

Pediatric Tear Gas Poisoning in Southern Israel: Clinical Characteristics and Outcomes

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ABSTRACT **Background:** Pepper spray and tear gas are chemical irritants causing ocular, dermal, and respiratory injury. Data specific to pediatric emergency department (PED) presentations remain limited.

Objectives: To characterize the epidemiology, clinical presentation, and short-term outcomes of chemical irritant exposure in children presenting to a tertiary PED.

Methods: We conducted a retrospective cohort study of patients aged 0–18 years of age presenting to a single tertiary PED between 2016 and 2024 following civilian-grade chemical irritant exposure. Cases were identified using ICD-9 codes and free-text electronic medical records search. Demographic characteristics, clinical findings, treatment, and disposition were analyzed using descriptive statistics.

Results: We included 84 pediatric patients (median age 12.5 years, IQR 6.0–15.6; 69.0% male). Exposures occurred most commonly at home (44.0%) and school (36.9%). Ocular involvement was common. Superficial punctate keratitis was identified in 54.5% of patients who underwent fluorescein examination by ophthalmologist (21.5% of the total cohort). Respiratory and dermal symptoms were mild and self-resolving. No severe complications were documented; 96.4% were discharged home.

Conclusions: Civilian-grade chemical irritant exposures in children were predominantly self-limited and managed successfully with conservative ED care, supporting decontamination-based protocols while highlighting home and school settings as priorities for prevention.

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KEY WORDS: chemical irritants, ocular injury, pediatric emergency department, pepper spray, tear gas

zalmalononitrile). These agents exert their effects through rapid sensory irritation of the eyes, skin, and respiratory tract, mediated by activation of chemosensory ion channels, most notably members of the transient receptor potential (TRP) family, with additional modulation by solvent or pyrotechnic co-formulants [1,2].

While clinical and toxicological literature has grown considerably in recent decades, most of the existing evidence is derived from adult or mixed-age populations. Data specific to pediatrics remain sparse, and few studies have characterized presentations to the pediatric emergency department (PED), including exposure settings, temporal patterns, and short-term clinical outcomes [2,3].

Ocular morbidity is the most frequently reported manifestation across exposure settings [4,5]. Although most ocular exposure is self-limiting with prompt decontamination and lubricating eye drops, close-range deployments and exposures in enclosed spaces are associated with more severe injury [1,5,6]. Typical findings include conjunctival hyperemia, lacrimation, blepharospasm, and ocular pain [3,4,5]. Corneal involvements on examination may range from superficial punctate keratitis (SPK), characterized by scattered fluorescein-staining epithelial erosions, to a more severe presentation with frank corneal erosions identified with discrete areas of epithelial disruption. Clinically, both SPK and corneal erosion share overlapping symptoms including eye pain, photophobia, tearing, and foreign-body sensation, although frank erosions generally indicate more significant epithelial disruption that can lead to significant complication including secondary bacterial infections and persistent epithelial defects [4,5]. The possibility of ocular damage supports the implementation of PED protocols that prioritize early decontamination, visual acuity assessment, and fluorescein slit-lamp examination (performed by ophthalmologists)

Chemical irritants used for riot control and self-defense include primarily oleoresin capsicum (OC, commonly known as pepper spray) and CS tear gas (2-chloroben-

to detect epithelial injury in symptomatic patients, with short-interval ophthalmology follow-up when clinically indicated [3,5].

Dermal effects of chemical irritant exposure include erythema, burning sensation, urticarial reactions, and contact dermatitis [5,7,8]. Respiratory manifestations are also common, encompassing cough, chest tightness, wheezing, and dyspnea. [7,8]. Symptoms typically resolve within minutes to hours following cessation of exposure; however, clusters of acute respiratory illness have been documented after high-concentration or prolonged exposures, particularly in confined spaces and among individuals with pre-existing asthma [9].

Severe complications and fatalities are uncommon in typical civilian emergency department presentations and

have been reported predominantly in the context of extreme concentrations, prolonged or repeated exposure, or vulnerable settings such as correctional facilities [1,2]. Data specific to pediatric populations remain limited. Most of the evidence in the pediatric population is derived from mixed-age cohorts in which children represent only a small subset of patients [10]. The aim of this study was to characterize the epidemiology, clinical presentation, and short-term outcomes of chemical irritant exposure in children presenting to a single large tertiary pediatric medical center. These data can help clinical management and guide preventive strategies tailored to the pediatric population.

PATIENTS AND METHODS

This observational cohort study was conducted at a single tertiary PED. The PED serves as the sole tertiary care facility for the southern region of the country, characterizing a largely arid area with diverse populations, including urban communities, rural villages, and semi-permanent Bedouin settlements.

The study population included children aged 0–18 years presenting to the PED with exposure to tear gas or pepper spray between January 2016 and December 2024. All exposures involved civilian-grade self-defense products commercially available to the public, and not military, law enforcement, or riot-control agents.

Data were collected through systematic review of electronic medical records (EMR). Records were screened using ICD-9 diagnostic codes related to tear gas exposure [Supplemental Table 1, which is available in the online version only]. supplemented by a free-text search of the complete medical chart for the following keywords: pepper spray, tear gas inhalation, and tear gas intoxication. Data were extracted from the EMR using a structured codebook and de-identified prior to analysis. The following variables were collected: age, sex, ethnicity, arrival time (hour 0–23), calendar month, season, and exposure setting (home, school, street/public, or unknown). For descriptive analyses, patients were stratified into three age groups: 0–5, 6–12, and 13–17 years. Seasons were defined as follows: winter (December–February), spring (March–May), summer (June–August), and fall (September–November).

Three anatomic domains of involvement were pre-specified: ocular, dermal, and respiratory. A severe outcome was defined by the presence of at least one of the following: dyspnea, loss of consciousness or syncope,

Table 1. The demographic profile of children assessed in a pediatric emergency department following tear-gas exposure

Variable	n (%)
Age, years	Median 12.5 (IQR 6.0–15.6)
Sex	
Male	58 (69.0%)
Female	26 (31.0%)
Ethnicity	
Arab	50 (59.5%)
Jewish	34 (40.5%)
Exposure location	
Home	37 (44.0%)
School	31 (36.9%)
Street	9 (10.7%)
Unknown	7 (8.3%)
Arrival method	
With a parent	43 (51.2%)
By ambulance	40 (47.6%)
Other	1 (1.2%)
Referral source	
None	58 (69.0%)
Family	8 (9.5%)
Pediatrician/community doctor	6 (7.2%)
General ED/emergency services	9 (10.8%)
Other (e.g., nurse, poison center)	3 (3.6%)

ED = emergency department, IQR = interquartile range

seizure, confusion, chest pain, or coma/stupor. To ensure accuracy, outcomes were identified through a systematic manual review of all medical records, including clinical summaries, consultations, and follow-up notes. Hospital admissions and return visits within the same week were recorded when applicable.

RESULTS

A total of 84 pediatric patients presented to the PED following chemical irritant exposure. Our cohort included 60 cases (71.4%) attributed to tear gas and 24 cases (28.6%) attributed to pepper spray. The median age was 12.5 years (interquartile range [IQR] 6.0–15.6). Most patients were male ($n=58$, 69.0%). Some 50 cases (59.5%) were of Arab ethnicity and 34 cases (40.5%) were Jewish. Most exposures occurred among school-aged children, accounting for 75% of the study population ($n=63/84$). Exposure occurred mostly at home ($n=37$, 44.0%) or at school ($n=31$, 36.9%), with a minority occurring in public or street settings ($n=9$, 10.7%).

Slightly more than half of the patients arrived accompanied by a parent ($n=43$, 51.2%), while 40 patients (47.6%) arrived by ambulance. Most cases were self-referred without prior medical consultation ($n=58$, 69.0%) [Table 1].

Symptoms at the time of exposure were reported by 79 patients (94.0%); however, only 37 patients (44.0%) remained symptomatic by PED arrival. Symptomatic involvement included ocular, respiratory, and dermal systems.

Respiratory symptoms were reported in 18 patients (21.4%), all presenting with shortness of breath. Symptoms had resolved in 12 patients prior to arrival and in the remaining 6 during observation in the PED. In the PED, all patients maintained normal oxygen saturation on room air, and none required supplemental oxygen or chest X-rays. Two children with a transiently elevated respiratory rate (> 1 SD) normalized during observation without intervention.

Dermal involvement was documented in 15 patients, all presenting with localized erythema at the site of contact, which resolved in all cases during observation. Additional symptoms included a headache in one patient, chest pain in two patients, and vomiting in three patients. All of the symptoms resolved by the time of arrival in the PED.

A formal ophthalmologic consultation was performed for 33 patients (39%). The remaining cases were evaluated by ED physicians, who determined that further specialist assessment was not clinically indicated. Ophthalmologic examination was normal for most of the patients

(69%). SPK was identified in 18 patients who underwent fluorescein examination (21.5% of all patients), and conjunctivitis in 8 patients (9.5% of all patients), notably, no cases of corneal erosion or deeper ocular tissue involvement were identified in our study population.

Documented prehospital treatment was uncommon; 82 patients (97.6%) received no treatment prior to PED arrival. One patient (1.2%) underwent ocular irrigation with water, and one patient (1.2%) received topical hydrocortisone before presentation.

Nearly all patients ($n=83$, 98.8%), received copious water irrigation of the eyes on arrival to the PED. PED treatment was administered to 30 patients (35.7%), included artificial tears alone ($n=15$, 17.9%), topical steroids, or topical antibiotics, either alone or in combination ($n=15$, 17.9%). The remaining 54 (64.3%) did not require treatment in the PED. Two patients (2.4%) required hospitalization; notably, both were siblings admitted primarily for social assessment and intervention rather than medical severity. One patient (1.2%) left the PED without receiving treatment. No severe complications were documented in any patient during the PED stay. No repeat hospital visits for the same complaint were documented in any patient within 7 days of the initial discharge.

DISCUSSION

In this study, we described the clinical characteristics and short-term outcomes of pediatric patients presenting to a tertiary PED following exposure to civilian-grade chemical irritants. As a descriptive cohort, we aimed to characterize real-world exposure patterns, clinical presentations, and ED management in children, a population for which dedicated data remain scarce.

Consistent with prior adult and mixed-age studies, ocular involvement was the most frequent manifestation in our cohort. Conjunctival hyperemia, lacrimation, blepharospasm, and corneal epithelial injury are well-established clinical effects of chemical irritant exposure [1-5]. In our series, SPK was identified in 21.5% of all patients (18/84), a rate comparable to those reported in ophthalmologic emergency cohorts following riot-control agent exposure [4,5]. Notably, despite this relatively high prevalence of epithelial injury, no sight-threatening complications or long-term sequelae were documented. This finding may reflect the prompt initiation of decontamination and supportive ocular care in the PED or the inherently self-limiting nature of the injury itself.

Rapid decontamination with irrigation and early supportive management are consistently emphasized in the literature as the cornerstones of treatment following tear gas or pepper spray exposure [1,3,6]. Studies from both civilian protest settings and controlled exposure environments demonstrate that most ocular and respiratory symptoms resolve within minutes to hours after cessation of exposure and prompt decontamination [3,6]. Our findings are consistent with these observations. Nearly all patients were managed conservatively. The majority were discharged home, and only two required hospitalization both for assessment by a social worker rather than medical severity. Collectively, these results support the effectiveness of early PED-based decontamination and observation protocols in preventing progression to severe injury in the pediatric population.

Although most exposures in our cohort were self-limited, the literature documents a spectrum of more severe and occasionally life-threatening complications, including acute laryngeal and bronchial obstruction, chemical pneumonitis, secondary infections, and, in rare cases, multisystem toxicity and death. Such outcomes have been reported predominantly following high-concentration exposures in confined spaces or among vulnerable populations [1,7-9]. Notably, none of these complications were observed in our pediatric cohort, which may reflect the civilian-grade nature of the products involved, brief exposure durations, and prompt presentation to medical care.

Respiratory involvement in our cohort was mild and transient. Most affected children presented with shortness of breath without objective hypoxemia or requirement for respiratory support. This finding contrasts population-level studies demonstrating increased rates of bronchial disease and respiratory emergency visits following large-scale tear gas deployment in urban protest settings [7]. The discrepancy likely reflects differences in exposure intensity, environmental dispersion, and agent concentration, none of which were characteristic of the civilian, non-crowd-control exposures in our cohort. No cases of respiratory failure or persistent pulmonary sequelae were documented.

Dermal manifestations were similarly mild and limited to localized erythema and irritation without evidence of significant chemical burns. Although the literature describes rare but severe cutaneous injuries following close-range deployment of pepper spray launchers, including penetrating lacerations [11], no such injuries were observed in our series. These findings further sup-

port the generally favorable safety profile of incidental civilian-grade chemical irritant exposure when managed promptly and appropriately.

A notable proportion of exposures occurred among school-aged children and within school settings, representing an important opportunity for targeted prevention. School-based injury prevention programs have demonstrated improvements in safety knowledge and behaviors, although consistent reductions in medically attended injuries have not always been established [11,12]. While direct evidence on the prevention of chemical irritant exposures in school environments is lacking, the predominance of home and school settings in our cohort underscores the potential value of educational initiatives addressing safe storage of self-defense products and clear protocols for rapid decontamination in community settings.

LIMITATIONS

This study has several limitations due to its retrospective design and reliance on EMRs. To improve data accuracy, the principal investigator manually reviewed all clinical notes to confirm the context of exposure. When available, hospital records were compared with emergency medical services (EMS) reports to verify that only civilian incidents were included. However, factors such as exposure intensity and distance from the source could not be measured. The reliance on patient reports may introduce recall bias, especially regarding the type of irritant, as public confusion between tear gas and pepper spray is common. In addition, while the regional context suggests possible military or police exposure, our manual review found no such cases in this pediatric group. Although no such cases were found, the potential for under-reporting exists.

Prehospital irrigation may have been performed but not fully documented, potentially underestimating its effects. The study's sample size may also limit the detection of very rare complications. Long-term outcomes were unavailable, including a lack of documented hospital readmissions within one-week post-exposure. Finally, as a single-center study, these findings may not be generalizable to other regions with different products or healthcare settings.

CONCLUSIONS

In this pediatric emergency department cohort, civilian-grade chemical irritant exposures were predominantly self-limited and managed successfully with

prompt decontamination and supportive care. Ocular involvement, including SPK, was common but did not result in permanent injury. The severe respiratory, dermatologic, and systemic complications described in the literature were not observed in our cohort. These findings support the safety and effectiveness of conservative PED-based management for most pediatric chemical irritant exposures, while underscoring the importance of rapid decontamination, early ophthalmology examination, and targeted prevention efforts in home and school settings.

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Nothing great in the world has been accomplished without passion.

Georg Wilhelm Friedrich Hegel (1770–1831), German philosopher and a major figure in the tradition of German idealism

To fall in love is to create a religion that has a fallible god.

Jorge Luis Borges (1899–1986), Argentine short-story writer, essayist, poet and translator

Capsule

Etuvetidigene autotemcel for the treatment of Wiskott–Aldrich syndrome

Ferrua et al. evaluated etuvetidigene autotemcel (etu-cel), an autologous hematopoietic stem/progenitor-cell gene therapy for Wiskott–Aldrich syndrome (WAS). Patient cells were transduced ex vivo with a lentiviral vector carrying functional WAS complementary DNA. The analysis combined two prospective studies and an expanded-access program, comprising 27 patients. The median age at gene therapy was 2.6 years, although the age range extended from 1.0 to 35.1 years. Median follow-up among survivors was 5.7 years, providing important long-term information. Overall survival was 96% at both

1 and 5 years. Severe infections decreased from 2.00 to 0.15 events per person-year after treatment. Moderate or severe bleeding declined from 2.00 to 0.80 events per person-year during the first post-treatment year. The most frequent grade ≥ 3 adverse event was infection associated with a central venous catheter. Importantly, no evidence of insertional oncogenesis was detected during follow-up. The results indicate sustained clinical benefit involving both the immune-deficiency and bleeding manifestations.

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