



TM-01-98

COMMENTS ON THE USE OF CAPSAICIN SPRAY

By: Jeremy Brown, MD.

TECHNICAL MEMORANDUM

Submitted by
Jeremy Brown, MD.
Chief, Occupational Health
Health Services Directorate
Royal Canadian Mounted Police

June, 1997

NOTE: Further information
about this report can be
obtained by calling the
CPRC information number
(613) 998-6343

EXECUTIVE SUMMARY

At the request of the Health Services Officer, Depot Division, RCMP, Dr. Jeremy Brown of Health Services Directorate, Ottawa, reviewed a publication and prepared preliminary comments on that publication and the use of Capsaicin Spray.

This Technical Memorandum is Dr. Brown's response to that request. It offers observations and comments on the spray as it relates to the respiratory and cardiovascular systems, the corneal effects of directed sprays and the carcinogenic and mutagenic potential of capsaicin. Advice and guidance is given to those who use the spray.

The information contained in this Technical Memorandum is provided for the information of all members of the Canadian police community.

The Canadian Police Research Centre would like to thank Dr. Brown for permission to distribute his comments.

SOMMAIRE

A la demande du medecin-chef de la Division Depot de la GRC, le Dr Jeremy Brown, de la Direction des services de Sante d'Ottawa, a examine une publication et formule des commentaires preliminaires sur cette publication et sur l'utilisation de l'aerosol capsique.

La presente note technique constitue la reponse du Dr Brown a cette demande. Elle contient des observations et des commentaires sur l'aerosol pour ce qui est des appareils respiratoire et circulatoire, des effets de la pulverisation dirigee sur la cornee et des actions cancerigene et mutagene de la capsicine. On y donne des conseils aux utilisateurs de l'aerosol.

L'information contenue dans cette note technique s'adresse a tous les membres de la collectivite policiere canadienne.

Le Centre canadien de recherches policieres tient a remercier le Dr Brown d'avoir permis que l'on publie ses commentaires.

COMMENTS ON THE USE OF CAPSAICIN SPRAY

At your request, I have looked at the paper entitled *The Medical implications Of OC Sprays* by Mike Doubet funded by PPCT Management Systems Inc. (1). I have not been able to locate all the references in the bibliography so this must be considered a preliminary report. I will continue to try to track down further information. In the interim, I offer these thoughts for your consideration and that of the other readers to whom this is copied.

The question of whether pepper spray has caused death in humans is frequently asked. There has been at least one death attributed to pepper spray (2) and there have been numerous cases of in-custody death where suspicion has been raised about a possible contribution from pepper spray (3,4,5). The question usually centres on the possibility of respiratory difficulty resulting from such exposure.

Respiratory System

There is no doubt that capsaicin can induce potentially lethal changes in the upper airways in certain circumstances (1,6,16) and that this may be more problematic in children (6, 16). There is also evidence that capsaicin can cause bronchoconstriction (7,8,9,10,11).

It is evident from these observations, therefore, that there exists a potential for respiratory difficulties to result from such inhalation. Certainly there is evidence that asthmatics may tolerate exposure to pepper spray without ill effects (14) but there is also the potential for severe or profound respiratory difficulty to result from such inhalation. Putting aside the rhetoric of strident voices for and against the use of this substance we need only realize that a bad asthmatic who goes from a warm building into a cold winter night may suffer bronchospasm. Similarly exposure of a serious asthmatic to something as benign as second hand cigarette smoke can trigger an asthmatic attack, as can physical exertion. To deny that such a reaction might occur from the inhalation of so irritating a compound as capsicum would be foolish. Of course respiratory embarrassment can occur, particularly in asthmatics. Possibly there may be serious respiratory effects in children. These respiratory sequelae could, in certain circumstances, cause the death of a suspect. For this reason, members should be aware of the potential impact of this compound on asthmatics, should closely monitor an individual who has been sprayed and should be prepared to obtain prompt medical assistance if the suspect experiences unusual or prolonged respiratory difficulties. There must be no doubt that this compound can probably induce a life threatening asthma attack in a susceptible individual.

It is necessary, in this context, to remember that an asthmatic attack might occur in a susceptible suspect who has not been sprayed with capsicum, as a result of the physical exertion of confrontation or flight, as well as a result of capsicum. Similarly, other chemical weapons (such as tear gas) have been shown to induce asthmatic events. Finally, serious injury may result from a baton or a bullet. Any weapon, chemical or physical, carries risks. The police officer must be aware of the risks and be ready to deal with the consequences. If we restrict the tools available to members to tools that carry no risk we will leave them with no tools at all.

Finally, with respect to the effects of capsicum on the airways, there is some evidence (12,13) that occupational asthma may result from repeated exposure. Members, particularly instructors, should avoid repeated exposures to this substance.

Cardiovascular System

There have been reports that pepper spray results in a sudden increase in blood pressure (1) which may lead to cardiac problems in individuals with underlying coronary disease. This is undoubtedly true. Any stimulus that gives rise to the fight-or-flight reflex will elevate blood pressure, increase myocardial oxygen demand and, in someone with critical coronary disease, could precipitate a heart attack. In this context, it is interesting that systemically administered capsaicin actually drops blood pressure (27,28) and that, too, can precipitate a heart attack in someone with heart disease. Running away from a police officer or engaging the officer in physical confrontation can also cause a heart attack in someone who is at risk. So might physical confrontation with a baton. The potential cardiac results of a bullet are apparent.

Corneal Effects/Directed Sprays/Alcohols

One of the most useful things to come out of the report by Doubet is the observation that many occurrences of use of pepper spray occur at a distance of two to three feet. The application of any chemical to a human subject by compressed gas carries risks. The application, by this method, of any chemical near the eye carries risks of eye damage or, more particularly, corneal damage. The risk is increased if the source is under high pressure and is increased as the source is held closer to the eye (14). It is reasonable to assume that the risk of ocular injury will be higher for directed sprays than for less directed sprays. Reports of severe eye injury,

resulting in the need for enucleation, that have resulted from chemical weapons under pressure may be found in the medical literature dating back many years (15). There must be no doubt that the discharge of any chemical under high pressure towards the eye carries with it a risk of damage to the eye. The higher the pressure in the canister, the closer it is to the eye, and the more accurately it is directed at the eye, the greater the risk of eye damage. The damage may, in certain circumstances, result in loss of vision. The risk may be reduced by using less directed spray from recommended distances.

We know that 23% of suspects in one study (16) who were sprayed with some version of pepper spray suffered corneal abrasions. We know that the vast majority of corneal abrasions heal and that only a minority of cases result in significant permanent loss of vision. Doubet cites one case of permanent vision loss.

Once again, we must maintain the perspective. A blow from a hand or a baton may result in eye damage or blindness too. The potential damage from a bullet doesn't bear thinking about. All 'less-than-lethal' technology carries risk.

Doubet goes on to suggest that the reason for corneal damage from pepper spray may be the use of isopropyl alcohol rather than ethanol as a carrier. The possibility of mechanical damage as discussed is not analyzed. The possibility that corneal abrasion might even result from the vigorous rubbing of the eyes after particulate matter from the spray has entered them is not considered.

Grant, in his classical text on toxicology of the eye (17) tells us that "irrigation of rabbit eyes for three minutes with 50% isopropyl alcohol causes a reaction graded 50 on a scale of 0-100" while 50% ethanol causes a reaction graded at 20 on the same scale.

He goes on to explain that "70% isopropyl alcohol has been employed in cleaning the skin of the lids in preparation for ocular surgery. Often it has entered the conjunctival sac and come into contact with the cornea and conjunctiva for several seconds before being washed away with a sodium chloride solution. Usually the patient has felt uncomfortable burning and stinging despite previous application of 0.5% tetracaine or proparacaine, but no damage is observed unless contact has been prolonged. After prolonged exposure with 70% solution or high concentration of the vapour pressure the corneal epithelium has become irregular and may be lost in patches, but

healing has been prompt. Splash or drop on the eye in the absence of local anaesthetic causes smarting and tearing but no significant injury.”

More recent work (18,19) points out that the toxicity of isopropyl alcohol to corneal epithelium begins at about 31%. The concentration used in pepper spray by this police force is 35%. That is half the strength of the isopropyl alcohol discussed above.

On the subject of ethanol, the same source tells us that it is probably even more benign but goes on to point out: ‘LHowever, repeated applications (seven drops) of 40-80% alcohol to rabbit eyes over an unspecified but presumably longer time caused loss of corneal epithelium and endothelium followed by haemorrhages in the conjunctiva, and infiltration and vascularisation of the corneal stroma.”

Moreover, before doing laser surgery for refraction, surgeons use 10-20% ethanol to “loosen” the corneal epithelium prior to scrapping it off in order to apply the laser and 70% ethanol has been reported to “denude the corneal epithelium” (20).

That chemical weapons can damage eyes is not in question (14,15,16,21,22,23,24). The possibility of physical damage is real and is increased when high pressure directed spray is directed at the face and eyes. The issue of flammability must be considered.

The question of chemical damage is equally clear. Alcohols in the eye can damage the eye. Both isopropyl alcohol and ethanol can damage the cornea. The likelihood of damage is probably most closely connected to the strength of the alcohol and the duration of contact than to whether isopropyl alcohol or ethanol is used. The likelihood of serious or permanent damage seems low for these relatively weak concentration in the brief contact of this context but there may be grounds to argue that ethanol is marginally safer.

Carcinogenic/Mutagenic Potential of Capsaicin

There is evidence that capsaicin may have carcinogenic potential in humans and in biological systems designed to model human cancer (25,26). This opinion is not unanimous (27,28) and there is even some evidence for an anticarcinogenic potential for this substance. A nice review on the subject was done by Surh and Lee (29). The balance of evidence seems to suggest a carcinogenic potential at this time. It is also noteworthy that plant derived capsaicin contains a variety of different compounds (30).

That capsaicin consumed regularly in foods may increase the risk of cancer of the stomach, or that large amounts can cause cancer in mice, is cause for concern. But it is not correct to conclude from these sorts of studies that getting sprayed with pepper spray during arrest is likely to cause the suspect to develop cancer at a later date.

Generally speaking, risk of cancer from a carcinogen increases with frequency of exposure and intensity of exposure. For example, cigarette smoke is known to be carcinogenic. People who smoke a pack of cigarettes every day are much more likely to get cancer than those who do not. This does not mean that the risk of lung cancer is significantly increased among individuals who are occasionally exposed to second hand smoke or that the person who experimented with a pack of cigarettes in adolescence is at an increased risk of cancer.

Certainly, repeated exposure to capsaicin should be avoided and this is particularly important for police trainers who should carefully avoid inhalation. To jump from this to the outright abandonment of the compound for fear that a one-time, or very rare, exposure will cause cancer, would seem something of a leap in logic at this stage. Indeed, the data would have to be sufficient that the extensive use of this compound in food preparation would be abandoned or at least officially discouraged before one would begin to consider 'one-time' or rare exposure as a cancer risk.

Nevertheless, repeated exposure by police officers or police trainers should be avoided. Similarly exposure of pregnant or possibly pregnant women should be avoided because of similar weak mutagenicity data. Mutagenicity and carcinogenesis data are often parallel.

In Summary

The assertion that pepper spray is potentially lethal for some subjects is probably true. Members who use pepper spray should be aware of the potential hazards of the compound and be prepared to intervene and to obtain prompt medical attention if a subject sprayed with capsaicin containing compound suffers prolonged or severe pulmonary symptoms or any cardiac symptoms. It is important to maintain the context. Physical confrontation with a police officer is potentially lethal for some subjects also, as might be the very act of fleeing from a police officer in a severe asthmatic or someone with severe coronary disease. A baton can cause death or severe injury also and so can a firearm. Education and common sense are required.

Eye damage from pepper spray is also a realistic possibility. This is more likely if high pressure delivery systems are used, more likely with directed high pressure spray and more likely when the source is closer than the recommended distance. There is some evidence to suggest that *ethanol* may be marginally safer than *isopropyl alcohol* but the major determinant of alcohol toxicity is the concentration of the alcohol in the spray rather than the type of alcohol and the duration of contact with the cornea.

Issues of risk for physical trauma are probably more important than whether 35% isopropyl vs 35% ethanol is used since both concentrations are relatively low and contact is likely to be brief. Degree of flammability is an important issue.

Once again, these issues must be judged in context. A physical blow to the eye from physical confrontation, either from a hand or a baton carries risk of cornea¹ damage, globe damage and even the possibility of orbital fracture. All 'less than lethal' technologies carry risk.

The question of carcinogenicity and mutagenicity from capsicum is cause for concern and further research in this field is necessary. This office will be monitoring published research in this field. In the meantime it is important to maintain the perspective that the likelihood of getting cancer from a carcinogen is usually related to intensity and frequency of exposure. Cigarette smoke causes cancer and someone who smokes heavily is at a dramatically increased risk of cancer. It does not follow that having smoke blown in your face once, or rarely, in your life will cause you to develop lung cancer. At this time, the likelihood of developing cancer from a one-time or rare exposure to this capsicum seems very, very small. Nevertheless, repeated exposure or exposure of pregnant women ought to be avoided where possible.

Much of the published material on this subject originates in the United States and opinions tend to differ. The supporters of pepper spray insist it is completely harmless; the opponents characterize it as lethal, blinding and cancer causing. It is neither. It is a tool in police work which offers an alternative to lethal force and to physical confrontation. Like all such tools, there are risks associated with the use of this tool. Members should be well trained and knowledgeable in the risks associated with the use of this tool and repeated exposure should be avoided. Exposure of pregnant women should be avoided. Members should know how to recognize complications of capsicum exposure and when to seek medical assistance for subjects exposed. Subjects who have been exposed should not be left unattended until they have completely recovered and any children inadvertently exposed

should be brought to hospital. There is not cause, at this stage, to abandon the use of this tool.

Truth is rarely found at the extremes of belief and is rarely reached by the process of confrontation. A careful analysis of the facts seems a better way to understand the issues so that informed decision making may occur. I hope that this document has achieved that goal.

References

1. Doubet, Mike
The Medical Implications of OC Sprays
PPCT Management Systems Inc.
500 South Illinois
Milstadt, IL USA 62260
2. Flanagan L.
Autopsy Case ME-93-658
Chapel Hill, NC
Office of the Chief Medical Examiner, 1993
3. Granfield J, Onnen J, Petty C
Pepper Spray and In-Custody Deaths
Executive Brief
International Association of Chiefs of Police
4. Steffee C H, Lantz P E, Flannagan L M, Thompson R L, Jason D R
Oleoresin Capsicum (pepper) Spray and "In-Custody Deaths"
The American Journal of Forensic Medicine and Pathology
16 (3): 185-192. 1995
5. Granfield J, Onnen J, Petty C S
Pepper Spray and In-Custody Deaths
The ASLET Journal May/June 1994
6. Winograd H D
Acute Croup in an Older Child: An Unusual Toxic Origin
Clinical Paediatrics Vol 16, No 10 October 1977
7. Barros M J, Zammatio S L, Rees P J
Effects of Changes in Inspiratory Flow Rate on Cough Responses to
Inhaled Capsaicin
Clinical Sciences 81, 539-542 1991
8. Lundberg J M, Martling C-R, Saria A
Substance P and Capsaicin -induced contraction of the Human
Bronchi
Acta Physiol Scand 119: 49-53 1983

9. Fuller R W
Pharmacology of Inhaled Capsaicin in humans
Resp Med 85 (Supplement A) 31-34 1991
10. Fuller R W, Dixon C M S, Barnes P J
Bronchoconstrictor response to inhaled Capsaicin in humans
J Applied Physiol Vol 58 No 4 1080-1 084 1985
11. Choudry N B, Fuller R W, Anderson N, Karlsson J-A
Separation of Cough and reflex bronchoconstriction by inhaled local
anesthetics
European Respir Journal
Vol 3, 597-583 1990
12. Blanc P, Liu D, Juarez C J, Boushey H A
Cough in Hot Pepper Workers
Chest 99 27-32 1991
13. Sastre J, Olmo M, Novalvos D, Lahoz C
Occupational Asthma Due to Different Spices
Allergy 51: 117-1 20 1996
14. MacRae W G, Willinsky M D, Basu M B
Corneal Injury Caused by Aerosol Irritant Projectors
Canadian J Ophthal 5: 3-10, 1970
15. Levine R A, Stahl C J
Eye Injury Caused by Tear Gas Weapons
American Journal of Ophthalmology
Vol65, No 4 497-508 1968
16. Watson WA, Stremel K R, Westdorp E J
Oleoresin Capsicum (CAP-STUN) Toxicity from Aerosol Exposure
The Annals of Pharmacology Vol30 733-735 1996
17. Grant W M
Toxicology of the Eye
3rd Edition 1986
Charles C. Thomas, Publisher
Springfield Illinois

18. Hill R M
Isopropyl Alcohol
The Eye and the Contact Lens
ICLC 15 No 8 262-3 1988
19. Roseman M J, Hill R M
Aerobic Responses of the Cornea to Isopropyl Alcohol, Measured in Vivo
Acta Ophthalmologica
65 306-312 1987
20. MacRae S M, Brown B, Edelhauser H F
The Corneal Toxicity of Pre-surgical Skin Antiseptics
American Journal of Ophthalmology 97: 221-232 1984
21. Leopold I H, Lieberman T W
Chemical Injuries to the Cornea
Federation Proceedings
Vol 30 No 1 92-95 1971
22. Berger C M, Christensen R E, Lee D A
Elevation of Intraocular Pressure After Systemic Absorption of Mace
Glaucoma 14: 47-47 1992
23. Rengstorff R H, Sim V. M, Petrali J P
CS in Water: !. Effects of Massive Doses Sprayed Into the Eyes of Rabbits
Military Medicine Vol 136 No 2 146-148 1971
24. Hull D S, Green K, Thomas L, Alderman N
Hydrogen Peroxide Mediated Corneal Endothelial Damage
Investigative Ophthalmology & Visual Science
Vol 25 1246-1253 1984
25. Balachandran B, Sivaramkrishnan V M
Induction of Tumors By Indian Dietary Constituents
Indian Journal of Cancer Vol 32 104-109 1995
26. Azizan A, Blevins R D
Mutagenicity and Antimutagenicity of Six Chemicals Associated with the Pungent Properties of Specific Spices as Revealed by the Ames Salmonella/microsomal Assay
Arch. Environ. Contam. Toxicol. 28 248-258 1995

27. Monsereenusorn Y, Kongsamut S, Pezalla P
Capsaicin-A Literature Survey
CRC Critical Reviews in Toxicology
32 1-332 1982
28. Govindarajan V S, Sathyanarayana M N
Capsicum-Production, Technology, Chemistry, and Quality
Part V.
Critical Reviews in Food Science and Nutrition
435-474 1991
29. Surh Y-J, Lee S S
Capsaicin in Hot Chili Pepper: Carcinogen, Co-Carcinogen or
Anticarcinogen
Fd Chem Toxicol Vol 34 No 3 313-316 1996
30. Haas J S, Whipple R E, Grant P M, Andresen B D
Chemical and Elemental Comparison of Two Formulations of
Oleoresin Capsicum
Science & Justice 37 (1) 15-24 1997