ABSTRACT.  Objective.  To describe the increasing incidence of ocular injuries in the pediatric population caused by paintballs. The awareness of this trend will help the physician who treats the child to give appropriate care as well as educate physicians, who counsel children, about this growing mechanism of pediatric injuries.

Methods.  Previously unpublished data from the US Consumer Product Safety Commission were analyzed to find the frequency of ocular injuries in children. A review of the English-language literature was also conducted to describe trends with regard to age, sex, location at the time of injury, use of eye protection, types of injuries sustained, and long-term visual outcome.

Results.  The incidence of paintball eye injuries treated in emergency departments has risen from an estimated 545 in 1998 to >1200 in 2000. The proportion of these injuries that occurred in the pediatric population may be well over 40%. These injuries are seen predominantly in boys, a growing proportion of whom are playing informally in unsupervised settings and not wearing eye protection. The cases previously reported include large numbers of hyphemas, retinal detachments, cataracts, corneal abrasions, vitreous hemorrhages, and commotio retina. Many of the patients in these cases sustained permanent visual impairment, with 43% having best vision at follow-up of 20/200 or worse.

Conclusions.  Pediatric eye injuries caused by paintballs are an unrecognized cause of severe injury and permanent visual loss. The advances in eye protection for the youngest population. Children and teens are unlikely to wear eye protection voluntarily when playing at the time of injury, use of eye protection, types of injuries sustained, and long-term visual outcome.

Pediatric eye injuries caused by paintballs are an unrecognized cause of severe injury and permanent visual loss. The advances in eye protection for the youngest population. Children and teens are unlikely to wear eye protection voluntarily when playing at the time of injury, use of eye protection, types of injuries sustained, and long-term visual outcome.

METHODS

The US Consumer Product Safety Commission (US CPSC) collects information regarding injuries associated with consumer products and disseminates it through the National Injury Information Clearinghouse. The National Electronic Injury Surveillance System (NEISS), one of the US CPSC’s databases, is composed of a representative sample of hospital emergency departments nationwide. From data collected in these emergency departments, an estimate can be made of the incidence of injuries associated with a particular product. The department of epidemiology at the US CPSC was able to provide an estimate of paintball injuries categorized by year, age, and whether the injury involved the eye. Data were also extracted from English-language publications of reports of ocular injuries related to paintballs.

RESULTS

Between 1997 and 2000, 181 cases of paintball-related eye injuries were seen in emergency departments that report to the NEISS (Rutherford G, US CPSC, Directorate for Epidemiology, NEISS, personal communication, November 20, 2001) (Table 1). On the basis of the reports, the US CPSC is able to estimate the annual incidence of similar injuries that were seen in emergency departments nationwide and provide a coefficient of variation for the estimate. The US CPSC did not provide estimates when the coefficient of variation was so large as to make the estimate unreliable.

For the years provided, the number of injuries rose from an estimated 926 to 2780 overall with between 26% and 33% occurring in patients younger than 15 years. For 1999, the only year that a reasonable esti-
A total of 187 cases that describe eye injuries from paintballs have been published since 1985. Although these are not necessarily a representative sample, they do provide some insight into patterns related to these injuries.

Sex was reported in 117 of the 187 cases. Of these, 115 (98.3%) were male. Location was reported in 78 cases. Half of the injuries occurred at designated sites (paintball centers or military operations), and half occurred at undesignated settings.

Status of eye protection was reported for 79 of the occurrences. Patients were considered to be wearing eye protection when they were wearing goggles but there was some failure of the device, such as being dislodged by a branch while falling, or when paint came through the ventilation holes. Patients were considered not to be wearing eye protection when they never wore goggles or a face mask or they purposefully removed them, such as for fogging or discomfort. Only 31 (39.2%) were wearing some type of eye protection at the time of the incident.

Detail of the injury was available for 149 of the cases (Table 2). Both anterior and posterior chamber injuries are common. Visual outcome was reported in 116 patients. For 43.1% of patients, visual acuity of 20/200 was recorded at latest follow-up (Table 3).

### DISCUSSION

Paintball, or “war games,” is a game in which paint-containing projectiles are shot from guns that use a compressed gas as the power source. The paintballs are 14-mm gelatin capsules filled with watersoluble paint (Fig 1). A player who is hit, or “marked,” is out of the game. The guns can have a muzzle velocity of up to 300 feet per second. The guns and paintballs are readily available at sporting good stores, at department stores, on-line, and at specialty stores.

In 1985, Easterbrook and Pashby first reported severe eye injuries related to war games. They described 26 injuries seen by Canadian ophthalmologists. In 1988, they expanded their cadre of injured patients to 44. These included 17 cases that resulted in blind eyes. The specific injuries included 38 hyphemas, 13 cataracts, 24 retinal injuries, and 2 ruptured globes. The authors recommended that universal use of eye protection would decrease the incidence of eye injuries, as almost all of the injured players either had not worn or had removed their eye protection for one reason or another. Tardif et al reported that paintball injuries represented 6% of sports-related injuries in Quebec in 1984. Many of the participants started the game with eye protection but...
removed them because of fogging, discomfort, or paint on the lens or had the goggles accidentally dislodged while running.2,3,5,6,12,14,16,17,19

In 1987, Martin and Magolan4 reported the first case of eye injury despite the use of goggles. Their patient’s goggles were driven into the globe from the force of impact of the paintball. Many similar reports have been published since then that described goggle failure6,11,12,14 and paint entering around the goggles7 and through ventilation holes.9,13 In their 1989 report, Welsh et al17 recommended a simple eye glass style safety lens with side pieces (Fig 2).

In recent years, the quality of the eye protection has improved dramatically with full face masks becoming the industry standard. The American Society for Testing and Materials has published a “Standard Specification for Eye Protective Devices for Paintball Sports” since 1997. It has been updated most recently in 2001.24 Modern designs integrate a polycarbonate lens into a full face mask (Fig 3). Ventilation holes improve ease of breathing while decreasing the incidence of fogging and are designed to limit the entry of paint or fragments to the eye. Despite these advances, ocular injuries continue to occur and result in severe vision-threatening injuries. Kitchens and Danis19 found that >4% of severe eye injuries reported to the Eye Injury Registry of Indiana between June 1996 and August 1998 were caused by paintballs.

As more sophisticated face masks with integrated protective lenses have become the standard at organized paintball centers, a higher proportion of the injuries take place at undesignated settings. In 2000, Fineman et al16 published an analysis of 35 patients with paintball-related ocular injuries. They found that injuries sustained after 1995 were 5.8 times more likely to have occurred at a noncommercial site as compared with injuries sustained before 1995.16 The likely implication is that participants do not wear eye protection as frequently or consistently at noncommercial sites.

It is reasonable to assume that children will continue to be common participants at these “backyard” events. Data from the US CPSC confirms that the under-15-year group represents a disproportionate number of those injured by paintballs (Rutherford G, US CPSC, Directorate for Epidemiology, NEISS, personal communication, November 20, 2001) and that a large proportion of injuries occur in undesignated settings. In the only report of exclusively pediatric patients, Hargrave et al23 described injuries in 4 young teens, none of whom were at centers or wearing eye protection. It is likely that younger patients are more frequently involved with noncommercial, informal games. Fineman25 in 2001 recommended “restriction on the sale of these potentially blinding devices to minors, public education regarding the proper use of EPD’s [eyewear protection devices], and increased adult supervision.”

CONCLUSIONS

Although there have been advances in paintball eye protection, it is unlikely that those will help reduce the number of injuries in the pediatric age
group. Children are “playing” in backyards, woods, and basements, not at organized paintball centers that both provide and require face masks. For protecting this younger age group, a new approach is needed. Pediatric practitioners must be aware of both the popularity and the danger of paintball activities, and they should lobby for restriction of sale of paintballs and paintball guns to minors or restriction of sales to organized facilities. Until there are restrictions on the availability of these dangerous devices, children and young teens must be counseled either to avoid this activity or to take appropriate precautions to avoid eye injuries. Parents or other caregivers should supervise these activities more closely and require their children to wear modern eye protection.

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Paintball Injuries in Children: More Than Meets the Eye
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