005 to 2010) medical facilities. Thus, the report does not account for injuries to members of the reserve components or those treated (but not systematically reported) during field training exercises, at sea, by medics in direct support of military units ("aid bag" care), and so on. As a result, the findings of this report underestimate the numbers of eye injuries that affect U.S. military members overall.

In addition, interpretations of trends of eye injuries described in this report should consider the significant variability during the surveillance period in the numbers and locations of deployed service members; the natures (e.g., improvised explosive devices [IEDs]) and frequencies of enemy attacks and the numbers of service members directly affected by them; compliance with use of protective eyewear during eye hazardous activities; the intensity of training and support activities; the overall operational tempo; and so on. These factors are likely determinants of risk of eye injuries; and since 2002, the overall risk of eye injuries to U.S. military members has undoubtedly increased. Yet, the rate of outpatient-treated eye injuries was lower and the rate of hospitalized cases was very similar in 2010 compared to 2000.

Annual rates of hospitalized eye injuries sharply increased from 2002 to 2004 and then generally declined through 2008. The sharp rise in hospitalized cases from 2002 to 2004 was concurrent with increasing numbers of deployed service members and combat-specific activities (including IED attacks) – and poor compliance with the use of protective eyewear⁵ – in Afghanistan and Iraq. The Military Combat Eye Protection (MCEP) program was initiated in late 2004. From 2004 through 2008, inpatient eye injury rates sharply declined while enemy initiated attacks on U.S. forces in Iraq generally increased. The results suggest that the increased use of eye protection accounted at least in part for lower eye injury rates among deployed service members. In addition, to the extent that MCEP became accepted by unit commanders and noncommissioned officers as necessary and important personal protection equipment during wartime operations, MCEP use spread beyond the deployed environment to recruit and deployment training, and even home use.

Increases in awareness, acceptance, and use of eye protection remain primary objectives of efforts to reduce rates as well as clinical and military operational effects of eye injuries among U.S. military members. Recent operations in Iraq and Afghanistan have raised awareness of the need for eye protection and acceptance of the MCEP program among commanders, noncommissioned officers, and service members at all levels. Future efforts should insure that awareness, acceptance, and use of eye protection do not fade after the current conflicts end. All military members should be informed and repeatedly reminded of the benefits of the use of eye protection – on the job and at home. MCEP use should be required during training activities, deployment operations, and in all other settings where ballistic eye hazards exist.

Reported by: David J. Hilber, COL, MS, USA. The author acknowledges Mark Reynolds, MAJ, MC, USA for his 2008 eye injury summary cited as reference 2.

References:

- Hilber D, Mitchener TA, Stout J, Hatch B, Canham-Chervak M. Eye injury surveillance in the U.S. Department of Defense, 1996-2005. *Am J Prev Med.* 2010;38(1S):S78-S85.
- Armed Forces Health Surveillance Center. Eye injuries among members of active components, U.S. Armed Forces, 1998-2007. *Medical Surveillance Monthly Report (MSMR).* 2008; 15(9):2-5.
- Andreotti G, Lange JL, Brundage JF. The nature, incidence, and impact of eye injuries among US military personnel: implications for prevention. *Arch Ophthalmol.* 2001 Nov;119(11):1693-7.
- Kuhn F, Morris R, Witherspoon CD, Mann L. Epidemiology of blinding trauma in the United States Eye Injury Registry. *Ophthalmic Epidemiology.* 2006;13:209-16.
- Thomas R, McManus JG, Johnson A, et al. Ocular injury reduction from ocular protection use in current combat operations. *J Trauma.* 2009 Apr;66(4 Suppl):S99-103.