ASOT News

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The American Society of Ophthalmic Trauma Newsletter

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Eye Trauma 2024: Last Chance to Register for the Annual Meeting!

As the date draws near for the highly anticipated ASOT Annual Meeting, ophthalmologists and researchers alike are abuzz with excitement over the exceptional lineup of speakers set to take the stage. Promising to be a beacon of inspiration and enlightenment, this year's event boasts a stellar array of experts at the forefront of ophthalmic trauma research and practice.

From groundbreaking case studies to innovative approaches, attendees can expect to be captivated by presentations that push the boundaries of knowledge and skill. The ASOT Annual Meeting promises to be an enriching experience for all involved, offering insights and perspectives that are sure to leave a lasting impact.

Registration Details and Membership Perks: For those eager to secure their spot at this unparalleled gathering, registering is a simple click away. ASOT members are in for an added treat, with a 15% discount on registration awaiting those who renew their membership prior to signing up. The regsitration deadline is coming up fast, so interested individuals are urged to act swiftly to guarantee their attendance. Membership with ASOT not only grants access to this exclusive event but also opens the door to a host of practical benefits. Renewing membership ensures not only a discounted meeting registration but also connects individuals with a passionate community of professionals dedicated to advancing the field of ophthalmology.

Exciting Pre and Post-Meeting Events: In addition to the enriching sessions planned for the main event, attendees are invited to partake in a series of engaging pre and post-meeting activities. Early arrivals to Houston on Thursday can look forward to a laid-back gathering before the official proceedings kick off. Meanwhile, a stellar post-meeting cocktail reception promises to provide the perfect opportunity for networking and relaxation after a day filled with stimulating discussions and presentations.

Please ensure you register for the Saturday breakfast roundtables if you plan to attend the annual meeting and haven't done so already! There are still available seats for the following tables:

1. Stabilizing Ophthalmic Injuries During War and Visual Rehabilitation Afterward, 2. Developing Commercial Products for Ocular Trauma and Navigating Market Entry, 3. Law and Ethics: Consent, Competency, Risk, and Liability in Ocular Trauma Care, 4. Handling Consults: Deciding Between Immediate Action, Delay, or Intermediate Measures + Implementing the Ophthalmic Hospitalist Model, 5. Securing Department of Defense Funding for Trauma Research, 6. Integrating Eye Care Into National Disaster Response Planning Systems.

We hope to see you in Texas!

HOT OFF THE PRESS

Recent Publications in Ophthalmic Trauma

Insights from a Decade of Chemical Eye Injuries: Retrospective Analysis of Acute Cases in Auckland, New Zealand

https://pubmed.ncbi.nlm.nih.gov/38594410/

The aim of this study was to analyze the causes, symptoms, treatments, and results of immediate chemical eye injuries treated at an emergency eye clinic. The authors looked at cases from January 2012 to December 2021 at the Greenlane Clinical Centre in Auckland, New Zealand. The study recorded patient details, the chemical involved, initial injury severity, treatment given, healing time, and follow-up visits for 1522 cases involving 1919 eyes. Most patients were around 40 years old, mostly male, and the injuries frequently happened during household cleaning. The majority of cases were mild (Grade I) with rapid healing. However, lack of immediate irrigation increased the risk of severe injuries and long-term vision problems.

Assessing Visual Outcomes in Pediatric Traumatic Retinal Detachment: Open versus Closed Globe Injuries

https://pubmed.ncbi.nlm.nih.gov/38569211/

The purpose of this retrospective study was to determine the burden of emergency room visits for ophthalmic trauma in the United States. Using the Nationwide Emergency Department Sample, emergency department visits for ophthalmic trauma from 2009 to 2018 were calculated and characterized. There were over 7.3 million ED visits for ophthalmic trauma in the United States over 10 years. There was an annual incidence of 233 per 100,000 population. Patients were found to be predominantly male (65%), 21-44 years old (39%), and from low-income households (56%). Only 1% of patients were hospitalized. Older age, male sex, metropolitan teaching hospitals, and trauma centers were associated with significantly higher odds of inpatient admission. Over the decade, the total charges exceeded $14 billion. Superficial injuries (44%) and orbital wounds (20%) accounted for a minority of visits, but were responsible for the most admissions (49% and 29%, respectively). Overall, ophthalmic trauma is an increasingly significant burden to emergency rooms across the United States. Preventative efforts should be aimed toward younger males and those from lower socioeconomic backgrounds.

ASOT FEATURED ARTICLE:

Tear Gas (Pepper Spray) Toxicity

R. David Tidwell; Brandon K. Wills; StatPearls
Online: https://www.ncbi.nlm.nih.gov/books/NBK544263/

Introduction

Tear gas and pepper spray are a group of heterogeneous agents known under broader categories as riot control agents, harassing agents, incapacitating agents or lacrimators. Although initially utilized by the military in World War I, they are now used for personal protection or by law enforcement agencies as a non-lethal option for subduing combative subjects as well as crowd control. As a group, these substances cause acute eye pain, tearing, skin irritation, and respiratory tract irritation.

The prototypical tear gasses are o-chlorobenzylidenemalononitrile (CS), chloroacetophenone (CN), and dibenzoxazepine (CR). CN was initially developed at the end of the first world war, although it did not get used during combat. After this time, CN was primarily utilized by military and law enforcement agencies until the development of CS, which is more potent and less toxic. CS, named for its creators Corson and Stoughton, was first developed in 1928 and first used in 1958 by the British army. CS was an attractive agent for law enforcement because it was more effective in the open air and has mostly replaced CN by law enforcement agencies. Pepper spray was created in the late 1970s and found use by law enforcement agencies in the early 1980s. Oleoresin capsicum (OC) is the active agent in pepper spray, which is an oily concentrated extract from plants of the genus Capsicum, more commonly referred to as the chili pepper. The physiologic and pharmacologic effects of capsaicin have been a topic of study since the 1920s. More recently it has found favor as a riot-control agent with law enforcement agencies. It produces some similar effects compared to the other tear gases and has become the popular agent for civilian use.

Etiology

Typically, these agents are deployed in an aerosol or liquid form. In law enforcement or military settings, grenades or canisters can be thrown or shot into an area. Additionally, the dispersion can be through handheld spray devices. Aerosol generally refers to spraying into a large area for crowd control, compared with sprays which are typically handheld canisters sprayed at a single person to incapacitate them.

On occasion, these products can be added to water and dispersed via water canon or other large-scale devices like bombs or large spray tanks. Immediately upon contact, these agents begin to exhibit effects on the skin, eyes, respiratory tract, and mucous membranes. Though colloquially referred to as “tear gas,” the CN, CS, and OC compounds are not actually gases but solids at room temperature. These agents have low solubility in water, so most agents are dissolved in organic solvents, allowing their use as aerosols or microparticulates. Another method for aerosolizing these agents uses high temperature dispersion, typically greater than 700 degrees Celsius.

Epidemiology

These agents were initially developed for military use. For example, the US military used CS during the Vietnam War for tunnel denial and crowd control. Though initially developed by the military, these agents are under a ban in warfare since 1997. Since then, exposures in the US are typically from law enforcement or civilian use. CS gas generally is limited to law enforcement, but mace and pepper spray are available for civilian use. In the United States, the National Poison Data System (NPDS) data from 2017 reported 4,007 total exposures to lacrimators. Of these, 83% of cases were from OC, 12% CN, 0.2% CS, and 4% other or unknown. Twenty-five percent of these cases saw evaluation in a healthcare facility, and most had minor effects. There were no deaths reported. Texas poison center data from 1998 to 2002 identified 1531 human exposures to pepper spray. During these five years, they noted a decline in the number of exposures. Additionally, the majority of exposures were unintentional (84%), occurred at home (68%), involved males (56%), and comprised children and adolescents (64%). Risk factors for pepper spray exposure varied by patient age.

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Although 85% of the pepper spray exposures underwent management outside of health care facilities, 97% of exposures involved at least minimal clinical effect. Another study using California poison control data between 2002 to 2011 identified 3671 cases of pepper spray exposures. The most frequently seen type of exposure was dermal (2183 victims, 59.5%). Most of these victims reported minor and self-limiting symptoms (56.7%). Only 2.8% of victims reported more severe symptoms that required medical evaluation, which included persistent dermatitis, dermal burns, and blister formation.

Pathophysiology

The different formulations of tear gases were all found to act on transient receptor potential (TRP) channels. One TRP ubtype is TRPA1, which is heavily expressed in nociceptors. Stimulation of TRPA1 causes a sensation of scalding heat and pain, which is why it is thought to help detect body temperature. Stimulation of TRPA1 is thought to mediate pain, cold, and pruritus. Mice bred with TRPA1 deletions will exhibit no pain behavior when exposed to CN or CS. When CS interacts with TRPA1 mucocutaneous sensory nerve receptors, it can cause severe facial pain with reflex blepharospasm and lacrimation. CS, CN, and CR gases have been found to be 10000 times more potent on TRP receptors than other natural agonists. Among the traditional tear gasses, CR is the most potent TRPA1 agonist. Other agonists of TRPA1 are temperature greater than 43 degrees C (109 degrees F), low pH and allyl isothiocyanate, the pungent compound in mustard and garlic.

Capsaicin is the active component in pepper spray. Similar to traditional riot control agents, capsaicin's target is a vanilloid TRP target called TRPV1.[1] TRPV1 is also a TRP ion channel expressed heavily in nociceptors. TRPV1 is found in peripheral sensory nerves and is present in all organs, including the skin, conjunctiva, cornea, and the mucous membranes of the upper and lower airways. TRPV1 also activates when nerve endings are exposed to noxious heat, acting as a thermal warning sensor for imminent tissue damage. Acidification can also lead to sensitization or activation of TRPV1.

In addition to pain, the TRPA1 and TRPV1 receptors are common pathways for inflammatory signaling. When the TRPV1 receptors become activated by OC gas, this leads to an increased release of Substance P at the terminals of the C and special A fibers peripherally and centrally in the spinal cord, causing increased pain and inflammation.

Toxicokinetics

CS (o-chlorobenzylidenemalononitrile)

CS has been an object of study in multiple animal studies. Systemic absorption of CS is primarily through the respiratory tract. After exposure of radiolabeled CS in rats, the tracer was seen mainly in the gastrointestinal tract, urinary bladder, mouth, and esophagus at one-hour post-exposure. By 24 hours, most of the residual radioactivity presented at the mouth, salivary glands, gastrointestinal tract, and urinary bladder. There are two metabolic pathways for CS. Most will be hydrolyzed (approximately 90%) to 2-chlorobenzaldehyde and malononitrile, or it can be reduced (approximately 10%) to 2-chlorobenzyl malononitrile. In humans, the half-life of CS, 2-chlorobenzaldehyde, and 2-chlorobenzyl malononitrile was found to be 5, 15, and 660 seconds respectively. The liver is thought to be involved in the metabolism of CS as half-lives increased in rats with their hepatic circulation excluded. No changes in half-life occurred when the kidney's circulation was excluded in rats. Studies of elimination of CS showed that 50 to 60% disappeared by unknown means. No similar studies are available in humans. The rest of the radiolabeled CS in rats was found mostly (44 to 100%) in the urine, 1 to 23% in feces and less than 1% recovered in respiratory CO.

CN (chloroacetophenone)

There is very little data on the kinetics of CN. The metabolism of CN has not received thorough study. Though it is known that CN is eventually converted to an electrophilic metabolite. It can act as an SN2 alkylating agent and will react with the SH groups and nucleophilic sites of macromolecules, which can result in the disruption of cellular processes. There is limited data on the absorption, distribution, and elimination of CN.

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OC (Oleoresin Capsicum)

The gastrointestinal tract readily absorbs capsaicin. Intravenous infusion of capsaicin in animals resulted in rapid central nervous system uptake. Subcutaneous administration resulted in a slow diffusion from the site of administration. Metabolism of capsaicin occurs mostly within the liver, with a small contribution by the kidney, lungs, and small intestine. On the skin, capsaicin's major metabolic pathway is via hydrolysis, which produces vanillylamine and vanillic acid. When metabolized by the liver, the three major metabolites were 16-hydroxycapsaicin, 17-hydroxycapsaicin, and 16,17-dihydrocapsaicin. Capsaicin and its metabolites get excreted in the urine.

History and Physical

Patients exposed to riot control agents often present reporting exposure to a noxious gas or spray. Symptom onset occurs within 20 to 60 seconds of exposure, usually beginning with ocular and respiratory symptoms. Other symptoms include burning pain, irritation, and inflammation of the eyes, respiratory tract, and skin. Systemic symptoms may include cough, shortness of breath, chest pain, headache, dizziness, or syncope. Patients exposed to high concentrations or in poorly ventilated areas may have more severe symptoms. These severe symptoms include bronchospasm, hemoptysis, chemical pneumonitis, pulmonary edema, asphyxia, and even death. Physical findings of the eyes may include lacrimation, conjunctival injection, blepharospasm, photophobia, conjunctivitis, and periorbital edema. Riot control agents typically do not cause significant ocular injury, but they can occur. Reported ocular injuries include hyphemia, uveitis, necrotizing keratitis, coagulative necrosis, secondary glaucoma, cataracts, and traumatic optic neuropathy and loss of sight.

Some of these injuries can be due to explosive devices, an organic solvent vehicle, or unintentional self-injury from the forceful rubbing of the eyes. Skin manifestations could include erythema, rashes, purpura, desquamation, vesicles, blistering, 1st, 2nd, or 3rd-degree burns, scaling and subcutaneous edema.

The severity of skin effects gets exacerbated by moisture. CN has been noted to cause more severe dermal injuries compared to CS. Delayed dermal manifestations like allergic contact dermatitis and acute generalized pustulosis can appear about 12 to 24 hours or more after exposure.

In most cases, symptoms are self-limited and resolve spontaneously within 10 to 30 minutes after removal from the source. Cough and shortness of breath may persist, especially of patients have intrinsic lung disease. In animal studies, a significant reduction in minute ventilation was noted in both CS and OC exposure but may also be due to the organic solvent. Visual acuity typically returns to normal within this same time frame. Erythema of the lid margins and photophobia could last longer. Runny nose and salivation may last for about 12 hours, and headaches can remain for up to 24 hours. Erythema of the skin typically resolves within an hour, while blistering and more severe lesions usually resolve within four days.

Evaluation

Hazardous materials management principles would suggest that decontamination should occur first to prevent responders and healthcare professionals from becoming contaminated. It is unlikely but possible depending on the setting that workers could be exposed to riot control agents and become symptomatic. Providers will need to exercise reasonable judgment on whether a patient needs decontamination before entering the healthcare environment. After initial stabilization, decontamination may be considered depending on the setting; this can initially start in the field if a patient is presenting via EMS. Aerosolized gases are heavier than the surrounding air, which is why an incapacitated patient should get lifted off of the ground, EMS vehicles should also try to park in higher areas than where the dispersion of gases occurred. Hospital workers can use customary personal protective equipment. Removal of contaminated clothing and prompt decontamination may be performed, including flushing the eyes and skin with copious amounts of water.

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If explosive devices were used to disperse agents, a close inspection of the skin and eyes should be performed to evaluate for foreign bodies, lesions, and shrapnel. Depending on the extent of ocular symptoms, a more detailed ophthalmologic exam with corneal staining could be an option. If there are concerning pulmonary signs or symptoms, pulse oximetry, arterial blood gas analysis, and chest radiography can be obtained to evaluate for acute lung injury. There are no routinely available laboratory tests for identification or confirmation of riot control agent exposure.

Treatment/Management

Management of patients exposed to riot control agents should begin with the customary resuscitative priorities of securing the airway, ensuring adequate oxygenation and ventilation, and supporting hemodynamics. The face should be wiped to remove any particles before being washed. Copious water irrigation with soap should be used to remove contaminants. If there is significant skin breakdown, saline irrigation is the best choice. Other solutions have been investigated and have had mixed data regarding their benefit. Diphoterine is a chelating compound that appears to be effective in decontaminating a variety of chemical splashes to the skin or eyes. Management of ocular exposures involves copious irrigation with water or saline. Irrigation should occur for at least 10 to 20 minutes but can continue longer if the patient continues to have ocular symptoms. Remove contact lenses before irrigation. A topical anesthetic can be used to reduce blepharospasm and improve irrigation. With CS exposures, soap or shampoo can be added to irrigation since CS is sparingly soluble in water. Diphoterine has also been noted to be effective for ocular irrigation and may prevent further chemical injuries to the eye. In patients with severe chemical injuries, systemic corticosteroids can reduce inflammation. For significant corneal injuries, there should be consultation with ophthalmology. glaucoma, cataracts, and traumatic optic neuropathy and loss of sight. Some of these injuries can be due to explosive devices, an organic solvent vehicle, or unintentional self-injury from the forceful rubbing of the eyes. Skin manifestations could include erythema, rashes, purpura, desquamation, vesicles, blistering, 1st, 2nd, or 3rd-degree burns, scaling and subcutaneous edema. The majority of respiratory symptoms following exposure to these agents are mild and self-limited, most resolve within 10 to 20 minutes after removal from exposure. Management of respiratory symptoms is largely supportive. Suctioning is an option for patients with copious secretions. If bronchospasm is present beta-agonists agonists and steroids can be administered. Patients with asthma, emphysema, or bronchitis may present with an acute exacerbation. Very rarely, these agents can precipitate laryngospasm, causing respiratory failure, requiring intubation and mechanical ventilation. Late findings are rare but may include reactive airway dysfunction and pulmonary edema. Treatment of acute lung injury is supportive and may include supplemental oxygen, non-invasive ventilation, or mechanical ventilation depending on the severity. Gastrointestinal symptoms are uncommon, but some patients will have nausea and vomiting. Symptomatic treatment with intravenous rehydration, antiemetic agents, and electrolyte replacement is generally adequate. Given that the gastrointestinal symptoms are typically minor and self-limited, decontamination techniques including gastric lavage or charcoal is not usually necessary. In law enforcement or military training environments, diphoterine may be useful as pre-treatment. In one study, police officers prophylactically exposed to diphoterine solution had less facial pain after entering a CS cloud and returned to action sooner.

Differential Diagnosis

Most exposures to either pepper spray or tear gas will present with a history of exposure to one of these agents and will have typical symptoms. Unknown exposures will be much less likely. Other agents that may have similar presenting symptoms could include cholinergic toxins, pulmonary irritants, or aerosolized caustics.

Prognosis

Tear gas and pepper spray classify as nonlethal agents and therefore usually have an excellent prognosis. In the vast majority of cases after removal from the exposure, resolution of symptoms will occur within 10 to 20 minutes.

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ASOT FEATURED ARTICLE: CONTINUED

In some cases of prolonged exposures, patients can have more serious injuries and respiratory complications. In most of these cases, patients typically improve relatively quickly. Death after exposure is extremely rare, but reports do exist. Post-mortem findings in patients examined after prolonged exposure to lacrimator agents included pulmonary edema, focal intra-alveolar hemorrhage, and necrosis of the respiratory mucosa with pseudomembrane formation, early bronchopneumonia, serosal petechiae, cerebral edema, and hepatic fatty metamorphosis.

Complications

The majority of exposures to lachrymator agents are benign with their irritant effects revolving within 30 minutes. Rarely serious exposure can lead to more severe injuries to the eyes, dermis, and respiratory tract. Acute injuries of the eye can include hyphemia, uveitis, necrotizing keratitis, cataracts, and traumatic optic neuropathy, which can ultimately result in decreased or lost vision. Injuries to the dermis can range from a mild rash, up to severe full thickness burns. Severe respiratory injuries include bronchospasm, chemical pneumonitis, pulmonary edema, and asphyxia requiring intensive care. Death is rare.

Consulations

Consultation with a medical toxicologist and/or regional poison center in the United States can occur by calling (800) 222-1222.

Deterrence and Patient Education

While the use of the lacrimator agents has been banned in warfare for many years, they are still in use by law enforcement and civilians for personal protection. Educate patients by offering reassurance that the vast majority of symptoms will resolve within 10 to 20 minutes, and most do not need medical treatment. Only 25% of lacrimator exposures undergo evaluation in healthcare facilities. Persistent ocular symptoms should undergo a formal eye examination.

Enhancing Healthcare Team Outcomes

Most exposures will be clinically stable and can undergo decontamination prior to direct medical treatment. Recognizing the excellent prognosis of most lacrimator exposures may help emergency departments, poison control, nurses, and pharmacists deal with mass casualty events. All these various disciplines need to collaborate across interprofessional lines to deliver optimal care. [Level V] The majority of patients will have self-limited symptoms; however, those with persistent respiratory or ocular symptoms will need further evaluation and treatment [Level V].

Do you have an interesting trauma article or case to submit for our newsletter? Please send an email to info@theasot.com to have it featured!

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