CANADIAN POLICE RESEARCH CENTRE

CENTRE CANADIEN DE RECHERCHES POLICIÈRES

# Technical Report

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# Review of Conducted Energy Devices

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Prepared by

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**For the**

**Canadian Association of Chiefs of Police**

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# Canadian Police Research Centre

## Review of Conducted Energy Devices

## Executive Summary

As a result of a number of deaths associated with the use of Conductive Energy Devices (CEDs), and growing concern within the public and the law enforcement communities in Canada, the Canadian Association of Chiefs of Police (CACP) approached the Canadian Police Research Centre (CPRC) in August 2004, to conduct a comprehensive review of the existing scientific research and data and provide a national perspective on the safety and use of CEDs.

CPRC closely collaborated with representatives from the Victoria Police Department who were concurrently studying CEDs on behalf of the BC Office of the Police Complaints Commissioner (BCOPCC). This horizontal collaboration enabled the optimization of resources and brought about mutual benefits with regards to information sharing. Moreover, this report complements the existing BCOPCC reports, which were published respectively in December 2004 and June 2005. At the same time, CPRC and BCPOCC consulted with their UK and US counterparts who were also reviewing the use of CEDs.

In Canada, the use of CEDs are limited to police officers and guided by policies established by the responsible agencies be they at the federal, provincial or municipal level. In turn, the agencies are guided by the National Use of Force Framework (NUFF), which was established in 2000, by the CACP. It is the intent of this report to provide guidance and assistance to the Canadian police community in reviewing the current operational use of CEDs and the development of future training programs, governing policies and procedures.

To guide its activities and to ensure appropriate representation from the community, CPRC established a Steering Committee. Membership included medical professionals, police officers, police trainers, policy analysts and stakeholder representatives from across Canada.

The CPRC's review of CEDs focused on three areas: the medical safety of CEDs, the policy considerations for Police CED operations and the analysis of the medical condition excited delirium. The term "Conducted Energy Device" has been used throughout the report rather than the trademarked term "TASER". This more inclusive term recognizes that there are other products, which may be entering the market. Only the TASER® M26 and X 26 were reviewed for this report.

## Section 1 - Medical Safety of CEDs

This section focuses primarily on the medical effects of the devices. The research and/or opinions (15 in total) were categorized as *vendor-sponsored, independent,* or *on-going*. Based on the existing research into the medical safety of CEDs, the CPRC team has concluded the following:

- Definitive research or evidence does not exist that implicates a causal relationship between the use of CEDs and death.
- Existing studies indicate that the risk of cardiac harm to subjects from a CED is very low.
- Excited Delirium (ED), although not a universally recognized medical condition, is gaining increasing acceptance as a main contributor to deaths proximal to CED use.
- The issue related to multiple CED applications and its impact on respiration, pH levels, and other associated physical effects, offers a plausible theory on the possible connection between deaths, CED use, and people exhibiting the symptoms of ED.

The contributors to this CPRC report believe that CEDs are effective law enforcement tools that are safe in the vast majority of cases.

## Section 2 – Policy Considerations for Police CED Operations

During the course of reviewing the existing research on CEDs, information has been collected that can substantially improve the knowledge that law enforcement agencies possess about the use of CEDs. Section 2 addresses issues relating to operational use, training, policy and accountability.

It has become evident that the emergence of CEDs as a use of force option for police services has been a substantial benefit. Proper training and use of CEDs have reduced the risk of harm to both police officers and suspects. Several positive aspects of CED usage are referred to in reports across North America, namely:

- Less injuries to police officers while completing arrests
- Less injuries to persons who are resisting arrest
- Less use of lethal force
- Less use of other force options

Originally, the CEDs were developed in an effort to provide “less-lethal” use of force options to police when faced with incidents that may otherwise require a lethal use of force option. At the time, this is also how the devices were marketed to the public, the media, civilian oversight bodies, government, and “watchdog” groups – as replacements for lethal force. There is no question that the use of CEDs can, and have, saved many lives, however, it is a common misconception that CEDs are

only used when an incident would require lethal force, and/or before lethal force is actually used in such situations.

Based on the existing research, the CPRC team puts forth the following policy considerations:

- The use of CEDs are related to a decrease in the use of lethal force in some jurisdictions and are also related to substantial decreases in police officer and subject arrest-related injuries.
- Although each use of force incident needs to be judged separately, for the most part the increased use of CEDs in non-lethal incidents is appropriate.
- Originally marketed and accepted as an alternative to lethal force, usage has grown to include incidents where intermediate (but not lethal) weapons should be used
- Police services and their governing bodies and agencies should give thoughtful consideration to developing CED usage reporting procedures, forms, or databases.
- It would be unwise and counter-productive for any police service or government body to develop policies and procedures that explicitly speciffiesy in what kinds of circumstances a CED may or may not be used.
- Notwithstanding the above point, police officers need to be aware of the adverse effects of multiple, consecutive cycles of a CED on a subject; deploying a CED on a subject's head, neck, or genitalia; deploying a CED where a person can fall from a height; and deploying a CED on a subject where it is known to the officer that the subject has flammable substances on their clothing or on their person, or are standing in or near obvious flammable/explosive substances conditions such as a puddle of gasoline or a natural gas leak.

**Section 3: Excited Delirium (ED)**

Given the attention surrounding the deaths proximal to CED use, Section 3 provides with a more thorough explanation of ED and its relationship to CEDs and the individuals who have died. The CPRC team believes strongly that this section sheds noteworthy light on the possible significant factors in these deaths.

To appreciate the complexity of ED, consider the following scenario:

> *Police are dispatched to intervene when a male subject (rarely is a female the subject in excited delirium), often inappropriately dressed for the environment, is acting in a violent and irrational manner in a public or residential space. There is seemingly purposeless, constant activity and violence. Attempts to intervene by bystanders have been unsuccessful, the violent rampage continues and there is concern for personal safety or the protection of property. On arrival of the police service, the subject is apparently incoherent, is often continuously screaming unintelligible words or sounds, does not recognize that*

*police are present and appears to be suffering from either some sort of psychosis, or a severe drug induced "high". The disruptive situation continues or escalates and the officers attempt to take the subject into custody. Upon physical contact, the subject immediately begins to fight aggressively with police resulting in a protracted physical encounter requiring multiple officer participation and varying methods of restraint. During the struggle, the subject is apparently impervious to pain and appears to have near superhuman strength, out of proportion with physical characteristics. Often officers note that the skin of the subject is extremely hot to the touch and the subject may (or may not) be sweating profusely. At the conclusion of the protracted struggle, the subject is finally taken under some semblance of control and handcuffed; everyone, including the subject, is exhausted. What is the diagnosis?*

In fact, there is no unifying diagnosis; rather, a set of signs and symptoms forming a condition that may be associated with sudden death proximal to restraint. That cluster of signs and symptoms collectively forms a condition known to some as excited delirium, also known as agitated delirium or delirium agité. When the subject has a fatal outcome following presentation in excited delirium, previous literature has called that specific clinical course "in custody death syndrome".

Whether as a result of illicit drugs, psychiatric illness or other metabolic derangements, the cause of the excited delirium is initially irrelevant since it can neither be investigated nor treated until the subject is contained. No therapeutic relationship can be entered with an individual who is incoherent, violent and resistive.

Not only is the commencement of therapy or the protection of public good in order, it may be harmful to allow the delirious state to continue. Usually, police engagement is requested as a result of property damage concerns, dangerous or threatening behaviours and commonly, real concerns about the imminent danger to the subjects themselves. Risks to these individuals are not necessarily mitigated by containing them in a large space until such time as exhaustion sets in. Not only are property owners not content to watch police allow a subject to continue to destroy property, there is some medical evidence that suggests that progression to a state of exhaustion is, in itself, dangerous.

Current attentions are focused on the use of CEDs as causative in the deaths through a variety of proposed but unproven mechanisms. Section 1 of this report deals specifically with the current level of medical research into conducted energy weapons and sudden death proximal to police restraint. Prospective investigation in the population of interest is still lacking and all causative theories are, at present, speculative.

Recent discussions surrounding the need for further scientific data for the population of interest during the situation of interest have prompted the development of a national protocol for the epidemiologic study of subjects resisting arrest with specific interest in features of excited delirium and the incidence of sudden in custody death.

Interest in further defining physiologic mechanisms potentially placing subjects suffering excited delirium at risk have lead to other scientific protocols investigating acid base balance and the influence of pH changes with and without various methods of restraint.

Evidence for the multifactorial nature of the deaths is further supplied by observations that subjects dying in police custody are not always restrained prone nor are all the characteristics replicated in all cases. Collection of data around all features of subjects resisting arrest and dying in police custody remains necessary to fully understand these events.

Based on the existing research on excited delirium, the CPRC team recommends the following:

- Police officers should recognize that acutely agitated persons are suffering from a medical emergency, and that emergency medical services (EMS) involvement is warranted as early as possible in the restraint process.

- Notification of EMS for dispatch prior to actual physical engagement with the subject may be the most rational policy

**Conclusions**

This report summarizes the efforts of the CPRC team in researching, analyzing, and communicating the vast array of complex issues associated with CEDs. The CPRC team believes that the following global statements will assist and guide the policing community in Canada establishing best practices for the safe use of CEDs:

- Definitive research or evidence does not exist that implicates a causal relationship between the use of CEDs and death.
- Existing studies indicate that the risk of cardiac harm to subjects from a CED is very low.
- Police officers need to be aware of the adverse effects of multiple, consecutive CED cycles
- The issue related to multiple CED applications and its impact on respiration, pH levels, and other associated physical effects, offers a plausible theory on the possible connection between deaths, CED use, and people exhibiting the

symptoms of ED.

- It would be unwise and counter-productive for any police service or government body to develop policies and procedures that explicitly specify in what kinds of circumstances a CED may or may not be used.
- The application of best practices relating to the safe use of CEDs should lead to an increase in public confidence in CEDs as appropriate law enforcement tools.

**Future Directions**

The team has identified areas for future work beyond the scope of this study.

It has become apparent to the CPRC team that there is no known, scientifically tested, independently verified, and, globally accepted CED safety parameters. This is problematic for a couple of reasons.

- Police services and authorizing agencies are completely reliant on manufacturer claims regarding the safety of their products. By comparison there are many policing tools and equipment that have an accepted range of safety parameters such as body armour, OC spray concentrations, and police vehicle specifications. In terms of CEDs what is known is limited to testing of the TASER® M26 and X26. If a new CED were to be introduced, police services and authorizing agencies could only rely on manufacturer claims.
- Because of this lack of known safety parameters relating to CED, authorizing agencies are ill-equipped to respond quickly to advances in technology that may be immediately beneficial to police and, eventually, community safety. At least in the context of a few Canadian examples, some authorizing jurisdictions have little independent information to form decisions and policy – with the end result being an unnecessarily bureaucratic process, devoid of leadership, that serves few stakeholders. This is a tangible “gap” in the complete understanding of CEDs that needs to be filled.

There is a lack of scientific information on death proximal to restraint.

- There is a need for a national epidemiological study of individuals resisting arrest to gather data around all features of these subjects and those dying in police custody to fully understand these events.

There is also great interest in gaining more information about what happens physiologically in subjects suffering excited delirium:

- Scientists are planning to investigate acid base balance and the influence of pH changes with and without various methods of restraint.

- In addition there is a need, at a national level, to develop research that can study the existence and nature of ED and how people suffering from this condition can be best subdued by police in order to expedite medical treatment.

# Acknowledgements

The Canadian Police Research Centre would like to thank all those who contributed to the success of this study. Over a twelve month period, thousands of pages of information were reviewed, dozens of meetings held and countless telephone calls and e-mails exchanged nationally and internationally.

While there are far too many people and organizations to name individually we would like list a few who played key roles in this report,:

- Office of the Police Complaints Commissioner, British Columbia, Mr Dirk Ryneveld, Commissioner
- CPRC Conducted Energy Device Steering Committee, (Appendix A)
- CPRC Team (Appendix B)
- Organizations who seconded staff and resources to the study: The BC Public Safety and Solicitor General, the Victoria Police Department, the Delta BC Police Department, l'École Nationale de Police de Québec, Service de Police de la ville de Montréal, the Edmonton Police Services, the National Research Council, the Ontario Police College, Ontario Ministry of Community Safety and Correctional Services, the Royal Canadian Mounted Police and Correctional Service Canada.
- Members of the Canadian Association of Chiefs of Police
- International organizations with whom we shared information such as: The National Institute of Justice (USA), The Police Executive Research Forum (USA), The Department of Defence, Human Effects Centre of Excellence, (USA), International Association of Chiefs of Police (USA), Home Office Scientific Development Branch (UK)

# Recommendation from the Conducted Energy Device Steering Committee

**To the CPRC Advisory Board:**

The Canadian Association of Chiefs of Police asked the Canadian Police Research Centre in August 2004, “to conduct a comprehensive review of the existing scientific research and data and provide a national perspective on the safety and use of CED in police work in Canada and around the world”

The Conducted Energy Device Steering Committee was established to provide advice and guidance to the Canadian Police Research Centre (CPRC) Advisory Board and Executive Director in the conduct of the CPRC Conducted Energy Device Study. The Steering Committee reports to the CPRC Advisory Board.

To address the request of the CACP, the CPRC worked in collaboration with the research community, end users and other stakeholders to review the medical safety of Conducted Energy Devices (CEDs), the policy considerations for police CED operations and the analysis of the medical condition excited delirium.

The CPRC team has conducted a thorough review of the existing research and presented the results in an objective manner. CPRC has encouraged open and frank discussion in an effort to separate opinion from the research regarding the use and safety of Conducted Energy Devices.

During the course of the study, the Committee reviewed and discussed the work in progress and the outcomes of the study.

On August 10, 2005 the Steering Committee approved the final report. In our opinion the findings in the CPRC report, TR-01-2006 “Review of Conducted Energy Devices”, are a fair representation of the current state of research regarding safety and use of the Conducted Energy Devices.

We recommend acceptance of the report by the Advisory Board of the Canadian Police Research Centre. We further recommend that CPRC communicate the findings to the Canadian public.

Yours Respectfully

Conducted Energy Device Project Steering Committee

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# Introduction

As a result of a number of deaths associated with the use of Conductive Energy Devices (CEDs), and growing concern within the public and the law enforcement communities in Canada, the Canadian Association of Chiefs of Police (CACP) approached the Canadian Police Research Centre (CPRC) in August 2004, to conduct a comprehensive review of the existing scientific research and data and provide a national perspective on the safety and use of CEDs.

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# Section 1 - Medical Safety of Conducted Energy Devices (CEDs)

The Canadian Police Research Centre's (CPRC) review of CEDs research focuses primarily on the medical effects of the devices. The CPRC has closely collaborated with the team from the Victoria Police Department (VPD) that studied CEDs on behalf of the British Columbia Office of the Police Complaints Commissioner (BCOPCC). The BCOPCC released an interim report in September of 2004 and the final report was released in June of 2005. In clear recognition and acknowledgment of the substantial work that culminated in the two BCOPCC reports, and in an effort to reduce unnecessary and unproductive duplication of efforts, this CPRC report (and in particular this section) summarizes the findings of the BCOPCC reports. Note that only one study listed below did not come from either of the BCOPCC reports (*Saul D. Levine, Christian Sloane, Theodore Chan, Gary Vilke and James Dunford, University of California, San Diego (UCSD), 2005).*

The BCOPCC reports reviewed either research that employed scientific methodology or opinions offered by medical professionals. This research or opinions are categorized as *vendor-sponsored, independent,* or *on-going*. The following summarizes the details of each research/opinion and states their conclusion (for further details please refer to the BCOPCC reports). The research/opinions are listed in chronological order, however for brevity and consistency, please note that the individual(s) or organization(s) that conducted the scientific research or provided the professional opinion is labeled as "Researcher":

**Independent Research**

Researcher: *Sgt. Scott Grenfell, Victoria (Australia) Police, 2003. (A-1;A-2,A-3)*

Focus: The Alfred Hospital in Melbourne, Australia conducted an electrical safety analysis of the M26 and X26 TASER®.

Conclusion: "The M26 TASER® output is less than 2% of the normalized current likely to produce ventricular fibrillation. The X26 improves this figure even more to less than 1% of normalized current likely to cause ventricular fibrillation." They also conclude that "the advanced TASER® appears from the manufacturer's data file to be a relatively safe device for immobilizing non-violent offenders. However, these subjects are exposed to a number of immediate risks/potentially fatal dangers operating either just before or just after being apprehended with the aid of a TASER®.

Researcher: *Portland Bureau of Police, Portland, Oregon, 2003. (B)*

Focus: Reviewed 227 TASER® M26 usages and the corresponding emergency medical services care reports for the period between June 2002 and July 2003.

Conclusion: "Of the 227 successful TASER® deployments. 96 (42%) of the incidents had EMS reports. Median patient age was 36 years: 92% were male and 64% were white. 31 (32%) patients received a "Dry stun" when 65 (68%) were shot with the TASER®. There were no documented deaths, dysrhythmias, or cardiac complaints. 60 (63%) of the patients had no documented injury, while 27 (28%) sustained minor secondary injuries (hematomas, lacerations and contusions) and 9 (9%) sustained self-inflicted or unrelated injuries." They conclude "the M26 appears to be a safe and effective non lethal weapon in this case series. No deaths were reported, however, a higher incidence of minor injury was observed than was noted in previous manufacturers' reports. A prospective trial of its use to better define a risk-benefit relationship is justified."

Researcher: *Joseph Heck, Casualty Care Research Centre, Henderson, Nevada, 2004. (C)*

Focus: Examined the medical implications of CED use from the perspective of emergency care providers.

Conclusion: "The electrical impulse delivered by either the stun or EMD (electromuscular disruption) device is well below the level established as "safe" by the federal government and International European standards in approving such devices as electrified cattle fence, and the risk of cardiac complications is low. Sudden death has been reported proximate to electrical impulse device use. However in all reported cases the cause of death was attributed to other factors, primarily drug intoxication, and there has been no direct link to the use of the device."

Researcher: *Dr. Charles Butler, 2004. (D)*

Focus: Dr. Butler was commissioned by the Kalamazoo County (Michigan) Sheriff's Department to assess the scientific and medical data evaluating the safety and efficacy of the TASER®.

Conclusion: Dr. Butler came to four main conclusions:

Up to the present there is no proven connection between the use of the TASER® and the occurrence of in-custody deaths;

There is no evidence of long-term harm from electric current in survivors of the TASER®;

The electrophysiological literature indicates that the M26 TASER® does not exceed published electrical current limits;

Use of the TASER® reduces injuries compared to all alternative methods studied.

Researcher: *Orange County (Florida) Sheriff's Office, 2004. (E)*

Focus: A panel of four medical professionals reviewed the literature and provided opinions in a public forum. The forum was held July 28, 2004, in response to several highly publicized incidents of death associated to TASER® use by police. This was the single most accessible document we located that canvassed the issues in a fashion readily understandable to a layperson.

Conclusion: Four members of the medical panel offered their opinions and they are as follows:

- *Dr. Aurelio Duran*, a cardiac-electro-physiologist of the Orlando Heart Center, stated, "In the real world, the individuals that I read who have problems tend to be people who have problems minutes or hours after being TASER®ED. If a device was able to cause a bad heart rhythm - if I by mistake was fixing one of these outlets here and got electrocuted and it caused a bad rhythm - you would see me immediately collapse and I wouldn't get up and start walking around and talking to you. I would collapse and wouldn't come back to life unless a paramedic came and shocked me out of death."
- *Dr. Daniel Brennan*, an emergency room physician at the Orlando Regional Medical Center, stated, "It's very hard to shock people's hearts. We use defibrillators with big paddles and high energy because of that resistance of air. So the TASER®, in contrast even though it is high voltage, it has very low current, very low amperage, and a very short duration as well. It does use repetitive cycles, 5-30 cycles per second. That's how we're actually able to immobilize the person we're trying to immobilize with the TASER®, I suppose, because it's not just one quick jolt where your body would give just a jerk, but it's several cycles, over several seconds, to immobilize the person. The energy used is about 1.6J, where as the exo-defibrillator we use in the EMS and the emergency fire unit is a minimum of 50-360J. So again, it's a very minimal amount of energy."
- *Dr. Bob Vandervoort*, a pharmacologist, then discussed the role of cocaine and the relationship between consumption and psychosis. He stated "In a study of 55 patients admitted into a hospital for cocaine help, these are people who actually sought treatment 53 percent this is over half the people who were regular cocaine users, had features of psychosis. It's not like five, ten percent of people. We used to think, back in the 70's, that the number was eighteen percent. But that was when it was the entry nasal form that everybody was using. When I looked up the different forms of ingestion, entry nasal form only had four percent incidence of psychosis. In that same study, the crack users had 52 percent very similar to this number. Of those people who had psychosis, ninety percent had delusions, 96 percent hallucinated, and look at the last one;

48 percent of people, half the people who had psychotic effects, said they had it every time they used the drug."

- *Dr. Jan Garavaglia*, the Chief Medical Examiner for Orlando, provided a summary of information relating to in-custody death. He stated "When I first got here, I had a TASER® death right away. The first thing I asked was what he did after he got shot with the TASER®. And they said he did this and this and this. Well, I know that the TASER® didn't kill him. You're not going to have a delayed effect with the electricity. So the common factor in the deaths reported seems to be the excited state of the individual being shot by the TASER®. The timeline of Excited Delirium deaths - that's what we call the deaths of people very excited- was first reported out of Miami in 1985. It was reported by a doctor there, who had seven cases, all showing bizarre psychotic behaviour. They all had hyperthermia, meaning elevated body temperature, and we're talking up to 107-108. They were all very hyperactive and had experienced extreme exertion while fleeing or being pursued by the police. And then they had sudden deaths, sudden death usually after being restrained by the police. 1985 is probably a very important date, because that's the date when crack cocaine started being actively marketed in Miami.

    - Excited Delirium Syndrome is found to be different than acute cocaine intoxication deaths. We see cocaine intoxication deaths a lot, because the mechanisms are usually heart weakness, seizures, and that can happen with your first time use. You can die from cocaine with your first time use and I've had some well-documented cases of that. This is a totally different syndrome. With Excited Delirium deaths, usually the cocaine is present in low levels. Sometimes you find them with the metabolite present. They always have a history of chronic cocaine use. They tend to be crack users. They are also IV cocaine users; you hardly ever see it with the nasal. They have very bizarre, excited behaviour, they have hyperthermia, and they tend to have a much lower instance of seizures than in acute cocaine death.

    - It is my belief that TASER® use is now associated with Excited Delirium, because it's associated; that's how they're bringing them down, but there's really no evidence that they're causing any of the deaths. Actually, according to the National Association of Medical Examiners, the physician paper, this cocaine Excited Delirium is now a fatal disease, whether the police interact or not. These are people with elevated temperatures (107-108F) and its chronic cocaine use; you don't ever see it with a first episode use. Thus I believe these individuals would have died with or without being shot with a TASER®."

Researcher: *Defence Scientific Advisory Council (DSAC) of the United Kingdom, 2004. (F-1,F-2,F-3,F-4,F-5)*

Focus: DSAC created a sub-committee to advise the Secretary of State for the Home Department with medical advice on various less-lethal weapons systems including the TASER® M26.

Conclusion: The DSAC sub-committee found a cardiac safety threshold of "70 fold" for the M26. They state, "the results from the study, together with evidence gleaned from the literature, suggest that **some frequently abused drugs have the potential to contribute to any cardiac-related morbidity or mortality that may arise in the context of TASER® use. Furthermore, it seems reasonable to assume that this conclusion could be generalized to other emotionally charged and possibly violent confrontations with law enforcement personnel**. **The adverse cardiac effects produced by any individual drug are likely to be dependent on several risk factors, including dose consumed, co-use with other drugs (including pharmaceutical drugs and ethanol) and pre-existing heart disease. This complex interplay of multiple risk factors could conceivably contribute to any cardiac-related morbidity or mortality associated with TASER® use against drug-intoxicated persons**. Officers should be aware that the risk of any adverse response in the aftermath of TASER® deployment may be higher in drug-impaired individuals, and accordingly, they should be vigilant of any unusual behaviour displayed by the apprehended person that may signal the need for early medical intervention." The sub-committee's overall conclusion was that "the risk oflife- life-threatening or serious injuries from the TASER® M26 is very low."

Researcher: *HECOE, (partnership of the U.S. Air Force Research Laboratory and the Joint Non-Lethal Weapons Program), 2004. (G)*

Focus: To assess the effectiveness and risk characterization of the M26 and X26 TASER® based on existing data.

Conclusion: "Overall, the results indicate that the use of the TASER® M26 and X26, as intended, will generally be effective in inducing the desired temporarily incapacitating effect without presenting a significant risk of unintended severe effects. Although likely to be uncommon, some severe unintended effects might occur.

The occurrence of in-custody deaths has been reported in conjunction with use of TASER® devices. However, there are several arguments against any predominant role of EMI (Electromuscular Incapacitation) in arrest-related deaths. In previous epidemiological reports, deaths were often attributed to illicit drug intoxication in suspects. Although these reports address incidents involving EMI waveforms different from those of the M26 and X26, drug intoxication has been associated with in-custody deaths under a number of circumstances, regardless

of how the subjects were subdued. Contemporary medical opinion supports the view that the drug intoxication itself causes or predisposes one to underlying vulnerability. Based on the documentation and research reviewed, this report concludes that EMI is likely not the primary causative factor in reported fatalities."

On the issue of cardiac effects the study states "ventricular fibrillation was not expected to occur in otherwise healthy adult populations, although data are too limited to evaluate probabilities for potentially sensitive populations or for alternative patterns of exposure."

Researcher: *Dr. James Jauchem, Senior Research Physiologist, Human effectiveness Directorate, U.S. Air Force Research Laboratory, 2004. (H)*

Focus: To test the effectiveness of CED systems and extrapolate the potential risk to human subjects based on effects observed in pigs subjected to the effects of the X26 TASER®. Dr. Jauchem's work has been released in peer literature.

Conclusion: Dr. Jauchem exposed pigs to repeated cycles from an X26 TASER® using five seconds of application followed by five seconds of rest for a period of three minutes. This meant the animals were TASER®ed 18 times within that three-minute period. After a delay of one hour, a second three-minute exposure period, identical to the first, was added.

Dr. Jauchem made a number of observations relating to blood chemistry. With respect to pH, he noted that blood became more acidic after the three-minute application, returning toward normal levels one hour after exposure. Blood carbon dioxide levels also rose immediately following the TASER application, returning to normal over a sixty-minute period.

Dr. Jauchem reached a number of conclusions, the first being that the X26 TASER® was successful in producing the desired effect - incapacitation. Using an experimental device that allowed greater power levels than the X26, he found that varying the pulse amplitude and duration over several orders of magnitude resulted in increased muscle contraction. He also found that maximum contraction occurred with a minimum probe spacing of 20 cm (8 in). In relation to the blood chemistry changes, Dr. Jauchem concluded that "some medical monitoring of subjects may be required."

The issue is the extent to which Dr. Jauchem's work can be usefully extrapolated to law enforcement scenarios, which are highly unlikely to involve such a prolonged series of shocks. Nonetheless, we believe this work is very valuable and supports investigation of a number of preliminary hypotheses about the role of blood pH, respiratory impairment, and sudden in-custody death.

Researcher: *James Ruggieri, 2005. (I-1)*

Focus: Presentation titled "Lethality of TASER®s" delivered at the Annual Meeting of the American Academy of Forensic Sciences.

Conclusion: Mr. Ruggieri asserted in his presentation that a review of available documents had led him to conclude that there were critical technical errors made by TASER® International (TI) in their assessment of electrical risk. He went on to express the opinion that the devices were indeed capable of killing people and that the electrical charge from the M26 fell into the zone that the International Electrical Commission standards described as causing ventricular fibrillation 50% of the time. Mr. Ruggieri went on to hypothesize that delayed ventricular fibrillation (VF) may be the cause of some TASER®-related deaths, arguing that the myocardium is capable of acting as an electrical sink that subsequently depolarizes into VF at a time point delayed from the initial shock. This argument is in direct contrast with the wide medical opinion that VF as a result of electrical shock must be instantaneous/simultaneous with the application of that shock.

In his presentation Mr. Ruggieri made a number of references to J. Reilly and his book *Applied Bioelectricity*. Mr. Reilly was contacted to seek his comments on the Ruggieri presentation. Mr. Reilly (I-2) stated, "it appears that some inappropriate conclusions have been circulated relative to the information in Mr. Ruggieri's slides." Mr. Reilly, it should be noted, was a participant in the HECOE study, which had concluded that the risk of VF in a healthy population was very low.

Mr. Reilly concludes, "in view of these facts, neither the M26 nor X26 TASER® is expected to produce a VF hazard when applied to the thorax of healthy human adults. I am not aware of scientific investigations of TASER® safety in potentially sensitive people (e.g. the ill or under the influence of drugs)."

Relevant to Mr. Ruggieri's assertions with respect to delayed VF was an opinion obtained by Dr. J. Cairns, the Deputy Chief Coroner for Ontario. Dr. Cairns asked Dr. Joel Kirsh, Staff Cardiologist at the

Hospital for Sick Children in Toronto and an Assistant Professor of Pediatrics, University of Toronto, for his opinion on the cardiac safety of the TASER®. Dr. Kirsh (I-3) specifically addresses the concept of VF occurring sometime after exposure to electrical current:

"The time course of deaths reported as being possibly related to TASER® use is not typical of the usual clinical picture that experienced cardiac electrophysiologists have observed over several decades of proactive testing for ventricular arrhythmias. During such tests, the ventricle is incrementally paced with progressively shorter extrastimuli until such time as tissue refractoriness is reached, or an arrhythmia is induced. Such experimentally induced arrhythmias are observed as occurring immediately with extrastimuli and there is no known electrophysiologic mechanism to explain any delayed induction of ventricular arrhythmias, whether minutes or hours following the extrastimuli." Dr. Kirsh also concluded "the time course of deaths reported as being possibly related to TASER® use is not typical of the usual clinical picture that experienced cardiac electrophysiologists have observed over several decades of provocative testing for ventricular arrhythmias.

Researcher: *Saul D. Levine, Christian Sloane, Theodore Chan, Gary Vilke and James Dunford, University of California , San Diego (UCSD), 2005. (J)*

Focus: Abstract titled "Cardiac Monitoring of Subjects Exposed to the TASER®", published in the supplemental edition of Academic Emergency Medicine.

Conclusion: Twenty police officers volunteered to be TASER®ed while the team from UCSD "evaluated cardiac changes utilizing monitoring during deployment of the TASER®." The researchers concluded "in this pilot study we found no significant cardiac dysrythmias in healthy human subjects immediately after receiving a TASER® shock. In addition, there were no morphologic, rhythm, or interval changes other than a small decrease in PR interval and an increase in heart rate." The team's complete study was presented at the Society of Academic Emergency Medicine's Annual Meeting in New York City, May 2005.

**Vendor-Sponsored Research**

Researcher: *Dr. Richard Stratbucker, Medical Advisor to TI, 1996.(K)*

Focus: Test the safety of the Air TASER®, a predecessor to the M26.

Conclusion: In 1996 Dr. Stratbucker conducted experiments to test the safety of the Air TASER®, a predecessor to the M26. Part of the research

involved applying electrical currents several times more powerful than those generated by the Air TASER® to an anaesthetized pig while the animal's heart function was monitored. Stratbucker reported the following results: "Of the more than 48 discharges of five seconds duration, there was no case in which the animal revealed any cardiac ectopy or myocardial injury. The cardiac tissue proved resistant to stimulation despite progressively increased skeletal muscle effects noted as the storage capacitors and battery output were increased by several hundred percent."

A more recent study conducted by Dr. Stratbucker utilized both the Air TASER® and the Advanced TASER® in a study designed to determine whether the devices could induce ventricular fibrillation when they were applied to the chest areas of anaesthetized dogs. The protocol involved the administration of 236 shock discharges via probes placed on the thorax area. No episodes of ventricular fibrillation were noted during these tests. Dr. Stratbucker concluded from these tests that the risk of inducing ventricular fibrillation by normal use of the TASER® in healthy humans is "very small."

Researcher: *Dr. Anthony Bleetman, Consultant in Accident and Emergency Medicine, and Dr. Richard Steyn, Consultant in Thoracic Surgery, Birmingham (UK) Heartlands Hospital, 2003. (L)*

Focus: TI funded study focusing on the injury potential of the M26 TASER®.

Conclusion: Dr. Bleetman and Steyn concluded:

- The medical risks of electronic weaponry compare favourably with those of more conventional methods of controlling non-compliant and violent subjects. It has been impossible to accurately calculate how much electrical energy the Advanced TASER® delivers into the human body.
- There exists no convincing evidence directly implicating TASER® weaponry in deaths of subjects in over 25 years' experience in America.
- Risk factors for death in "TASER®ed" subjects appear to be no different from known risk factors for death in custody (drugs, exhaustion, bizarre behaviour leading to arrest etc.).
- The risk of harm might well be higher for using these devices on patients with pre-existing heart and neurological diseases. These risks are largely theoretical and have not been demonstrated in field application or laboratory testing to date.
- The risk to patients with implanted pacemakers and defibrillators are probably quite small.

- The potential for significant injury exists for TASER® barbs striking the eye, open mouth, neck, genital, and large blood vessels in the groin.
- The TASER® delivers electricity that incapacitates the subject and ends the physical, (and likely the psychological), resistance to arrest. It causes a degree of stunning. Much useful data has been gained from over 800 volunteers. More work is required to record the effects of the TASER® on physiological variables and ECG tracings.
- The TASER® is most unlikely to cause any permanent physical problems in healthy individuals.

Researcher: *Dr. Wayne McDaniel, University of Missouri-Columbia, 2005. (M)*

Focus: Dr. McDaniel published a peer-reviewed supplement entitled "*Cardiac Safety of Neuromuscular Incapacitating Defensive Devices*" in the January 2005 edition of Pacing and Clinical Electrophysiology (the official journal of the International Cardiac Pacing and Electrophysiology Society).

Conclusion: This study was focused on the issue of VF and the hypothesis of the researchers was that "the induction of VF would require significantly greater discharge levels than delivered by electrical NMI (neuromuscular incapacitation) devices fielded by law enforcement agencies."

This study utilized adult domestic pigs chosen to simulate human bodyweights of between 30 kg (66lb) and 120 kg (265lb). Researchers used a device that provided the same waveform and pulse duration as the X26 TASER®, but which could be adjusted to provide increasing levels of electrical charge, far beyond that which can be produced by the X26. Power levels were increased until VF could be reliably induced, and the results recorded.

This study "confirmed the cardiac safety of an experimental NMI device emulating the performance of commercially used devices. An NMI discharge that could induce VF required 15-42 times the charge of the standard NMI discharge. Furthermore, this study demonstrated a safety index strongly correlated with increasing weight. In addition, the observation of the hemodynamic stability of the animals suggests that these devices may be safely applied multiple times if needed. Discharge levels output by fielded NMI devices has an extremely low probability of inducing VF."

## Ongoing Research

Researcher: *Dr. William Bozeman, Wake Forest University. (N)*

Focus: Sponsored by the National Institute of Justice (NIJ), this study is a multi-centre trial that will record the number and severity of injuries produced by law enforcement officers using lower lethality devices such as TASER®s, rubber bullets and beanbag projectiles. The Wake Forest University Baptist Medical Center is receiving $140,000.00 from the NIJ for the study, led by Dr. William Bozeman.

The study is utilizing twelve different cities as study sites, where emergency room physicians will assess and report on injuries related to lower lethality weapons deployment. The researchers anticipate between 750 and 900 individuals will be examined in the course of the study, the first injury epidemiology study of its kind. This study should provide valuable insight into how tactical choices relating to the deployment of lower lethality weapons affect injury rates.

Researcher: Dr. J. G. Webster *University of Wisconsin.* (O)

Focus: Also sponsored by the NIJ, this study is the one most immediately relevant to CED. This study is utilizing live animals (swine) and is focusing on mapping the path of TASER® current in the body. Using models that will most closely simulate field applications, this study should provide definitive answers about how much, if any, electrical energy is able to reach the heart and the possible effects. This study will also examine issues such as fibrillation thresholds, the impact of a variety of stimulant drugs, including cocaine and methamphetamine, and changes in blood chemistry.

## Summary of Medical Concerns and CED

The previous listing of scientific research and professional opinion can possibly be overwhelming to the layperson, as the listing briefly summarizes relatively complex conclusions. In recognition of this, the following sub-section attempts to further summarize these conclusions into categories directly affecting a person's medical well-being:

- **Electrocardiophysiology**

During the course of this review of existing research into the physical safety of CED, it became apparent that most of the studies reviewed focused on the cardiac safety of CED. Based on these studies' findings, it is reasonable to conclude that the risk of danger to the heart, from VF or any other aspect of electrocardiophysiology, as a result of the use of a CED, is very low in healthy subjects. The research does call for a greater understanding of CED effects on vulnerable subjects, such as those that are intrinsically and/or extrinsically compromised (such as substance abuse and/or mentally ill), but that the use of CED should not be limited or suspended until this understanding is obtained.

There is little research that makes any conclusions about the safety of using a CED on a subject who has an implanted pacemaker/defibrillator (AICD). A recent case in BC involved such an incident. A person with an AICD with was subdued with a CED. During the CED application, the AICD recorded no interruption in heart rhythm and no extrasystoles in a subject known to have unstable dysrhythmias requiring an AICD. The current applied did interfere transiently with the AICD's ability to discharge itself appropriately, which normalized when the CED discharge was stopped.

- **Respiratory Impairment/pH Changes in Multiple Applications**

Depending on probe location in the upper torso, it appears likely that the muscular tetany produced by a TASER® deployment could impair a subject's respiration. TI acknowledges this in their most recent instructor-level teaching material. Whether such impairment would occur in a push stun deployment to a limb is a matter of speculation. If breathing is stopped or impaired during the five-second cycle, this could affect both $CO_2$ and pH levels. If the TASER® is cycled continuously for 15-20 seconds, the effects could be expected to increase.

The issue of respiratory impairment due to restraint appears to play a role in some of the deaths proximal to the use of CED, although no hypothesis has yet been verified. Respiratory impairment becomes particularly crucial when the weapon is used or restraint is applied during, or at the end of, a prolonged physical struggle. The ability to breathe freely is critical as the body tries to return to homeostasis and compensate for the metabolic acidosis incurred during periods of prolonged anaerobic activity, such as that incurred during a prolonged struggle. During such struggle, rapid breathing allows the body to eliminate $CO_2$, allowing pH to remain constant; suppression of effective respiration may inhibit the body's ability to compensate.

Based on Dr. Jauchem's research (H), it would appear that prolonged TASER® applications (three minutes of five seconds on - five seconds off cycling) can produce significant lowering of pH levels in pigs. This may be the interaction of respiratory interruption along with high levels of muscular contraction.

Evidence for low pH as a factor in the deaths of these subjects was presented in a paper by Hick et al (19) in Academic Emergency Medicine, in which Dr. Hick describes a case series of consecutive patients with sudden cardiac death while in a state of ED. Promptly done arterial blood gases demonstrated severe acidemia in each case. If the starting pH was extremely low in an individual, then repetitive hypoventilation secondary to repeated TASER® strikes could be contributory. Unfortunately, no prospective data regarding the presence of acidemia in acutely agitated subjects exists making it difficult to anticipate the effect of further lowering pH.

There will be situations, particularly in areas where back-up officers may be distant or unavailable, where multiple applications are necessary to control violent subjects. Training protocols, however, should reflect that multiple applications, particularly continuous cycling of the TASER® for periods exceeding 15-20 seconds, may increase the risk to the subject and should be avoided where practical. Conventional use-of-force theory dictates that officers abandon any particular tactic after it has been employed several times without achieving the desired result (i.e. control of the subject). If multiple TASER® applications have not succeeded in gaining control, the officer should reassess and consider another force option or disengagement.

Conversely, recognizing that prolonged struggle heightens the risk to both the officer and the subject, it may be appropriate to use a TASER® as soon as it becomes clear that the subject's active resistant or assaultive behaviour will justify physical control, and that negotiation is unlikely to succeed. A single TASER® application made before the subject has been exhausted, followed by a restraint technique that does not impair respiration may provide the optimum outcome.

- **Pregnancy**

There is currently no peer-reviewed research on the effects of CED current to a pregnant woman and her fetus. The only report located specific to pregnancy was a 1992 medical report regarding a woman, 12 weeks pregnant, who began to miscarry seven days after being exposed to an early model TASER®.

TI's medical staff has theorized that the womb and amniotic fluid provide a "Faraday shield" effect that would prevent electrical current from reaching the

fetus, and they have conducted one unpublished animal study that found the X26 TASER® did not induce miscarriage in two pregnant pigs. There have been several out-of-court settlements involving pregnant women, but these have not produced any independent research outcomes.

Pregnancy is another situational risk factor that has to be evaluated in the entire context of a use-of-force event. A TASER® is clearly preferable to a firearm, if the situation warrants deadly force, but more difficult decisions have to be made where physical force is necessary to resolve a situation that does not require a firearm. The risk from secondary injuries, such as falling, obviously takes on more significance when dealing with a pregnant subject.

- **Body Weight and Size**

Scientific literature has long recognized that body mass directly impacts on the effects of electrical current on an individual. The PACE Study (M) is the most recent confirmation that those with a lower body weight, such as children, have lowered margins of safety when exposed to an electrical current. It found that a 30 kg (66 lb) pig had a safety ratio of 15:1 (with respect to ventricular fibrillation) when exposed to X26 TASER® current. A pig with a body mass of 117 kg (258 lb) had a safety ratio of 42:1 before fibrillation could be induced.

However, public concern about the use of TASER®s against children and the elderly does not rest solely on the issue of electrical safety. Because, as we have discussed, blanket prohibitions against TASER® use on specific groups can be counterproductive, the test in every case remains one of reasonableness.

- **Seizures**

The HECOE (G) study suggests that both the M26 and X26 TASER® have electrical outputs that exceed the seizure threshold. However the probability that this would occur is very low, given that at least one, if not both of the probes would have to hit a subject's head. Furthermore, even if this situation were to occur, HECOE estimates that the probability that a seizure were to be induced is 0.7%.

Standard police training in CED does not recommend probes be fired at a subject's head, but it is possible that a subject may physically move before the probes strike their intended target, and strike the head instead. However, there are two incidents during CED training in the US where subjects suffered seizures after being struck in the head by probes.

- **Long-Term Superficial Damage to Skin**

Depending upon the time, duration, and skin type of the individual, second-degree burns are likely from a CED application. Research indicates that long-term superficial damage to skin (i.e. permanent scars, short-term burn marks) is possible, and this is more prevalent in dark-skinned individuals. Also, it appears that skin damage is greater when the push stun mode is used compared to the entry burn marks seen when the probes are deployed. This last point is particularly true of light-skinned individuals in the first 24 hours after being subject to a push stun.

It appears that none of this skin damage would have a significant health risk to the subject. However the psychological and emotional impact on the subject must be respected.

## CED Probe Removal

When used in "probe mode", meaning that when a CED fires its probes into a person or their clothing, it becomes necessary for the probes to be removed. Manufacturer training guidelines recommend that the removal of the probes from a person's skin is generally not difficult and can be readily performed by police officers.

To minimize the risk of injury occurring as a result of probe entry into the body, officers are trained not to aim at the head, neck, or genitalia. Some agencies provide training in the removal of the probes from a person's skin while others require medical personnel to perform the removal. Police officers are also trained to seek medical attention when the removal of the probes is difficult, in a sensitive location, or further injury occurs after the probes have been removed (i.e. excess bleeding). In short, injuries to subjects as a result of probe removal have not been a significant issue.

## Deaths Proximal to CED Use

This section of the report summarizes the research that is currently available and on-going that touches on the physical safety of a subject who is undergoing the experience of a CED. However, a significant factor in the decision behind the CACP's request for the CPRC to review existing CED research was the deaths in Canada that are proximal to the use of CED. To date, (August 10, 2005)

there have been 151 deaths associated with CED use in North America, 13 in Canada. Consequently, it only stands to reason that any discussion on the physical effects of CED must eventually consider what, if any, connection there is between the use of the CED and the death of the subject.

The investigative team that authored the BCOPCC reports recognized this need. As such they formed a medical review panel that consisted of the following individuals:

- Dr. J. Butt (Forensic Pathologist)
- Dr. D. Docherty (Exercise Physiologist)
- Dr. R. Leather (Cardiologist)
- Dr. S. Lohrasbe (Forensic Psychiatrist)
- Dr. A. MacPherson (Vice Chief of Emergency Medicine)
- Dr. V. Sweeney (Neurologist)
- Mr. C. Lawrence (Trainer with the Ontario Police College)
- Mr. P. Leslie (District Superintendent for the BC Ambulance Service)
- Mr. S. Palmer (Executive Director of the Canadian Police Research Centre)
- Mr. M. Rutledge (Advanced Life Support Paramedic)

There was consensus on the issue that sudden and unexpected death proximal to the use of CED and eventual restraint is caused by a variety of factors, not a single precipitating issue. Risk factors identified included significant amounts of acidosis, which affect cardiac contractility, respiratory muscle impairment, rhabdomyolysis (the destruction of skeletal muscle tissue from traumatic injury, substance abuse, some prescription medication, and/or excessive exertion) that is accompanied by the release of muscle cell contents into the bloodstream) hypoglycaemia, and high levels of adrenaline.

With respect to ED, it was observed that this is not a single entity, but rather a "symptom cluster" that also occurs in hospital settings. It was also noted that cocaine and methamphetamine abuse overlap with mental disorders and produce paranoia and control over-ride, where the subject feels a loss of control over their thoughts and actions. Because these drugs can over stimulate already delirious patients, increased fatality rates are seen in hospitals without the presence of CED or other lower lethality weapons.

Both doctors and ambulance personnel identified that the period immediately following successful restraint of an individual in the field is the appropriate

interval in which to involve prehospital care practitioners. Acutely agitated persons are to be recognized as suffering from a medical emergency; therefore, EMS involvement is warranted as early as possible in the restraint process. Intramuscular chemical restraint in the field is felt to be potentially beneficial in limiting further struggle and thereby potentially decreasing injuries to subjects, police officers and EMS personnel. However, it should be cautioned that chemical restraint is not a guarantee of life preservation as there have been multiple anecdotal cases of subjects dying immediately following chemical restraint with benzodiazepines, major tranquilizers or combination therapy. Utilization and choice of chemical restraint agents is left to the discretion of the appropriate EMS medical director. It was noted that paramedics in Calgary, AB and Toronto, ON employ chemical restraint on a regular basis and that a prospective study on this is being proposed. The committee has currently no evidence on which to suggest changes in ALS treatment protocols or the implementation of attempts at prehospital biochemical analysis such as blood gas measurement.

It was clear from the discussion that the development of new medical protocols for dealing with ED hinges on research that will confirm a number of the existing hypotheses. It was agreed that a national or international standard of evaluation and information gathering would be the preferred method for obtaining this data. Based on this, the investigative team moved forward to propose the inclusion of blood gas monitoring in the University of Wisconsin research project to provide further comprehensive data on acidosis, $CO_2$, and other factors. As discussed, members of the investigative team will continue to support the CPRC-sponsored epidemiological study of ED across Canada.

**Section 1 - Summary**

Based on the existing research, the CPRC team can conclude the following main points:

- Definitive research or evidence does not exist that implicates a causal relationship between the use of CEDs and death.
- Existing studies indicate that the risk of cardiac harm to subjects from a CED is very low.
- ED, although not a universally recognized medical condition, is gaining increasing acceptance as a main contributor to deaths proximal to CED use.
- The issue related to multiple CED applications and its impact on respiration, pH levels, and other associated physical effects, offers a plausible theory on the possible connection between deaths, CED use, and people exhibiting the symptoms of ED.

The contributors to this CPRC report believe that CEDs are effective law enforcement tools with a low risk of harm to the subject. Other developments have come to light that should have an effect on police CED training and operational use that will further mitigate an already minimal risk. These will be discussed in Section 2.Section3.

# Section 2 – Policy Considerations for Police CED Operations

During the course of reviewing the existing research on CEDs, information has been collected that can substantially improve the knowledge that law enforcement agencies possess about the use of CEDs. This information can address themes related to operational use, training, & policy, and accountability.

Prior to a discussion of these four categories, it may be useful to consider the impact that CEDs have had on law enforcement across North America. For example:

### Cincinnati Police Department

Cincinnati PD reported in July 2004, that in the first six months of that year, that there have been "over 300 deployments of the TASER®. Arrest related injuries to officers have dropped 70%. Suspect injuries have dropped 40% and the use of force by other traditional means has dropped 50%. The number of citizen complaints arising from the use of force by officers has seen a similar reduction."

### Orange County (Florida) Sheriff's Office (OCSO)

OCSO and the Florida Gulf Coast University collaborated to identify the effectiveness of various lower lethality options employed by police and examining the potential for force escalation. The OCSO Study found that lower lethality munitions such as the bean-bag round produced injuries in 80% of the instances where they were deployed; the majority being bruises or abrasions from the projectile. They reported eight deaths in 373 deployments. Conventional impact weapons like batons also produced blunt trauma injuries, and had a very high potential for escalation of subject resistance if they were not immediately effective. Chemical agents had a very low associated injury rate, and the OCSO Study found them to have a lower failure rate (12%) than other studies. Conventional defensive tactics-officers using hand-to-hand techniques to subdue subjects were ineffective 29% of the time and resulted in the largest number of subject and officer injuries.

OCSO found the TASER® to be effective in 77-95% of the cases studied, with the effectiveness varying greatly between divisions. Specialized units had much lower failure rates (11 %) than patrol (22%). The study's authors speculated this may have been the result of specialized units deploying the TASER® much earlier in an event where there was an expectation of resistance, and

thus providing less opportunity for the subject to move out of the 21-foot range.

Most significantly, the study found that the TASER® had the highest level of de-escalation (subjects were less likely to fight harder against arrest) and provided a substantial deterrent effect even when not used. In a 3-year period OCSO reported a decrease in worker's compensation claims of 50% from "arrest injuries". OCSO documented one death associated to the TASER in 870 deployments studied. They have received only 50 excessive force complaints in "approximately 1,000 uses of the TASER®."

The OCSO Study identified 18 instances in a one-year period where subjects were subdued with a TASER® in circumstances when deadly force was warranted. Using the figure of $100,000.00 as the cost for deadly force litigation (not including any damages that may be awarded), OCSO estimated that this had saved $1.8 million in legal costs.

The OCSO Study may be most valuable for highlighting that many of the lower lethality options available to police have high potential for causing blunt force trauma and do not necessarily terminate the physical confrontation. This may be why these tools are used so infrequently in a Canadian context.

**Madison (Wisconsin) Police Department (MPD)**

The MPD concluded a pilot program that saw TASER®s introduced into their inventory in the summer of 2003. They found that in 92 TASER® deployments the device was successful in producing incapacitation 77% of the time. This is in line with similar studies across North America. This study also documented six cases where the TASER® was used to subdue suspects whose actions would have justified the use of deadly force.

The Madison report documents two significant secondary injuries as a result of suspects falling with one individual requiring seven stitches to close a laceration. It also noted a reduction in officer injuries during physical confrontations, although with the caveat that this reduction could not be entirely attributed to the TASER® alone.

The key findings in the report were summarized as follows:

- MPD deployment of the TASER® has reduced injuries to officers and suspects resulting
- from use-of-force encounters;
- MPD deployment of the TASER® has reduced MPD officers' utilization of deadly force;

- The TASER® has proven to be a safe and effective use-of-force tool;
- MPD officers are deploying the TASER® in an appropriate manner.

**Toronto Police Service (TPS) X26 TASER® Pilot Study**

The TPS undertook a pilot study of the X26 TASER® from April 1 to September 30, 2004. Officers of the TPS' Emergency Task Force (ETF) were trained and issued with the X26 and data was recorded for each incident that required TASER® presence. Prior to this pilot study, TPS ETF units were equipped with the M26 TASER®.

The results of the pilot test were:

- The X26 was activated in 92 incidents by the TPS during the six-month period of the study. The weapon was used in 32 of these 92 incidents; thus in 65% of all incidents the presence of the X26 contributed to a successful resolution of the incident without the weapon being used. As an example, officers only had to display the TASER® to gain compliance from a man who had previously injured an officer and required cell extraction.
- The X26 was effective in 28 incidents (or 88% completely effective of incidents where the X26 was used), semi-effective in two incidents (6%) and ineffective in two incidents (6%).
- Thirteen of these incidents (or 40% of all incidents where the X26 was used) involved an intoxicated or mentally/emotionally disturbed person (3 of whom were suicidal), while eleven incidents (34%) involved a subject armed with a weapon (7 knives, 2 hammers, 1 axe, and 1 ice pick).
- In 47% of the incidents, officers required only one cartridge shot or "drive-stun" to resolve the incident. In only one incident did the subject suffer any injury (an abrasion) that was not self-inflicted.

Due significantly to the successful field-testing of the X26 by the TPS, Ontario's Ministry of Community Safety and Correctional Services approved the X26 TASER® for use by Ontario police services in January 2005.

The results from these four police agencies typify the positive aspects of CED usage that are frequently reported across North America, namely:

- Less injuries to police officers while completed arrests
- Less injuries to persons who are resisting arrest

- Less use of lethal force
- Less use of other force options

It has become evident that the emergence of CEDs as a use of force option for police services has been a substantial benefit. Proper training and use of CED has demonstrated to reduce the risk of harm to both police officers and suspects. However, a more thorough understanding of what is meant by "proper training and use" requires a brief description on police use of force in Canada.

**The Canadian National Use of Force Framework**

In 2000, the CACP endorsed the National Use of Force Framework (NUFF). It was the intent of the CACP that the NUFF bring together the best theory, research and practice about officer use of force. The NUFF would also be dynamic, support officer training, and facilitate professional and public understanding of officer use of force. The NUFF was drafted in a manner that would apply to any common law country such as Canada, USA, UK, and Australia. The NUFF is also consistent with two standards produced through the United Nations Office of the High Commissioner for Human Rights. The standards are the *Code of Conduct for Law Enforcement Officials* and *the Basic Principles on the Use of Force and Firearms by Law Enforcement Officials*.

With the provision of policing being a provincial responsibility, since the 1980's many provinces and the Royal Canadian Mounted Police (RCMP) have developed their own use of force models which pre-date and certainly helped develop the NUFF.

<u>Six basic principles</u> underlie the NUFF:

1) The primary responsibility of a peace officer is to preserve and protect life.
2) The primary objective of any use of force is to ensure public safety.
3) Police officer safety is essential to public safety.
4) The NUFF does not replace or augment the law; the law speaks for itself.
5) The NUFF was constructed in consideration of (federal) statute law and current case law.
6) The NUFF is not intended to dictate policy.

It is not necessary here to expand on all of the details of the NUFF, but it suffices to conclude that the framework takes into account the situation, subject behaviours, and an officer's perception/tactical considerations which eventually guide the

officer's decision-making about if, when, and how much force may be required to use on a subject in any given incident.

**NUFF and CED**

Understanding the NUFF is important in the context of this review of CEDs for two reasons: 1) it helps shed some light on the original policing need for the development of CEDs and, 2) it explains the increasing use of CEDs beyond this original need.

Originally, the development of CEDs occurred in an effort to provide "less-lethal" use of force options to police when faced with incidents that may otherwise require a lethal use of force option. Such incidents are frequent and can best be understood by the following recent incident in Toronto:

> *Police were called to a scene where a man, apparently distraught over a domestic dispute with his spouse, was found in the middle of his residential street brandishing a large kitchen knife. The man was shirtless despite the fact that the time of year was in the all.*
>
> *At least three TPS patrol units were dispatched to the scene, where officers attempted to calm the man down and instructed him to put down his knife. The man ignored these instructions and began walking slowly towards the officers.*
>
> *The officers had parked their vehicles in a semi-circle pattern and were able to keep at least one vehicle between themselves and the man. All of the officers had their firearms drawn while continuing to dialogue with the man. For approximately ten minutes the officers kept pacing away from the man while always keeping a vehicle between themselves and the distraught man.*
>
> *The responding officers were able to contain the incident and patiently wait for the TPS' Emergency Task Force (ETF) to arrive who were equipped with a M26 TASER®. ETF eventually arrived, deployed the TASER®, and the man was arrested without further harm to himself, the officers or any bystanders.*

The above incident demonstrates precisely what the development of CEDs were intended for. This was a situation where, instead of walking slowly, had the distraught man , ran towards, jumped, or lunged at the officers, it would have been reasonable to expect that the officers would have resorted to a lethal use of force option for fear of grievous bodily harm or death from the man.

It is similar situations, where officers may be faced with lethal force options that prompted the need for CEDs. It is also how the devices have been marketed and accepted by the public, the media, civilian oversight bodies, government, and "watchdog" groups – as replacements for lethal force.

However what is under-appreciated is the benefit to individual police officers that are placed in these situations. The use of lethal force can have profound adversely stressful effects on the officer's emotional and psychological health, including that of the officer's family, no matter how justified the use of lethal force may have been. Richard Parent quantified these effects in his Master's Thesis titled "*Aspects of Police Use of Deadly Force In British Columbia: The Phenomenon Of Victim-Precipitated Homicide*." (Q) In his study Mr. Parent notes that "three of the twenty police officers (15%), who were directly involved in a fatal shooting incident, have since left policing to pursue other interests." In summary, although trained and prepared to use lethal force where lawfully justified, it is accurate to state that the overwhelming majority of officers hope to never resort to lethal force.

There is no question that the use of CEDs can and has saved many lives. However, it is a common misconception of the CED's benefits that assumes they should only be used when an incident would require lethal force, and/or before lethal force is actually used in such situations. The most successful interventions using a CED in lethal force incidents frequently reveal circumstances where officers are able to contain the scene, and that back-up lethal force is present if the CED should fail in resolving the incident. It is not reasonable for anyone to expect officers, a great many of which patrol remote regions all over Canada, to automatically use a CED in the face of a lethal or grievous bodily harm threat, when the safeguards of containment and back-up are not present or when the situation escalates rapidly.

This discussion is important, because many of the individuals who have died proximal to the use of a CED were not armed with weapons that could deliver grievous bodily harm or death to an officer (beyond the person's own physical strength). Consequently some observers have questioned why a CED would be used in these incidents.

Because it is reasonable to assume that the use of a CED will likely not cause death to a person (unlike a firearm), CEDs are considered intermediate weapons in the North American, law enforcement, use of force vernacular. Other intermediate weapons commonly include oleoresin capsicum (OC) spray, batons, and other weapons also described as less lethal (such as bean bag projectiles or rubber bullets). The concept of intermediate weapons is best explained as the use of

force tool options available to officers when their presence, communication skills, instructions/commands, or direct physical attempts at control without using a weapon, are not adhered to, are unsuccessful during an incident, or inappropriate for the type of threat. The label of "intermediate" implies that these tools are distinct between non-weapon application of force and lethal force on the use of force spectrum.

As previously mentioned a person's behaviour at an incident is one of the key components assessed by officers as part of their use of force decision-making. The NUFF categorizes and explains these behaviours:

- Co-operative - the subject responds appropriately to the officer's presence, direction and control.
- Resistant (Passive) - the subject refused, with little or no physical action, to cooperate with the officer's lawful direction. This can assume the form of a verbal refusal or consciously contrived physical inactivity.
- Resistant (Active) – the subject uses non-assaultive physical action to resist, or while resisting an officer's lawful direction. Examples would include pulling away to prevent or escape control, or overt movements such as walking toward, or away from an officer. Running away is another example of active resistance.
- Assaultive – the subject attempts to apply, or applies force to any person; attempts or threatens by an act or gesture, to apply force to another person, if he/she has, or causes that other person to believe upon reasonable grounds that he/she has, present ability to effect his/her purpose. Examples include kicking and punching, but may also include aggressive body language that signals the intent to assault.
- Grievous Bodily Harm or Death – the subject exhibits actions that the officer reasonably believes are intended to, or likely to cause grievous bodily harm or death to any person. Examples include assaults with a knife, stick, or firearm, or actions that would result in serious injury to an officer or member of the public.

In practice, police in Canada can utilize some form of intermediate weapon when dealing with subjects that demonstrates Active Resistant, Assaultive, or Grievous Bodily Harm or Death behaviours. Ultimately each individual incident where an officer uses force is accountable to the existing laws and administrative "checks and balances" that ensures public trust and confidence in police use of force. With this system in place, it is reasonable to conclude that police equipped with CEDs may use it instead of another intermediate weapon in a non-grievous bodily harm or death incident.

Consequently, the increased deployment of CEDs in incidents requiring such force is an indicator of this reality. Police officers now have the option of using a CED

instead of OC spray or a baton strike. There are some "schools of thought" which imply that the use of a CED is more pervasive to the subject and should be used minimally, while others think that the CED is a more humane force option that reduces the risk of injury to the subject and the officer. Indeed there are reports that quantify and lend credence to the latter. Neither of these opinions is inherently more correct over the other; the final judgment can only be made on a case-by-case basis that examines the totality of events in a particular incident.

Thus, it is correct that many of the deaths proximal to CED use involved subjects who were not behaving in a manner that would be consistent with grievous bodily harm or death. However, it is highly probable that they were actively resistant, if not assaultive, requiring police intervention and use of force. The police were required to make a decision on if, when, and how much force to use and what, if any, weapons can assist in their intervention. Often the use of the CED might be the most effective option and it is likely that the use of any other force option would not have changed the unfortunate outcomes witnessed.

The BCOPCC Final report states "the variety and complexity of the circumstances that may confront an officer make it impossible for any policy to encompass every possible scenario." The contributors of this CPRC report agree and ***believe that it would be unwise and counter-counter-productive for any police service or government body to develop policies and procedures that explicitly specifies in what kinds of circumstances a CED may or may not be used.*** For example, many law enforcement agencies in the United States have developed procedures that prohibit the use of a CED on handcuffed individuals, pregnant women, the elderly, or youth/children. It is very difficult for police officers to envision an incident where they may have to lawfully use a CED on one of these groups of people – in fact the idea may be abhorrent to them.

However, cases exist where CEDs were used in similar circumstances and the use of the CED was the best alternative. For example in Ontario, a large, aggressive handcuffed individual refused to be placed in the back of a police vehicle while a large unruly crowd was gathering. Contrary to a common misconception, handcuffing a person does not prevent them from escape or make them incapable of offering significant resistance to an officer's control efforts. In this incident, although already restrained by police the handcuffed person was still being actively resistant. One arresting officer chose to push stun him in the back of the leg, which then allowed the officers to place him in the vehicle as the arrested person's knees buckled. Had those officers been prohibited to use a CED on a restrained person, they likely would have resorted to a possibly more harmful force option (e.g. baton strikes).

Similarly, it would not take much to envision a pregnant woman, a youth/child, or an elderly person being armed with a weapon that could bring an incident into the

realm of lethal use of force. The Victoria Police Department (VPD) in British Columbia (BC) used a TASER® to subdue a man in his 80s who was armed with a weapon that could have easily brought grievous bodily harm or death to the officers or other bystanders at the scene. What would a prohibition on using a CED on an elderly person have contributed in this case? It would likely have resulted in the lawful use of lethal force by those officers.

There will be some incidents where, through improved training and common sense, an officer will not use a CED. An example would be a situation where a person may fall from a height after being subjected to the CED, or if it is known to the officer that the subject has doused themselves with a flammable substance (e.g. gasoline). It is important that officers are aware of these rare, unintended, but serious consequences.

**CED Accountability**

The BCOPCC Final Report recommends that the Government of British Columbia fill the position of Provincial Use of Force Coordinator as is specified in their use of force regulations. Comparatively, Ontario has developed a regulation on police use of force that does not require a similar position; however depending on the level of force used and the circumstances of the specific incident police officers in Ontario must complete a mandatory, provincial use-of-force report form. The local police service maintains these completed forms for training purposes and presents results to their police services board on at least an annual basis.

Police services and their governing bodies and agencies should give thoughtful consideration to developing CED usage reporting procedures, forms, or databases. Given the increasing use of CEDs, it would be a prudent, transparent step to assure Canadians that police services and governments are responsible and capable of managing the growth in the use of CEDs and improving our knowledge. Such reporting can form the basis of a database that eventually could be applied nationally, in order to better understand the use of CEDs.

Current models of TASER®s provide police with the capability to test the charge-level of the battery of the weapon before it is taken out on patrol. This provides the officer with the comfort that the weapon is adequately charged and will likely be effective. It would be ideal for officers to be able to calibrate their CEDs, to ensure that the amount of conducted energy sent to a subject meets the manufacturer's specifications. Please note that no evidence exists to suggest that this is a problem at all, however, much like mobile radar installed in police vehicles, it would be an ideal precautionary step.

Similarly, some are of the minds that, in order to further ensure accountability, after use each CED be delivered to a firm capable of electrical testing to determine if the specifications were met. In BC only one firm has that capability at a cost of $4,000 per test. The ability to test a CED post-use would also be ideal, however one could argue that these costs are prohibitive. Consideration should be given to such a test if a subject suffers serious injury or death proximal to CED use.

Information has been received that there may be data corruption issues in certain versions of the software that captures TASER® use in the X26 model. Any version lower than software version 15 for the X26, can cause dataport problems. Most agencies should have TI upgrade their software to version 15. As for the M26, TI has been using version 585 software since the M26's inception. They do not do upgrades to the software or the programming of the M26. The only upgrades would be to the lifespan of the unit itself, such as improving the epoxy used inside the unit. That being said, there are some issues with the dataport in the M26 as they have a tendency to time "creep", what is meant by that is the dataport time can move forward or back by a couple minutes in a month. This “time-creep”; could really add up if the TASER® is not downloaded on a regular basis and the time corrected. The worse case scenario is a dataport that is out by hours. Police services or approving government agencies should consider contacting TI or their distributors to ensure that these software issues are resolved.

Lastly, in an unscientific experiment conducted by use of force trainers at the Edmonton Police Service (EPS), one trainer volunteered to be push stunned in the side of her torso by her colleagues, to determine the effects of the push stun on her skin. Upon being push stunned, her natural reaction was to get away from the burning sensation of the device, while the deploying officer continued to push stun her for a few seconds. The volunteer officer took photographs of her torso to demonstrate the immediate skin markings resulting from push stuns. Within a week most of the marks had disappeared, but the initial amount of skin-redness and pigmentation was significant – to the point where one could reasonably assume that she had been push stunned repeatedly. The point is that she had endured only a couple of push stuns and it was her natural inclination to move away from the current and cause an arc that caused the amount of immediate skin changes visible. Although not scientific this is a powerful anecdote that could assist in resolving police complaints. In fact the BCOPCC Final Report states that the vast majority of complaints related to the use of CEDs is in relation to push stuns.

**Police Exposure to CED during Training**

One of the first areas that must be discussed is the need for police officers to experience the effects of a CED while undergoing training and the possibility of injury. In training officers to use a CED, it has been common for instructors to

expose all the trainees to a short period of exposure. Typically officers are shocked for a period of one to two seconds, rather than the full five-second cycle. TI's original training material made experiencing the abbreviated shock mandatory for users, but this was subsequently changed from a mandatory requirement to one that was "strongly recommended". This mirrored previous experiences with OC sprays, where direct exposure to the spray was a requirement for user certification. That requirement was subsequently removed in BC, at least in part because of concerns raised by the Workers Compensation Board of British Columbia.

Most CED trainers were aware of the potential for secondary injuries, particularly to the head, during this exposure and positioned officers around the trainee, supporting their weight, and preventing them from falling. What is now emerging, however, suggests there may be a potential for musculoskeletal injuries caused by the powerful muscular contraction when a CED is applied.

In December 2004, the Arizona Republic reported the case of a Maricopa County sheriff's deputy who was suing TI claiming that he had sustained a compression fracture of his spine during such a training exposure. A doctor who examined the deputy found he had pre-existing osteoporosis; a condition that leaves people at increased risk of bone fractures. Other officers have come forward reporting training injuries that include shoulder dislocations and chipped teeth; the majority caused by falls after being shocked. Phoenix Police Department, one of the first major American agencies to equip all of its line officers with TASER®s, now prohibits training exposures.

In consultation with the lead CED instructor for the Edmonton Police Service (EPS), she advised that they have experienced three hamstring injuries as a result of CED applications during training. These injuries were believed to have been caused by muscular contraction when the probes were placed on the quadriceps and upper chest of trainees. The contraction of the quadriceps caused a pull in the hamstring. The VPD has not experienced any significant injuries during TASER® training, although there are occasional anecdotal reports of transient muscle soreness following exposure and one report of vertigo lasting for approximately three hours after a five second X26 TASER® probe exposure.

Recently during a CED exposure in a training session, a Saskatoon Police Department officer suffered a lower back injury that may limit his police duties for the remainder of his career. The officer did not have any medical issues that concerned him prior to the exposure to the CED.

To place these events in some context, it is relevant to note that physical training in arrest and control techniques, either at the Justice Institute of British Columbia (JIBC) for recruits, or in-house for serving members, has routinely resulted in

broken bones, bruises and ligament tears. Hard, realistic training inevitably results in some level of injury to the participants; however, this type of training ensures that officers are both physically and mentally prepared to deal with real-world challenges.

Given the information currently available, it is foreseeable that musculoskeletal injuries may occur during CED training and thus agencies need to revisit the issue of mandatory exposure. This also suggests that subjects exposed to a CED in a field usage may also be at risk from similar injuries, particularly if they have some underlying pre-disposing condition that makes them especially vulnerable.

The most common secondary injuries related to a probe deployment from a CED are the minor lacerations and electrical burns at the site where the probes have penetrated the skin. Seen immediately after deployment, the probe sites are typically surrounded by small circular areas of reddened skin. Little attention has been paid to the issue of permanent scarring as a result of CED use. The BCOPCC Final Report notes of a civil suit launched in Alaska where an individual who was TASER®ed was successful in collecting damages for permanent scarring. We have also observed cases where law enforcement trainers who have been subjected to probe deployments have sustained permanent scarring, albeit minor in nature. The degree of scarring will be dependent upon both skin type and probe penetration and is impossible to predict prior to the event.

The risks of musculoskeletal injuries and scarring must be weighed against the benefits of CED exposure by agencies and individual trainees. In order to make an informed decision, officers should be provided with accurate information as to possible unintended consequences.

**Implications for Police CED Operational Use**

As previously acknowledged, the CPRC has collaborated with the authors of the BCOPCC reports to produce this document, which may be considered as a “best practice” document that combines the efforts of all involved (again the majority of which is courtesy of the BCOPCC team). Additional information, feedback, reference material, and formatting have been provided by all of the contributors of the CPRC working group.

With that in mind the following summarizes what else we have learned in relation to the most proper use of CEDs:

- Personnel must complete agency approved CED training carried out by a certified instructor and meet minimum standards on all CED tests. CED trainers may wish to alter their current curriculum on CEDs to reflect this new information and consider incorporating issues of ED and restraint.
- CEDs should be carried by officers in agency-approved holsters on the non-dominate/support side of the body. There have been a few incidents where officers mistook their firearm for their CEDs and shot a subject that they intended to use a CED on. By placing the CED on the side of the duty belt opposite the side of their firearm (e.g. support side), these tragic errors will hopefully be minimized.
- Officers should ensure the CED is in proper working order and record the serial number of the CED prior to start of shift.
- Officers need to be aware that multiple, consecutive cycles of a CED on a subject may have adverse effects on respiration as well as other physiological effects. There may be times where such consecutive cycles are appropriate, but officers should allow some time for the subject to comply with the officer's instructions before another lawfully justifiable cycle is deployed. Officers need to be aware that it is possible that the subject cannot hear the officer during the CED exposure, or after the exposure the subject may be momentarily "dazed" and will appear to be ignoring the instructions. During the initial cycling of a CED on a subject, officers are encouraged to consider their options once the cycling has concluded whether the subject is compliant or not.
- Officers should consider telling the subject that they have been subjected to a CED after the first cycle. Often subjects think they have been shot with a firearm and knowing that it was a CED may help calm them and encourage them to comply.
- Officers should avoid using a CED on a person's head, neck, and genitals, unless such intended usage occurs in an incident where lethal force is justifiable.
- Officers should avoid, where practical, deploying a CED on a subject who is at risk of falling from a significant height and suffering injuries as a result of the fall.
- Officers should avoid, where practical, deploying a CED on a subject who they know, or suspect, has flammable or ignitable substances on their clothing or on their skin. It is important to stress that this probably will not be readily apparent to the officer. The obvious example is if the subject was standing in a pool of gasoline, but there has been a case where an officer was fatally injured when he deployed a CED in an area of a natural gas leak, causing an explosion. This is particularly noteworthy in relation to some OC sprays. In 2004, the Dallas Police Department replaced 1,800 canisters of OC spray that had an alcohol base, after a subject's long hair became flammable as a result being sprayed and then a CED being deployed. It would be prudent for authorizing bodies to ensure that approved OC spray does not have a flammable base. Furthermore, concerns have been raised by a First Nations Police Service in Ontario, which unfortunately responds to violent subjects who have become intoxicated on

inhalants on a regular basis. These inhalants are often gasoline or lacquer, which my or may not be on their clothing.

- Related to this issue is the statement from the United Kingdom Police Scientific Development Branch (PSDB), which concludes “it is clear from these tests that there is a risk of ignition if the TASER® is fired at a target with a flammable solvent on their clothing. On at least two occasions when TASER®s have been used operationally in other countries, the TASER® has ignited subjects who were soaked in a flammable liquid. There will also be a risk of ignition when there are flammable vapours present in the environment. It should be noted that the solvent for PAVA is 50% ethanol, 50% water which means that it is also flammable, although less so than MIBK. The flames produced from this ethanol/water mix will be blue and quite small, compared to the larger orange flames produced from, for instance, petrol or MIBK. This could mean that the former are more difficult to see which may cause a delay in extinguishing them. It is strongly recommended that the TASER® is not used against a subject who has already been sprayed with either CS or PAVA, both of which are currently contained within a flammable solvent, if it is possible to avoid doing so. Extreme caution must also be exercised when using it on a subject who is suspected of being covered in any other flammable solvent, such as strong alcohol (e.g. undiluted spirits) or petroleum spirit, or in a dangerous environment, such as a petrol station.”

**Section 2 - Summary**

Based on the existing research, the CPRC team can conclude the following main points:

- The use of CEDs is related to a decrease in the use of lethal force in some jurisdictions and it is also related to substantial decreases in police officer and subject arrest-related injuries.
- While originally marketed and accepted as an alternative to lethal force, the use of CEDs have grown to include incidents where intermediate (but not lethal) weapons should be used.
- Although each use of force incident needs to be judged separately, for the most part the increased use of CEDs in non-lethal incidents is appropriate.
- Police services and their governing bodies and agencies should give thoughtful consideration to developing CED usage reporting procedures, forms, or databases.
- It would be unwise and counter-productive for any police service or government body to develop policies and procedures that explicitly specify in what kinds of circumstances a CED may or may not be used.

- Notwithstanding the above point, police officers need to be aware of the adverse effects of multiple, consecutive cycles of a CED on a subject; deploying a CED on a subject's head, neck, or genitalia; deploying a CED where a person can fall from a height; and deploying a CED on a subject where it is known to the officer that the subject has flammable substances on their clothing or on their person, or are standing in or near obvious flammable/explosive substances conditions such as a puddle of gasoline or a natural gas leak.

**Section 2 -Future Directions**

It has become apparent to the CPRC team that there is no known, scientifically tested, independently verified, and, globally accepted CED safety parameters. This is problematic for a couple of reasons.

- Police services and authorizing agencies are completely reliant on manufacturer claims regarding the safety of their products. By comparison there are many policing tools and equipment that have an accepted range of safety parameters such as body armour, OC spray concentrations, and police vehicle specifications. In terms of CEDs what is known is limited to testing of the TASER® M26 and X26. If a new CED were to be introduced, police services and authorizing agencies could only rely on manufacturer claims.
- Because of this lack of known safety parameters relating to CED, authorizing agencies are ill-equipped to respond quickly to advances in technology that may be immediately beneficial to police and, eventually, community safety. At least in the context of a few Canadian examples, some authorizing jurisdictions have little independent information to form decisions and policy – with the end result being an unnecessarily bureaucratic process, devoid of leadership, that serves few stakeholders. This is a tangible "gap" in the complete understanding of CEDs that needs to be filled.

This concludes the section on Policy Considerations for Police CED Operations and Training. However, given the attention surrounding the deaths proximal to CED use, Section 3 follows with a more thorough explanation of ED and its relationship to CED and the individuals who have died. The CPRC team believes strongly that this next section sheds noteworthy light on the possible significant factors in these deaths.

# Section 3 - Excited Delirium

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## The Scenario

The details are startlingly similar between cases. Police are dispatched to intervene when a male subject (rarely is a female the subject in excited delirium), often inappropriately dressed for the environment, is acting in a violent and irrational manner in a public or residential space. The subject displays seemingly purposeless, constant activity and violence. Attempts to intervene by bystanders have been unsuccessful, the violent rampage continues and there is concern for personal safety or the protection of property. On arrival of the police service, the subject is apparently incoherent, is often continuously screaming unintelligible words or sounds, does not recognize that police are present and appears to be suffering from either some sort of psychosis, or a severe drug induced "high". The disruptive situation continues or escalates as the officers attempt to take the subject into custody. Upon physical contact, the subject immediately begins to fight aggressively with police resulting in a protracted physical encounter that requires multiple officer participation and varying methods of restraint. During the struggle, the subject is apparently impervious to pain and appears to have near superhuman strength, out of proportion with his physical characteristics. Often officers note that the skin of the subject is extremely hot to the touch and the subject may (or may not) be sweating profusely. At the conclusion of the protracted struggle, the subject is finally taken under some semblance of control and handcuffed; everyone, including the subject, is exhausted. What is the diagnosis?

In fact, there is no unifying diagnosis; rather, a set of signs and symptoms forming a condition that may be associated with sudden death proximal to restraint. That cluster of signs and symptoms collectively forms a condition known to some as excited delirium, also known as agitated delirium or delirium agité.(1-4) When the subject has a fatal outcome following presentation in excited delirium, previous literature has called that specific clinical course "in custody death syndrome".(5;6)

## Delirium

Delirious states are familiar to medical practitioners and are known to be associated with a wide variety of medical conditions that result in the common endpoint of an altered level of consciousness with loss of both cognition and perception (7). In medicine, delirium is recognized not as a specific diagnosis of its own but rather a clinical state for which the list of potential differential diagnoses is broad. Determining the specific etiology often requires extensive medical investigation; the cause is often not readily apparent at first contact with the individual.

Some delirious states, such as those associated with fevers and hospital use of sedatives and analgesics, are characterized by the loss of cognition and perception but have little or no increase in motor activity. Physiologic excitement in these cases is sometimes seen by virtue of an elevated temperature, heart rate and/or breathing rate. Persons suffering these kinds of delirium are often visualized by lay persons as lying semi conscious, moaning in a hospital bed of tangled sheets. However, other kinds of delirious states can be generated by illicit drug use, acute psychosis or mania, or a combination of psychiatric illness and illicit drug use.(8;9) These delirious states are also defined by a loss of cognition and perception but they are most identifiable by profound increases in motor activity leading to the subject being described as extremely agitated or in a state of extreme excitation. Physiologic excitement in terms of elevated temperature, heart rate, blood pressure and/or breathing rate may also be detected once physical examination is possible.

There are many potential causes for the combination of extreme physical exertion and a delirious state that leads medical practitioners to describe a subject's presentation on the whole as consistent with "Excited Delirium". This large number of potential causes generates some variation in the symptom cluster, which makes it difficult to establish a consistent definition. However, Morrison and Sadler have recently defined excited delirium as "a state of extreme mental and physiological excitement, characterized by extreme agitation, hyperthermia, epiphoria, hostility, exceptional strength and endurance without apparent fatigue". (10) Other practitioners prefer a more general description of "an altered level of consciousness combined with extreme physical exertion", which allows for some variation in the symptom cluster but does not address the physiologic derangement which is occurring simultaneously.(11-20)

The concept of excited delirium is not new. In 1849, Bell first described a "peculiar form" of delirium that was fatal in at least three quarters of those suffering it.(21) However, much of the current interest in excited delirium began in 1995 when San Francisco medical examiner Steven Karch outlined his concerns with the need to clarify whether excited delirium as well as positional asphyxia were both processes at work in the sudden death of individuals restrained by police. (3;14;22-27)

Cocaine induced excited delirium (also often called cocaine excited delirium) is a type of excited delirium which has received academic scrutiny and first came to the attention of physicians in the early 1980's as the cocaine epidemic gained momentum in the United Sates. (4;25;28-33) Death of the agitated individual suffering cocaine excited delirium has often occurred while the subject is in police custody after being restrained to protect public interests. (8;9;34-36) Whether death from excited delirium can be extrapolated to include methamphetamine induced excited delirium is unknown, although the extreme stimulant response in a subject is similar following methamphetamine abuse. (4;37;38) The exact pathogenesis of

excited delirium and cocaine excited delirium is unknown at this time.(4;13;39) While no specifically toxic level of cocaine exists, it has been documented that cocaine levels in those thought to have succumbed to excited delirium are similar to levels measured in recreational users and lower than those who actually died from known cocaine intoxication. (8)

Whether excited delirium occurs as a result of illicit drugs, psychiatric illness or other metabolic derangements, the cause is initially irrelevant since it can neither be investigated nor treated until the subject is contained. No therapeutic relationship can be entered with an individual who is incoherent, violent and resistive.

Not only is it desirable to commence therapy and the protection of public good in order, it may be harmful to allow the delirious state to continue. While it is tempting to suggest that persons suffering from excited delirium simply be allowed to "wind down", there are good reasons not to allow the subject to continue to run rampant. Usually, police engagement is requested to prevent property damage, dangerous or threatening behaviours and commonly, overt harm to the subjects themselves. Containing an individual in a large space until such time as exhaustion sets in does not necessarily mitigate risk to the individual. There is some medical evidence that suggests that progression to a state of exhaustion is, in itself, dangerous.(27) Prior to the development of effective treatment for the acute phase of mania or psychosis, death as a consequence of exhaustion in psychiatric patients was reported. In 1952, Bellak et al described that "sustained motor and mental excitement with continued activity for a period of time" was a risk factor for sudden death due to excited delirium.

Delirious states, particularly those associated with extreme physical exertion need to be recognized as true medical emergencies with plans to institute treatment as soon as possible after containment. (10;16;19;20;40;41) Excited delirium can progress rapidly to cardiopulmonary arrest and death in individuals who are struggling violently and are then subdued either in the prehospital or hospital setting. Thus, recognition of the symptom cluster – not ascertainment of a cause may- may be the most important initial intervention, with mobilization of medical resources as early as possible in the restraint process.(19;20;40;42)

**Identification of a state of excited delirium**

It is difficult for police officers to anticipate a condition for which the incidence and characteristic features have not been published in summary. The condition of excited delirium is not a clinical entity of its own, but a constellation of symptoms from a varied and severe underlying process.

While there is currently no prospective scientific evaluation outlining historical features of excited delirium and retrospective reviews are fraught with selection and reporting bias, a review of a large number of published series, case studies and anecdotal reports suggests the following guidelines to identify a potentially high risk situation. (3;4;8;14;19;26;28;31;32;35;36;39;43-45) Police officers can look for three types of information: pre-encounter descriptions from witnesses, features visible at a distance and those experienced on direct physical contact with the individual.

Occasionally, information is available prior to the police encounter that suggests that excited delirium may be present, particularly if the call is in response to a violent outburst/activity. That information may include *any, all or none* of the following:

- known history of schizophrenia, psychosis or mania
- previous similar presentation(s) in an acute agitated state
- known or suspected history of illicit substance abuse
- known or suspected history of ethanol abuse
- police dispatched for violent disturbance, destruction of property, disruption of traffic

Once the officer is on the scene, *any or all* of the following may be observed:

- bizarre, purposeless and violent behavior
- attraction to glass and other inanimate objects
- hyperactivity
- incoherent shouting/screaming/animal like noises
- failure to recognize police presence
- extreme aggression
- paranoia

On direct physical contact, the officer may note *any or all* of the following:

- unbelievable strength that may be out of keeping with physical characteristics of the subject
- subject apparently impervious to pain including injuries sustained during violent outburst. No response to pain mediated methods of restraint i.e.) “limb holds”
- able to offer effective resistance against multiple officers
- very hot skin
- sweating profusely or skin extremely dry for level of exertion

Unlike other medical conditions, there is no published set of major and minor criteria for establishing a diagnosis of excited delirium, and currently no ability to predict what number of symptoms and signs alone, or in combination, is predictive of a poor outcome. There is no published series that has prospectively documented the incidence of excited delirium in persons undergoing the arrest process or in those resisting arrest in any way. However, the above signs represent a list of factors often associated with an acutely delirious state which should prompt police officers to treat the situation as a medical emergency.

**Death in custody**

In anecdotal cases of death associated with features of excited delirium reported from the prehospital setting, persons of police interest who have required restraint have progressed from extreme violence and agitation to death in a matter of minutes, with or without presence of emergency medical personnel. (8;23;35;36;46-49) The true pathogenesis for sudden death of subjects undergoing restraint in a state of excited delirium state remains unknown. While one study attempted to determine risk factors for death due to excited delirium, cases reported were not chosen in a way that allows generalization of the findings.(8) The incidence of death in persons exhibiting characteristics of excited delirium prior to or during the arrest process is not known, nor is the relative risk of death in persons exhibiting excited delirium features as compared to those simply resisting arrest.

While Ross et al did hypothesize that the state of excited delirium had more to do with the sudden death than the nature of the restraint process, further papers to that effect have not been forthcoming and the controversy continues.(50) Part of the problem is that it is difficult to study the effects of custody and restraint in the actual persons suffering the condition, especially because excited delirium has historically not been recognized until death ensued. All previous investigators have attempted to simulate the rigors of the resisting arrest and restraint process in normal healthy individuals in order to determine the biochemical processes leading to death.(51-55) However, most true reported cases of sudden and unexpected death proximal to restraint seem to involve young men in an “excited” state or one of “agitated delirium” as a result of psychiatric illness or intoxication from illegal drugs; a state far removed from the normal healthy volunteer being strenuously active. These individuals are combative, violent, and often struggle past the point of exhaustion, sometimes sustaining traumatic injuries during the confrontation with law enforcement before being subdued.(28) However, no author has prospectively documented how often any set of situational features or subject characteristics suggestive of excited delirium exist in the prehospital arrest scenario, or whether their presence is associated with sudden death. Lack of such information has prevented adequate planning of investigational or interventional strategies.

Attempts to define risk factors for death have been undertaken in a retrospective manner, again subject to the selection bias in defining that excited delirium existed. In 1998, the Ontario Coroner's Office published a retrospective study of 21 cases of unexpected death in people with Excited Delirium that occurred between 1988 and 1995 within the province of Ontario.(8) Of the cases reported, 18 deaths occurred while the subject was in police custody. In all 21 cases, Dr Pollanen found that "many deaths related to Excited Delirium are associated with restraint in the prone position" and that all of the subjects who died had lapsed into "tranquility" shortly after being restrained. Nearly 50% of subjects had undergone multiple forms of restraint and engaged in struggle with 1-5 people.

Other studies demonstrate the wide variation in the circumstances of subjects dying in an excited delirium state proximal to police restraint. For example, in Stratton's study of 18 deaths in 216 arrests associated with excited delirium, 198 subjects who were subject to the position of maximal restraint did not die suddenly and survived the arrest and restraint process, 18 succumbed. (35) Multiple force options have been implicated. There are many causes for the state of excited delirium although stimulant drugs are common and the deaths occur suddenly and unexpectedly.(9;35;36;56) In all studies to date cardiopulmonary arrests were unanticipated and preceded by a short period (an estimate of 5 minutes or less) during which the victim ceased in struggling against restraints and developed a labored or shallow breathing pattern.

## Theories on the etiology of death in excited delirium in the setting of police restraint

### Asphyxia

Currently no study has demonstrated a clear causal link between any risk factor or physiologic derangement and sudden death proximal to police restraint. Pathologists have proposed many possibilities as they struggled to determine a cause of death for persons suddenly expiring while in police custody. In the 1980s, positional asphyxia or inadvertent death by suffocation was the theory with medical examiners and practitioners suggesting that chest compression invoked by prone position, maximal restraint position or multiple officers' weight on the subject caused inadvertent asphyxiation and death due to oxygen deprivation. (14;31;32;32;45;47-49;51;57;58) Inconsistencies in the data led to much controversy and investigation of other potential mechanisms/risk factors for the deaths.(18;50;52;53;59-61)

It is possible that rather than oxygen deprivation, proning precludes effective ventilation and respiration. In this scenario, a subject who has just undergone minutes to hours of extreme physical exertion and is breathing at a very rapid rate, becomes restrained in a prone position, inhibiting his ability to breathe fast enough to compensate for the recent metabolic excitation. (18-20;42) While the subject is

certainly breathing, the rate of breathing may be insufficient, leading the subject to have *relative* hypoventilation. This theory makes intuitive sense but has not been explored in these subjects.

Until the process of proning subjects can be more fully examined and clearly found not to be directly associated with death, it is recommended that long term proning be avoided and subjects be placed lying on their side or sitting at the earliest possible opportunity. It is understood that in order to apply handcuffs, subjects may have to be in a prone position at least once (and often more than once) during the process of gaining control.

**Cardiac dysrhythmia**

Illicit drugs, especially stimulant agents such as cocaine and methamphetamine, may make subjects more likely to have unusual heart rhythms. (37;62) Long term use of cocaine markedly increases circulating norepinephrine (the precursor to adrenaline) as the receptors that usually take up excess norepinephrine fail because of chronic exposure to the drug. This excess of adrenaline and its precursors potentially puts cocaine abusers at risk of life threatening arrhythmia.(37) During violent activity and struggle, adrenaline release is increased as part of the normal nervous system response to a perceived threat or a struggle. Release of more adrenaline into a system that cannot uptake the excess safely may sensitize the heart and promote rhythm disturbances. The combination of adrenaline and cocaine can then enhance the toxicity of cocaine which can lead to seizures, respiratory arrest, and cardiac arrest. (37)

Some members of the population are genetically susceptible to arrhythmia through certain medical conditions.(63-65) These are rare conditions which cannot be anticipated by police officers since even the affected individuals may be unaware of their own condition. Other congenital and acquired cardiac conditions such as Wolfe-Parkinson-White syndrome and left ventricular enlargement may predispose subjects to arrhythmia but police officers cannot anticipate this information either.

**Dopaminergic dysfunction**

Chronic cocaine use prevents clearance of cerebral dopamine resulting in delirium and potential increases in body temperature (hyperthermia).(11-13;66) Hyperthermia may also result when a subject is engaged in extensive muscular activity in a warm and/or humid environment (summer months or even hot rooms with poor ventilation). Increased ambient temperature and high levels of muscle activity may combine with a person's inability to regulate body temperature to result in extreme and potentially fatal elevations of core body temperature.(14;15;26)

## Rhabdomyolysis

Rhabdomyolysis is an overwhelming breakdown of muscle tissue that can be caused by severe over exertion of the muscle (such as struggling with police or continued struggle against restraint once in custody) or other physiologic derangement. It can also be caused by many drugs of abuse. (4;14;39) Long term cocaine use and untreated persons with schizophrenia have elevations in serum creatine kinase suggestive of muscle breakdown. This finding lends support to the theory that chronic alterations in how dopamine works in the body can also affect skeletal muscle physiology. Whether rhabdomyolysis has any role in sudden cardiac death proximal to restraint remains unclear.

## Metabolic acidosis

Hick et al studied five consecutive cases of sudden cardiac arrest proximal to police restraint in individuals with features of excited delirium, all of whom were found to have initial pH measurements far below 7.00. (19) At this pH level, enzyme mechanisms and physiologic function become deranged. The authors postulated that cocaine and other stimulants exacerbate the effects of exercise induced lactic acidosis through sympathetic induced vasoconstriction. Delirium alters cognition and perception, thereby altering pain sensation and allowing for physical exertion far beyond normal physiological limits. In other words, the subject does not respond to the burning of muscles that limits more aware individuals' activity. The unaware subject continues to exert himself which can lead in turn to a severe acidosis for which the body must immediately compensate. Hick et al found that when severe metabolic acidosis, stimulant drug use (notably cocaine) and exertion are all combined, the subsequent profound changes in pH can contribute to cardiovascular collapse. (19;42;67) Changes in pH may be made worse through continued increase in metabolic activity or through failed compensation such as hypoventilation. Since their publication, Hick et al have changed their practice such that they have adapted their treatment of agitated patients to include measuring blood pH and administration of aggressive fluids and sodium bicarbonate. After this practice change, five subsequent patients had their acidosis resolved and all five survived.(19;42)

Similarly, in 2001, Allam and Noble submitted a letter to the editor of "Anaethesia" describing an anecdotal case of a subject with cocaine induced excited delirium and extreme acidosis who survived following treatment with hyperventilation, sodium bicarbonate and dantrolene sodium .(68)

However, relative hypoventilation with its resultant elevation in blood carbon dioxide levels and metabolic acidosis remain theories for deaths proximal to police restraint in subjects suffering from excited delirium that need to be validated in prospective studies of the subjects in question rather than healthy volunteers or small case series.

## Conducted energy weapons

The use of conducted energy devices like the Taser ® is currently being examined as a possible cause of death through a variety of proposed but unproven mechanisms. A previous section of this entire report deals specifically with the level of medical research to date into conducted energy weapons and sudden death proximal to police restraint. Prospective investigation in the population of interest is still lacking and all causative theories are, at present, speculative.

## Interventions to potentially lessen the risk of death

Because there is no effective medical treatment that can be administered from a distance, physicians and prehospital care personnel have suggested that the period immediately *after successful physical restraint* of an individual in the field is the best time to involve prehospital care practitioners in an attempt to mitigate subject risk. (69-72) Police officers should be trained to recognize that acutely agitated persons are suffering from a medical emergency, and that EMS involvement is warranted as early as possible in the restraint process. Notification of EMS for dispatch prior to actual physical engagement with the subject may be the most rational policy.

While sedative injections by EMS in the field may be beneficial in limiting further struggle and thereby potentially decreasing injuries to subjects, police officers and EMS personnel, it must be cautioned that such chemical restraint is not a guarantee of preservation of life.(69;72) There have been multiple anecdotal cases of subjects dying immediately following chemical restraint with benzodiazepines, major tranquilizers or combination therapy. There is currently no evidence to support or reject using any specific drug or combination of drugs to sedate persons suspected of suffering excited delirium and undergoing police restraint in the field. Therefore, utilization and choice of chemical restraint agents is left to the discretion of the appropriate EMS medical director. Similarly, there is no evidence on which to suggest changes in advanced life support treatment protocols or attempts at prehospital biochemical analysis such as blood gas measurement.

## Section 3 - Future directions

- Recent discussions surrounding the need for further scientific data in the subjects of interest during the situation of interest have prompted the development of a national protocol for the epidemiologic study of subjects resisting arrest with specific interest in features of excited delirium and the incidence of sudden in custody death.

- There is also great interest in gaining more information about what happens physiologically in subjects suffering excited delirium. Scientists are planning to investigate acid base balance and the influence of pH changes with and without various methods of restraint.

- The many factors surrounding the deaths are evident from observations that subjects dying in police custody are not always restrained prone, nor are all the characteristics replicated in all cases. (8;73) There is a need to gather data around all features of subjects resisting arrest and dying in police custody to fully understand sudden and unexpected death proximal to police restraint as well as excited delirium as a condition and its role in these deaths.

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## Glossary of Terms

| | |
|---|---|
| **BCOPCC** | British Columbia Office of the Police Complaints Commissioner |
| **CED:** | Conducted Energy Device |
| **CPRC:** | Canadian Police Research Centre |
| **DSAC:** | Defence Scientific Advisory Council |
| **DSTL:** | Defence Sciences Technology Laboratory |
| **ED:** | Excited Delirium |
| **EMI:** | Electro-Muscular Incapacitation |
| **EMS:** | Emergency Medical Service |
| **ETF:** | Emergency Task Force |
| **HECOE:** | Human Effects Centre of Excellence |
| **ISTAT:** | A medical tool which measures blood gas levels |
| **NMI:** | Neuro-Muscular Incapacitation |
| **NIJ:** | National Institute of Justice: the research and evaluation branch of the U.S. Department of Justice |
| **NUFF:** | National Use of Force Framework |
| **OC** | Oleoresin Capsicum spray (commonly referred to as Pepper Spray) |
| **OSCO:** | Orange County Sheriff's Office |
| **PACE:** | Pacing and Clinical Electrophysiology |
| **TASER:** | Trademark of Taser International Inc, **(**Thomas A. Swift Electric Rifle), |
| **TI** | Taser International Inc |
| **VF:** | Ventricular Fibrillation |
| **VPD:** | Victoria Police Department |

## Appendices

A. Conducted Energy Device Steering Committee
B. Conducted Energy Device Working Group
C. British Columbia Office of the Police Complaints Commissioner Final report
    - http://www.opcc.bc.ca

D. British Columbia Office of the Police Complaints Commissioner Interim report
    - http://www.opcc.bc.ca

## A -Conductive Energy Device Steering Committee

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**C- British Columbia Office of the Police Complaints Commissioner Final report**

- Available on line at http://www.opcc.bc.ca or http://www.cprc.org/docs/bcopcc_final.pdf

**D-British Columbia Office of the Police Complaints Commissioner Interim report**

- Available on line at http://www.opcc.bc.ca or http://www.cprc.org/docs/bcopcc_interm.pdf