Hennepin County Medical Center

ULTRASOUND USE IN CONDUCTED ELECTRICAL WEAPONS RESEARCH

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Introduction

The TASER Electronic Control Device (ECD, TASER International, Scottsdale, AZ) is a law enforcement tool that causes Neuro-Muscular Incapacitation (NMI) in violent suspects. There are many models of ECDs available and ECD use is gaining popularity worldwide. The ECD is often used on suspects that require emergency medical attention following the law enforcement interaction. This may be due to factors such as behavioral control problems, metabolic acidosis, or drug intoxication. Occasionally, death has occurred temporally following ECD use. ECDs utilize electrical current for effect. The relationship between ECD use and death has been hypothesized to be via direct inducement of cardiac arrhythmia (electrocution) or suffocation. Artifact from ECD application prevents real-time monitoring of research subjects using traditional means such as cardiac monitors during ECD research.

This project describes the novel use of ultrasound as a ECD research tool that successfully allows real-time cardiac physiology evaluation in this emerging area of research. This research should be of interest to field paramedics, emergency physicians, critical care clinicians, cardiologists and medical examiners because they are often called upon to evaluate or manage persons who have experienced sudden death after law enforcement interaction. They are also called upon to provide opinions about the mechanisms of death and there have been several speculative opinions proffered by this population that have been directly refuted by human research evidence. Ultrasound use has allowed more accurate conclusions to be made regarding these opinions.

We present the first known comprehensive description of this ultrasound application in the ECD research environment. This abstract demonstrates the utility and contribution of ultrasound technology in aiding the scientific understanding of how ECDs affect human physiology.

Methods

After informed consent, volunteers have participated in a number of ECD studies. These studies have occurred over the last 5 years and have examined various ECD models as well as application locations, durations and subject conditions.

Before, during and after ECD exposure, cardiac and diaphragmatic ultrasonography with a SonoSite M-Turbo (SonoSite, Inc., Bothell, WA) is performed with standard windows. Real-time two-dimensional imaging allows direct observation of diaphragmatic excursion (indicating respiration) and gross cardiac activity during ECD exposure. M-mode imaging of the mitral valve or left ventricle can be used to determine the cardiac rate and rhythm.

Data are compiled in a database for analysis. All views are interpreted using a trained, emergency physician ultrasonographer as the gold standard.

Results

*Successful ultrasonographic imaging of the heart and/or diaphragm has occurred in 113 subjects during ECD exposure.

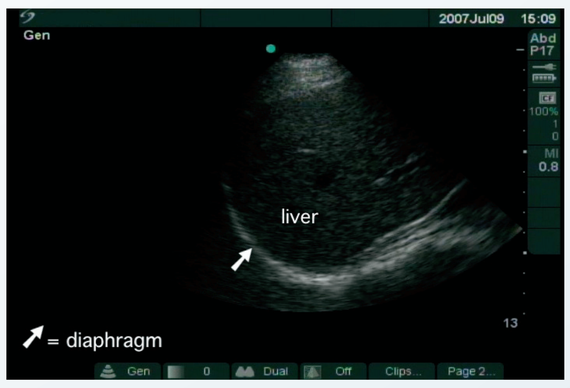
*There are continuous, ongoing studies occurring that are adding to this database.

*Ultrasonography has allowed us to definitively determine whether ECD exposure causes "capture" of the heart or diaphragm.

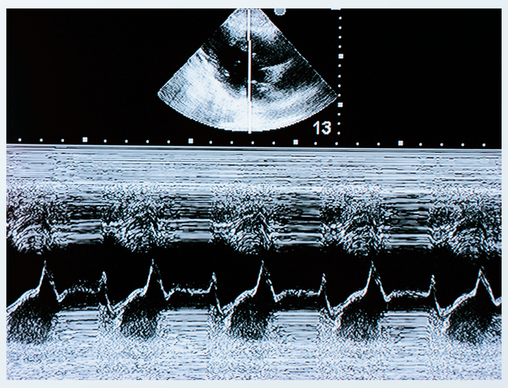
*We have not found evidence of heart or diaphragm "capture" with any current ECD in production.

*ECD applications studied have been in various modalities (probes, drive stuns) and on various thorax locations.

*These findings have been published in several original research studies or reports.[1 2 3 4]



Diaphragm Measurement for Respiration



Cardiac Mitral Valve Measurement for Rate and Rhythm Determination

Discussion and Summary

*ECDs have been a subject of research interest because they are used on persons that have died after application.

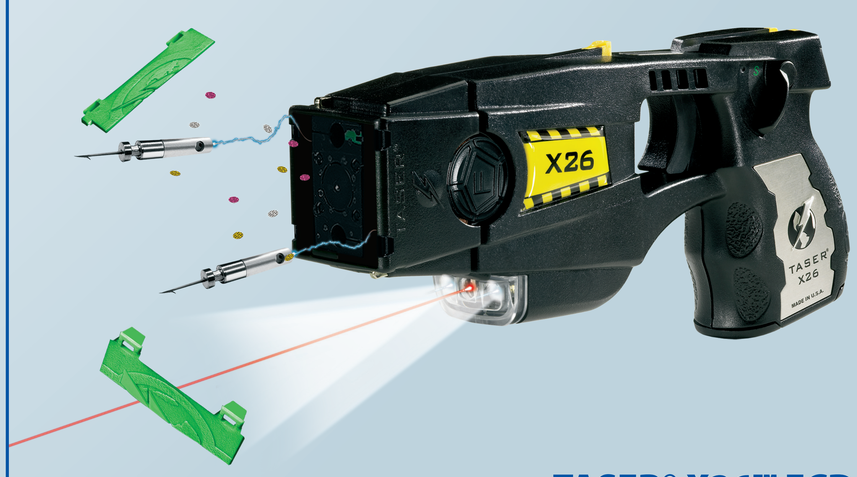
*A proposed mechanism of death is ECD induction of cardiac arrhythmia (electrocution) or suffocation.

*Traditional cardiac monitoring during ECD application is not possible due to electrical artifact.

*Cardiac ultrasonography in ECD human research has not shown this mechanism to occur in currently produced CEWs.

*It is more likely that death following ECD use is coincidental and likely to be related to other factors such as drug intoxication, severe metabolic acidosis or extreme delirium.

*Use of cardiac/diaphragm ultrasonography allows for characterization of the human diaphragmatic and cardiac rate/rhythm before, during and after actual ECD application.



TASER® X26™ ECD

Conclusions

*Ultrasonography is effective for directly observing the effects of ECDs on human organs in real-time.

*No other monitoring or imaging modality can provide this valuable information.

*Ultrasonography should continue to be part of the ECD comprehensive evaluation process and this non-traditional application of ultrasound technology will continue to evolve.

Citations

1. Ho JD, Dawes DM, Bultman LL, Thacker JL, Skinner LD, Bahr JM, Johnson MA and JR Miner. Respiratory effect of prolonged electrical weapon application on human volunteers. Acad Emerg Med, 2007;14:197-201.
2. Ho JD, Reardon RF, Dawes DM, Johnson MA and JR Miner. Ultrasound measurement of cardiac activity during Conducted electrical weapon application in exercising adults. Ann Emerg Med, 2007;50:S108.
3. Ho J, Lapine L, Joing S, Reardon R and D Dawes. Confirmation of respiration during trapezial conducted electrical Weapon application. Acad Emerg Med, 2008;15:398. (available as on online Data Supplement at http://www.blackwell-synergy.com/doi/suppl/10.1111/j.1553-2712.2008.00077.x)
4. Ho JD, Dawes DM, Reardon RF, Lapine AL, Dolan BJ, Lundin EJ and JR Miner. Echocardiographic evaluation of a TASER-X26 application in the ideal human cardiac axis. Acad Emerg Med, 2008;15:838-844.