

# Mass Casualty Acute Pepper Spray Inhalation Respiratory Effect Severity

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**Abstract**—Pepper spray use has gained momentum since 1992 and although the active ingredient is readily available, it is considered a weapon with restricted use in many regions, including The Bahamas. In light of controversy in the literature regarding the severity of presenting respiration complaints among individuals post-acute exposure of pepper spray inhalation, this descriptive case series study was conducted to assess the respiratory status of persons evaluated during a mass casualty in The Bahamas. Parameters noted were patients' demographics and respiration severity determined via clinical examination findings, disposition and follow-up review of the 20 persons. Their most common complaint was difficulty breathing post exposure. Two required admission and stayed for <24 hours uneventfully. All cases remained without residual complaints upon follow-up. Results showed that although respiration difficulty was perceived as the most detrimental of presenting complaints, it was noted to be mostly subjective with benign outcome.

**Keywords**—Acute Pepper Spray Inhalation, Capsaicinoids, Oleoresin Capsicum, Pepper spray, Respiratory severity severity.

## I. INTRODUCTION

THE use of pepper spray, since 1992, has gained much momentum within the arena of law enforcements and self-defence in subduing potentially violent individuals, and as a chemical weapon to facilitate criminal acts [1], [2]. The active ingredient Oleoresin Capsicum (OC), which is derived from the hot cayenne pepper plant, is considered a naturally occurring inflammatory agent that is 300 times hotter than Jalapeno pepper [3], [4]. Although the active ingredient is readily available in many local produce stores, pepper spray is considered to be a weapon. Its use is restricted in many regions, including The Bahamas, both as a law enforcement and personal defence weapon [3], [4]. Limited controlled clinical studies have been conducted regarding human respiratory health and pepper spray exposure with varying controversial results and characteristic correlations with the presentation or severity of respiratory status [1], [2]. The varying responses ranged from minimum to severe respiratory effect, which can be potentiated by the presence of certain risk factors [4]-[10].

In light of controversy in the literature, limited human clinical studies regarding acute pepper spray inhalation exposure, its respiration effect severity and the recent utilization of pepper spray as a chemical weapon during a robbery attempt in the local region, with themajor presenting complaints pertaining to difficulty breathing and respiratory

status the case series study was conducted to ascertain the severity of the presenting respiratory complaints. In The Bahamas, this was the first noted large scale chemical agent use as a weapon, and the first pepper spray related exposure mass casualty experienced by the emergency departments of the private health institution of

Doctors Hospital Health Service (DHHS), and the public health facility of the Princess Margaret Hospital (PMH). This was also the first pepper spray respiratory effect human study done in the Caribbean region.

## II. MATERIAL AND METHOD

### A. Objective

A descriptive case series study was conducted with the objective of assessing the severity of respiratory complaints of patients' post-acute pepper spray inhalation involvement during a mass casualty in The Bahamas in light of controversies in the literature.

### B. Methodology

Data relevant to the study was obtained from documented information in the medical notes and via telephone follow-up review interview of persons then exposed to pepper spray. Study parameters included patient demographics, presenting complaints, past medical history, and examination findings. Respiratory status severity was determined according to clinical findings. Also measured were documented emergency room management, patients' final disposition, and follow-up results. Follow-up review of each patient was conducted by telephone interview ten days after their initial presentation.

### C. Ethical Consideration

Confidentiality was maintained with patients' information and ethical consideration and approval to conduct the study was requested and obtained from the Joint Ethics Committee of the Public Hospitals Authority and The University of the West Indies School of Clinical Medicine and Research in The Bahamas.

## III. RESULTS

A total of 20 individuals reported exposure to pepper spray. Results pertaining to medical and social history, demographic characteristics and mode of transport to the emergency department (ED) of the 20 individuals who reported exposure are outlined in Table I. Seventeen of the 20 individuals reporting pepper spray exposure were transported to the ED of the PMH and DHHS for acute evaluation and management of resultant complaints. Fourteen were transferred to the private

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DHHS and three to the public health facility of PMH. The additional three persons contacted the ED by telephone; two telephoned the ED of PMH and the other contacted the ED of DHHS. They each reported to have experienced no complaints as a result of being exposed to the pepper spray, and therefore had refused being transferred to the ED; but contacted the ED to ensure if any precautionary measures should be maintained. Information subsequently obtained from the three persons by an emergency room physician that included clinical status and past medical history was considered unremarkable and not warranting ED presentation.

All patients reporting exposure were women. The ages ranged between 27 years and 59 years old, with mean age of 43.6 of standard deviation of  $\pm 5.92$ . Five patients reported having a medical history inclusive of a diagnosed chronic illness, of which three were hypertensive and two were asthmatics. One patient was a heavy smoker, who smoked 1-2 packs of cigarettes daily and seven patients drank alcohol occasionally. No illicit drug use or known allergies were noted. The body weight of the patients fell within the range of 127lbs to 288lbs with a mean of 176.75 of which the standard deviation was  $\pm 38.27$ .

TABLE I  
DEMOGRAPHIC CHARACTERISTICS OF PATIENTS REPORTING EXPOSURE TO  
ACUTE PEPPER SPRAY INHALATION

Characteristic	Patients Demographics
Number of patients reported exposure	20
ED presentation	85% (17)
ED telephone contact	15% (3)
Mode of transport to ED	
Ambulance	58.8% (10)
Private vehicle	41.2% (7)
Gender	
Female	100% (20)
Male	0
Age	
Age range (years)	27 – 59
Mean age	43.6 (SD $\pm 5.92$ )
Weight (lbs)	
Weight range	127 -288
Mean weight	176.75 (SD $\pm 38.27$ )
Chronic illness history	
Hypertension	15% (3)
Asthma	10% (2)
Social history	
Cigarette smoker	5% (1)
Alcohol	0
Illicit drug use	0
Allergy history	
Penicillin	5% (1)

Difficulty breathing was the most common presenting complaint and was present in all acute cases. This was followed by coughing, chest tightness and throat irritation in descending order, as outlined in Fig. 1.

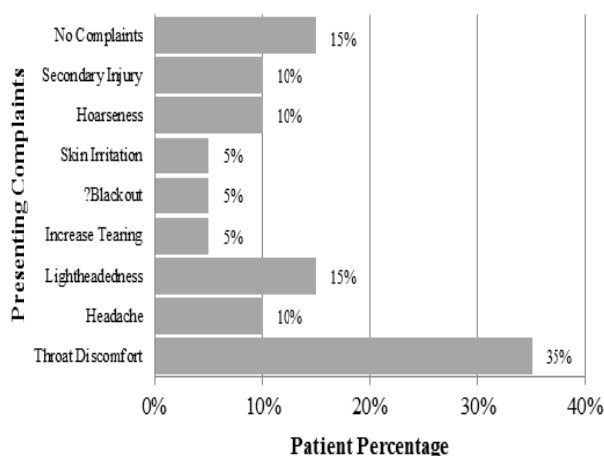


Fig. 1 Presenting complaints of pepper spray exposed patients

Additional complaints included skin irritation, increase tearing or eye discomfort. Two patients complained of shoulder pain that accidental falls while attempting to flee the exposed environment. One patient complained of a sore throat that was present prior to the incidence. Many of the difficulty breathing complaints were transient and documented as subjective. Examination findings of the acute cases are shown in Table II. Vital signs which included blood pressure, pulse rate, respiratory rate and oxygen saturation and temperature, were normal in over 50% of acute cases. Coughing and increased respiratory rates were the most common examination findings. Wheezing was auscultated in two patients; and hoarseness was noted in two patients who were eventually admitted.

TABLE II  
EXAMINATION FINDINGS OF ACUTE PATIENTS EXPOSED TO ACUTE PEPPER  
SPRAY INHALATION

Examination Findings	Patients Demographics
Number of Acute Patients	17
Normal Vital Signs	58.8% (10)
Increased Respiratory Rate	35.3% (6)
Increased Pulse Rate	17.6% (3)
Elevated Blood Pressure	5.9% (1)
Coughing	23.5% (4)
Wheezes	11.8% (2)
Hoarseness	11.8% (2)
Shoulder pain	11.8% (2)

Management administered in the ED included beta-agonist nebulization for twelve patients, analgesia for the two patients who suffered the secondary injury shoulder pain and a third patient suffering from a sore throat. Four of the acute cases required no ED management. All patients managed in the ED of DHHS were discharged with a minimum stay of 1 hour and 8 minutes and a maximum stay of 2 hours and twenty-three minutes. Admission and discharge times for PMH could not be confirmed. Follow-up of the two patients who were admitted showed a less than 24 hours hospital admission stay which was uneventful. Follow-up of the patients ten day

following ED presentation revealed all cases remaining asymptomatic without residual complaints.

#### IV. DISCUSSION

Pepper spray is available in varying chemical compositions and concentrations consisting of the components Orthochlorobenzalmalonitrile, Alphachloro-acetaphenone and OC in inert substances [3], [4]. Oleoresin Capsicum is the chief component of pepper spray. It is derived from the plant genus *Capsicum* and primarily utilized as a culinary spice and an anaesthetic agent [5]. The concentration of the complex mixture of fat soluble capsaicinoids component of OC determines the potency or hotness of the pepper spray mixture, which is measured in Scoville Heat Units (s) [3]-[5]. Most commercially available canister-contained pepper spray mixtures have an OC concentration between 5-15% [3]-[5]. This was reported by the local Forensic Lab analysis as consistent with the specimen retrieved from the crime site in The Bahamas.

Route of pepper spray systems exposure can occur via ocular, nasal, oral or dermal routes, and although particles can be washed off with relative ease, pepper spray can cause transient incapacitation from an attack distance range of 8 to 20 feet [4], [3], [5]. Subsequent stimulation of chemonociceptors of the primary afferent nerve endings and the release of substance P and peripheral neuropeptides by OC, accounts for the dermal, neurologic or cardiac adverse responses [1]. Difficulty breathing is a common presenting complaint of acute pepper spray inhalation exposure [1], [5]. Numerous deaths have been reported over the last two decades as being attributed to respiratory depression caused by pepper spray inhalation exposure [1], [8]-[13]. However the coexistence of other potential causes for the mortalities prompted concern as to the severity of respiratory effects of acute pepper spray inhalation exposure and its potential role in these deaths [1], [5]. Knowledge is limited as to the exact mechanism and effects of OC capsaicinoids on the respiratory system in human beings [1]. However, capsaicinoids airway exposure in rats produced acute airway inflammation with resultant coughing, bronchoconstriction, laryngospasm, laryngeal and pulmonary oedema, chemical pneumonitis, respiratory depression, and airway cellular damage as shown in Fig. 3; without inducing tachyphylaxis [13], [14]. The severity of the adverse response was shown to be dependent upon the OC dose.

In vitro cytotoxicity analyses revealed that cultured lung cells of human referred to as the BEAS-2B and A549, were more vulnerable to necrotic cell death than cells of the HepG2 liver cells [13], [14]. Activation of transcriptase human vanilloid receptor type-1 known as TRPV1 was identified as the initiating cause of cellular cytotoxicity [13], [14]. Controlled clinical studies in humans regarding respiratory health relationship to pepper spray exposure is limited [1], [2], [6], [7], [13]. However results from studies conducted showed that adverse respiratory response was minimal with short-term inhaled pepper spray exposure, in otherwise healthy

individuals [6], [7]. Inhalation of nebulized Capsaicin particles of sizes between one to two micrometre ( $\mu\text{m}$ ), in ethanol and 0.9% saline, among healthy subjects between the ages of 25 years to 35 years old caused an increase of  $35 \pm 6\%$  in mean inspiratory flow which was considered a benign outcome [7].

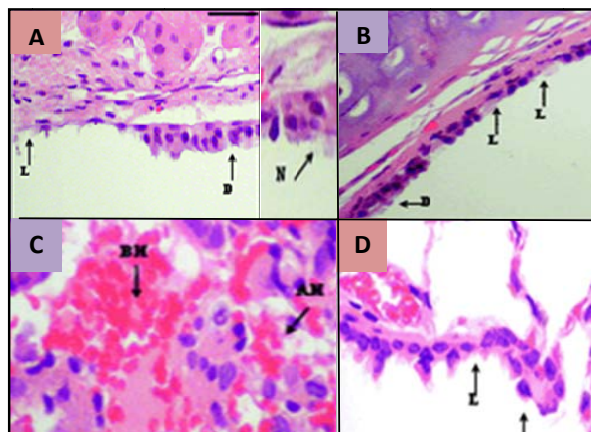


Fig. 3 Cellular changes in rats after inhaled pepper spray. L, loss of epithelial; N, normal; D, epithelial dysplasia; BM, bronchiolar haemorrhage; AM, alveolar haemorrhage [13]

The occurrence of laryngo spasm was rare and associated with direct OC vocal cords contact, not lasting beyond 45 seconds, and requiring no intubation intervention [5], [8]. Cyanosis, apnoea and respiratory arrest, were also rare, and found to be associated with more prolonged exposure of increased OC concentrations; and individuals suffering from chronic obstructive lung diseases were considered more sensitive to the effects of OC [7], [9]. Two patients in the case series were diagnosed asthmatics but did not suffer prolonged complaints. One required nebulization and was subsequently discharged from the ED and the other suffered no ill effects.

There are no studies in human regarding exposure to pepper spray in the face of a respiratory infection however results from animal studies showed a 60-fold increase of vascular permeability of 60-fold and an increase likelihood of respiratory arrest [5], [9], [15]. In addition coexisting Parainfluenza infection showed a three to five-fold increase in airway inflammation response, a thirty-fold airway inflammatory response and prolongation of complaints with coexisting *Mycoplasma pulmonis* infection [5], [9], [15]-[18]. One patient in the case series exhibited upper respiratory tract infection related complaints prior to pepper spray exposure, but did not experience prolonged or more severe complaints when compared to the otherwise healthy patients involved in the mass casualty.

In America deaths reported as a result of OC in 13 states were found more likely to be caused by the occurrence of positioning asphyxia, substance or drug intoxication, pre-existing respiratory or cardiovascular illness, obesity, or neuroleptic malignant syndrome [5]. Elderly persons and children were also considered as being more susceptibility, potentiating the respiratory effects and severity of pepper spray. [5], [10], [11], [17], [18]. The mass casualty cases

involved no children, elderly persons or illicit drug users; however person's weight recorded ranged from 127lbs (57kg) to 288lbs (130kg). According to the female average height most of the case series patients had grossly increased body mass index, yet no related fatality or significant or prolonged adverse respiratory effect was noted.

Most of the presenting respiratory complaints in the case series were found to be subjective, with an overall benign respiratory status outcome resulting. This was consistent with study results, where acute OC inhalation was not observed as resulting in severe acute physical harm, indisposition or death [1], [4], [12]. Test subjects exposed to a commercial aerosol form of pepper spray for durations of one and five seconds, from a five feet distance, in a laboratory setting, experienced no significant adverse response [1]. The included small percentage of test subjects who had a history of asthma and other forms of chronic lung disease also suffered no significant respiratory complaints [1]. Asthma was the only lung related disease noted in two of the index cases. One required ED nebulization prior to being discharged from the department, and the second experienced no complaints and refused ED presentation. In the open environment of a field setting as was the case with the mass casualty incidence, exposure may be associated with longer and repeated doses of OC but the open environment and lengthen distance of exposure may contribute to more benign respiratory status outcome. No distinct characteristics were noted in the case series as correlating with respiration severity. Results of this descriptive study however showed minimal adverse respiratory response and an overall benign outcome in regards to the persons exposed to acute pepper spray inhalation during the mass casualty event in The Bahamas.

#### A. Study Limitations

The small sample size of the study and study reliant upon adequate documentation in the medical notes documentation are two notable study limitations; which can be alleviated with controlled clinical trials.

#### V. CONCLUSION

The severity of respiratory complaints as a result of acute pepper spray inhalation is a controversial topic that involves the consideration of varying determinants; which are not only related to the degree of substance exposure but the accompanying demographic, medical and social history characteristics of the individual involved. Despite evidence of the active component of pepper spray having destructive inflammatory and cellular results on the respiratory system during exposure, studies dispute a direct correlation of pepper spray and reported related deaths. Although benign respiratory outcome was noted with the results of this case series, for better understanding and reliable evidence of respiratory severity response in acute pepper spray inhalation exposure, more comprehensive controlled clinical studies of human respiratory health outcome must be conducted.

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