Clinical Practice Statement:
What Evaluations Are Needed in Emergency Department Patients after a TASER Device Activation? (7/12/10)

2. Literature Search

A literature search of the National Library of Medicine's MEDLINE database's PubMed system was performed and limited to studies published from January 1988 to January 20, 2010 written in the English language. Keywords used in search: TASER, conductive energy device(s), electronic weapon(s), conductive energy weapon(s), non-lethal weapon(s), conducted energy device(s), conducted energy weapon(s), conductive electronic device(s), electronic control device(s) The findings of this search are noted in the column "# ALL references" in table 1. Combining these references resulted in 140 unique articles on CEWs. From the original 140 articles, the reference sections were reviewed, and no further novel articles were identified.

Studies included for final review were limited to randomized controlled trials, clinical trials, prospective and retrospective cohort studies and meta-analyses. Case reports, case series, and general review articles were not included for the selection criteria for formal rigorous review. The references yielded by the various search parameters are included in the column labeled "final review" in table 1.

The list of the titles of the 140 articles was assessed independently by two physicians, and refined using the selection criteria to a combined total of 20 articles deemed appropriate for review based on their suspected relevance to the clinical question. These 20 articles include: randomized controlled trials (2), prospective controlled trials (2), prospective cohort studies (13), and retrospective cohort studies (3).

Table 1: All English language papers found with the following search parameters:

Search Parameter	**# ALL references**	**# final review**
conductive electronic devices	145	0
TASER	137	15
conductive energy devices	113	4
conductive electronic device	112	0
conductive energy device	87	4
electronic weapon	70	8
electronic weapons	54	8
conducted energy weapons	32	6
non-lethal weapons	30	0

non-lethal weapon	22	0
electronic control devices	12	0
electronic control device	11	0
conducted energy weapon	4	1
conductive energy weapon	3	3
conductive energy weapons	3	3
conducted energy device	0	0
conducted energy devices	0	0

3. Final Evidence Database – Grade of Evidence Review

For each of the 20 articles subjected to detailed review, the evidence was assigned a grade using reference focus, design and methodology.

Grade A	Randomized clinical trials or meta-analyses (multiple clinical trials) or randomized clinical trials (smaller trials),directly addressing the review issue
Grade B	Randomized clinical trials or meta-analyses (multiple clinical trials) or randomized clinical trials (smaller trials), indirectly addressing the review issue
Grade C	Prospective, controlled, non-randomized, cohort studies
Grade D	Retrospective, non-randomized, cohort or case-control studies

4. Final Evidence Database – Quality Ranking

Each of the 20 articles subjected to detailed review was critically assessed with regards to design and methodology. This includes Design Consideration (focus, model structure, presence of controls, etc.) and Methodology Consideration (actual methodology utilized)

Ranking	Design Consideration Present	Methodology Consideration Present	Both Considerations Present
Outstanding	Appropriate	Appropriate	Yes, both present
Good	Appropriate	Appropriate	No, either present
Adequate	Adequate with Possible Bias	Adequate	No, either present
Poor	Limited or Biased	Limited	No, either present
Unsatisfactory	Questionable / None	Questionable / None	No, either present

List #	Article Information	Grade	Quality	Design, size
1	Bozeman WP: Immediate cardiovascular effects of the Taser X26 conducted electrical weapon. Emerg Med J. 2009	**C**	**Good**	Prospective Cohort (n = 28)
2	Bozeman WP: Safety and injury profile of conducted electrical weapons used by law enforcement officers against criminal suspects. Ann Emerg Med. 2009	**D**	**Good**	Retrospective Cohort (Field use) (n = 1201)
3	Dawes DM: Echocardiographic evaluation of TASER X26 probe deployment into the chests of human volunteers. Am J Emerg Med. 2010.	**C**	**Good**	Prospective Cohort (n = 10)
4	Dawes DM: Electrical Characteristics of an Electronic Control Device Under a Physiologic Load: A Brief Report. Pacing Clin Electrophysiol. 2009	**C**	**Good**	Prospective Cohort (n = 9)
5	Dawes DM: 15-Second conducted electrical weapon exposure does not cause core temperature elevation in non-environmentally stressed resting adults. Forensic Sci Int. 2008	**C**	**Good**	Prospective Controlled Trial (n = 32)
6	Dawes D, Ho J, Miner J. The neuroendocrine effects of the TASER X26: a brief report. Forensic Sci Int. 2009	**B**	**Good**	Prospective Randomized Controlled Trial (n = 52)
7	Eastman AL, et al Conductive electrical devices: a prospective, population-based study of the medical safety of law enforcement use. J Trauma. 2008 Jun;64(6):1567-72.	**D**	**Adequate**	Retrospective Cohort (Field use) (n = 426)
8	Ho JD: Prolonged TASER use on exhausted humans does not worsen markers of acidosis. Am J Emerg Med. 2009	**C**	**Good**	Prospective Cohort (n = 38)
9	Ho JD: Lactate and pH evaluation in exhausted humans with prolonged TASER X26 exposure or continued exertion. Forensic Sci Int. 2009	**B**	**Good**	Prospective Randomized Controlled Trial (n = 40)
10	Ho JD: Absence of electrocardiographic change after prolonged application of a conducted electrical weapon in physically exhausted adults. J Emerg Med. 2009	**C**	**Good**	Prospective Cohort (n = 25)
11	Ho JD: Echocardiographic evaluation of a TASER-X26 application in the ideal human cardiac axis. Acad Emerg Med. 2008	**C**	**Good**	Prospective Cohort (n = 34)
12	Ho JD, Dawes DM, Bultman LL, et al Respiratory Effect of Prolonged Electrical Weapon Application on Human Volunteers. Acad Emerg Med.2007; 14:197–201	**C**	**Outstanding**	Prospective Cohort (n = 52)
13	Ho JD: Cardiovascular and physiologic effects of conducted electrical weapon discharge in resting adults. Acad Emerg Med. 2006	**C**	**Outstanding**	Prospective Cohort (n = 66)
14	Levine SD: Cardiac monitoring of human subjects exposed to the taser. J Emerg Med. 2007	**C**	**Good**	Prospective Cohort (n = 105)

15	Sloane CM: Serum troponin I measurement of subjects exposed to the Taser X-26. J Emerg Med. 2008	**C**	**Good**	Prospective Cohort (n = 66)
16	Strote J, et al [Conducted Electrical Weapon Use by Law Enforcement: An Evaluation of Safety and Injury.]() J Trauma. 2009 Dec 22. [Epub ahead of print]	**D**	**Adequate**	Retrospective Cohort (Field use) (n = 1101)
17	VanMeenen KM, Cherniack, NS, Bergen, MT, et al. Cardiovascular Evaluation of Electronic Control Device Exposure in Law Enforcement Trainees: A Multisite Study. JOEM 2010 [Epub ahead of print]	**C**	**Good**	Prospective Cohort (n = 118)
18	Vilke GM: Physiologic effects of the TASER after exercise. Acad Emerg Med. 2009	**C**	**Outstanding**	Prospective Controlled Trial (n = 25)
19	Vilke GM: Twelve-lead electrocardiogram monitoring of subjects before and after voluntary exposure to the Taser X26. Am J Emerg Med. 2008	**C**	**Good**	Prospective Cohort (n = 32)
20	Vilke GM: Physiological effects of a conducted electrical weapon on human subjects. Ann Emerg Med. 2007	**C**	**Outstanding**	Prospective Cohort (n = 32)

5. Assign the Reference Support of the Question

Independent review of the articles as well as discussion and joint review by the authors was undertaken to answer our clinical question. The references were sorted into 3 categories: supportive, neutral, and opposed. There were no neutral or opposed references. A table was constructed to assign the supportive references to the appropriate location using both the Grade of Evidence and the Quality of Evidence.

Supportive Evidence (Article # referenced)

Quality / Grade	**A**	**B**	**C**	**D**	**E**	**F**
Outstanding			12, 13, 18, 20			
Good		6, 9	1, 3, 4, 5, 8, 10,11, 14, 15, 17, 19	2		
Adequate				7, 16		
Poor						

Unsatisfactory						

6. Recommendations

Level of Recommendation	Criteria for Level of Recommendation	Mandatory Evidence
Class A recommended with outstanding evidence	• Acceptable • Safe • Useful • Established / definitive	• Level A / B grade • Outstanding quality • Robust • All positive
Class B acceptable & appropriate with good evidence	• Acceptable • Safe • Useful • Not yet definitive	• Level A / B grade lacking • Adequate to Good quality • Most evidence positive • No evidence of harm
Class B 1	• Standard approach	• Higher grades of evidence • Consistently positive
Class B 2	• Optional or alternative approach	• Lower grades of evidence • Generally, but not consistently, positive
Class C not acceptable or not appropriate	• Unacceptable • Unsafe • Not useful	• No positive evidence • Evidence of harm
Class Indeterminate Unknown	• Minimal to no evidence	• Minimal to no evidence

Background and goals: CEWs are commonly used by police as an intermediate force option. Civilian models of CEWs are also available. Patients may be brought for medical evaluation after CEW exposure. The primary goal in conducting this literature search was to identify whether routine monitoring, EKG, with or without laboratory tests are necessary for a patient who presents after receiving an electrical discharge from a CEW.

Our evaluation considered both techniques in which a CEW can be used. They are the drive or touch stun mode, and the probe mode. In the drive stun mode, the tip of the device is placed into contact with the subject and locally conducts energy across the two probes that are present on the tip of the device. This mode typically causes local painful stimuli. The other technique is the “probe mode”, which uses two sharp metal darts that are shot from a distance into the subject or the subject’s clothing, causing energy to arc a greater distance across the two probes. If there is enough of a probe spread, generalized muscle contraction, sometimes termed “neuromuscular incapacitation,” is produced. This may result in the subject falling if he or she is in a standing position. There are case reports of injuries sustained directly from the darts such as ocular, skull or genital penetration. Other case reports of spinal compression fractures presumably from intense muscle contractions of the back musculature in subjects with osteopenia have been documented.(Rehman 2007, Sloane 2008, Winslow 2007, Ng 2005)

Recommendation: ***Cardiac monitoring and EKG screening after CEW use***

The current human literature has not found evidence of immediate or delayed cardiac ischemia or dysrhythmias after CEW exposures of up to 15 seconds. *Therefore, the medical literature does not support routine performance of EKGs prolonged ED observation or hospitalization for ongoing cardiac monitoring after CEW exposure in an otherwise asymptomatic awake and alert patient with a short duration (< 15 second)of CEW exposure.*

Studies have looked for dysrhythmias during and immediately after CEW use (Bozeman, 2009, Ho 2006, Ho 2007, Ho 2009, Levine, Vilke 2007, Vilke 2008). There have been no reports of ectopy, dysrhythmia, QT prolongation, interval changes or other EKG changes immediately following CEW use. Additionally, studies have looked at delayed monitoring findings and there have been no changes in EKGs sixty minutes or longer post CEW use (Ho 2006, Vilke 2007, VanMeenen 2010).

Studies have also looked at serial troponin levels as a marker of cardiac injury or ischemia. A number of studies have looked at troponin levels at six hours post CEW activation, and all levels except one have been normal (Ho 2006, Ho 2007, Sloane, Vilke 2007). The one study that showed elevated troponin, (Ho 2006), was on a healthy young male subject who received a five second TASER activation. The troponin I values all were <0.3 ng/ml, except a single value of 0.6 ng/ml at the 24 hour draw, which was previously normal at the 16 hour draw as well as the subsequent 32 hour draw. The subject was evaluated at the hospital by a cardiologist and showed no evidence of MI or cardiac disability.

Echocardiograms during CEW use have also shown no abnormalities during activation that suggest no cardiac electrical capture or structural cardiac damage.(Dawes 2010, Ho 2008).

Level of recommendation: Class A

Recommendation: ***Laboratory testing after CEW use***

The current human literature has not found evidence of dangerous laboratory abnormalities or physiologic changes after CEW exposures of up to 15 seconds. *Therefore the medical literature does not support routine performance of laboratory studies, prolonged ED observation or hospitalization for ongoing laboratory monitoring after a short duration of CEW exposure(<15 seconds) in an otherwise asymptomatic awake and alert patient.*

Studies have not shown any clinically significant changes in electrolyte levels or renal function in subjects with up to 15 second CEW activations (Ho 2006, Ho 2009, Vilke 2007, Vilke 2009). There have been mild, but clinically insignificant elevations in lactate levels with CEW activations. However, these have been demonstrated to be of a smaller magnitude relative to other forms of exertion with a similar duration (Ho 2006, Ho 2007, Ho 2009, Ho 2009, Vilke 2007, Vilke 2009).

Acid base status has been evaluated and has not shown any significant pH shifts for a 5 second CEW activation (Ho 2006, Vilke 2007, Vilke 2009). Similar findings with mild transient pH shifts were noted in CEW use for longer durations of application up to 15 seconds (Ho 2009).

Level of recommendation: Class A

Recommendation*: Evaluation after use of CEW in drive stun or touch stun mode*

For patients who have undergone drive stun or touch stun CEW exposure, medical screening should focus on local skin effects at the exposure site, which may include local skin irritation or minor contact burns. This recommendation is based on a literature review in which thousands of volunteers and individuals in police custody have had drive stun CEWs used with no untoward effects beyond local skin effects.

As above, routine EKG, cardiac monitoring, laboratory testing, or other forms of evaluation specific to the electrical component of short duration CEW use are generally unnecessary.

Level of recommendation: Class B

Recommendation*: Evaluation after use of CEW in probe mode*

For patients who have undergone probe mode CEW exposure, medical screening should focus on probe penetration sites, potential injuries due to muscle contractions, and potential trauma due to falls. CEW probes may strike the eyes, and /or penetrate skin and nearby superficial structures such as vessels, nerves, and bones. Muscle contractions due to the CEW may produce spinal compression fractures and other soft tissue injuries. Falls may occur from loss of muscular control and protective reflexes, resulting in blunt trauma. Literature review indicates that significant injuries due to this mechanism are rare, occurring in less than 0.5% of real world deployment in subjects (Bozeman 2009, Strote 2009).

As above, routine EKG, cardiac monitoring, laboratory testing, or other forms of evaluation specific to the electrical component of short duration CEW use are generally unnecessary.

Level of recommendation: Class B

7. List all conflicts of interest:

There were no conflicts of interest declared by any committee members.

8. Discussion

As noted above, the literature review for this clinical guideline focused on studies that involved rigorous methodologies to evaluate the physiologic effects of CEWs in humans. We did not include specific case reports or case series which in and of themselves cannot support any causal connection between CEWs and physiologic changes. We also did not include animal studies which are often more limited in scope and have questionable applicability to clinical human findings.

Recommendations in this review are limited to CEW exposure durations of 15 seconds or less. This reflects the exposure durations commonly used in the existing human literature and will apply to the large majority (>90%) of subjects against whom CEWs are used by police officers. While several reports have included exposure durations of 20 to 45 seconds and have not demonstrated concerning cardiac or physiologic effects, collectively this small body of literature is inadequate to support guidelines on medical screening after longer duration exposures. Therefore, until confirmatory studies of adequate power are available, clinicians should use their own judgment regarding the need for screening tests in this population.

It is important to point out that these recommendations focus solely on the issue of CEWs and their physiologic effects on humans. Clinical evaluation and testing may very well be warranted when evaluating patients after CEW application not because of the CEW exposure, but as a result of the patient's underlying condition such as alcohol or drug intoxication, altered mental status, physical exhaustion, excited delirium, or psychiatric conditions which precipitated the application of the CEW in the first place.

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