

# Use of Force Continuum: Medical Aspects

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# Disclosures

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- No corporate funding or financial investments in any of the companies whose equipment will be discussed.

# Objectives

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- Discuss medical related issues
  - Restraint position and asphyxia
  - OC spray
  - Conductive Electrical Devices

# Death in custody

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- Deaths have been **associated** with use of force techniques
- Deaths will continue to be **associated** with use of force techniques

**“POST HOC ERGO PROPTER HOC”**

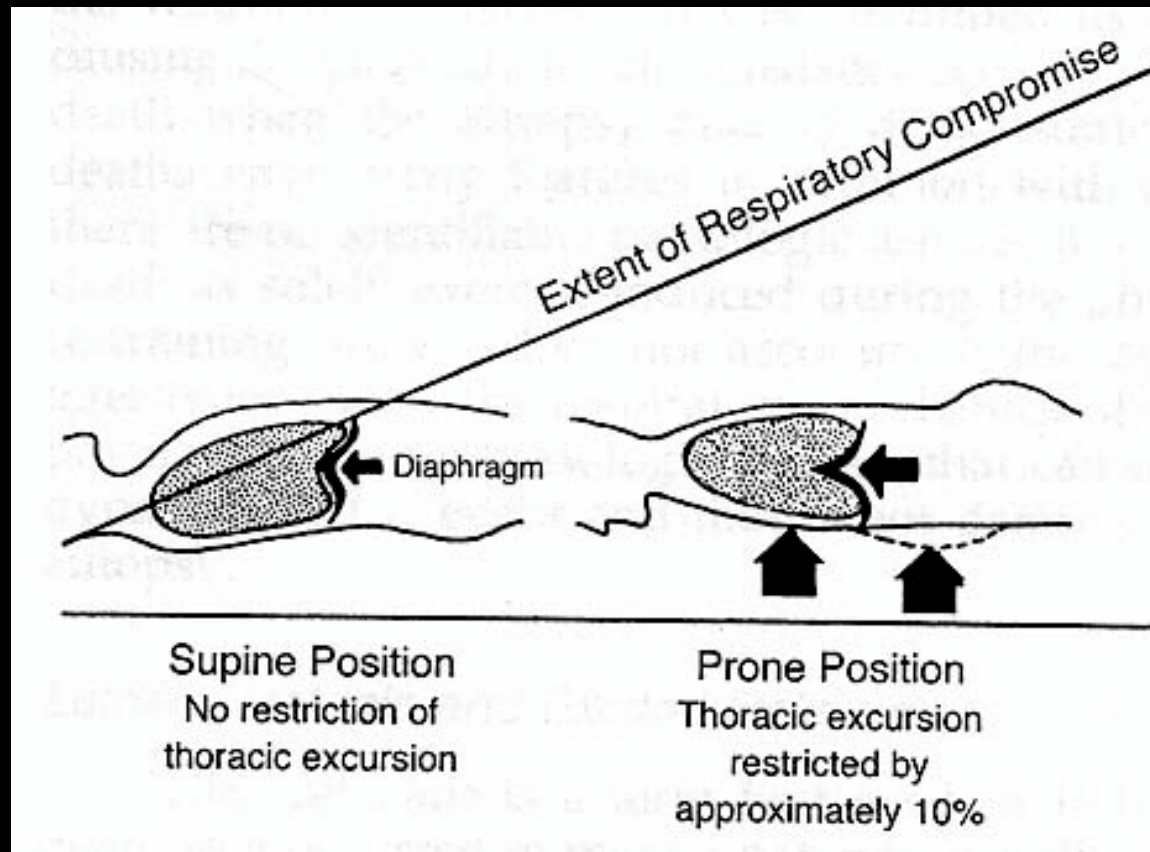
**"after this, therefore because of this."**

# Positional Restraint and Asphyxia

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# Positional Asphyxia - Pump Failure



# Respiratory Failure

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## Respiratory Failure

### Lung Failure

gas exchange failure  
hypoxemia

### Pump Failure

ventilatory failure  
hypercapnia

### Airway Obstruction

hypoxemia & hypercapnea

# Original work

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Theory of Positional Asphyxia in custody restraint based primarily on the work of Reay et al in 1988

Crossover study of 10 healthy individuals

- exercised on ski machine to HR 120
- measured recovery times for HR and O2 sat to baseline in first the sitting then hogtie positions
- prolonged recovery for HR and O2 sat in hogtie position
  - mean O2 sat recovery time increased 20”
  - mean HR recovery time increased 24”

Reay et al: Effects of positional restraint on oxygen saturation and heart rate following exercise. Am J Forensic Med Pathol 1988; 9(1):16-18.



# Original work

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- Reay concluded that custody deaths are a result of adverse physiologic and respiratory effects of body position

# Other caser reports and series

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**1985 Wetli & Fishbain:** 7 cases of custody death, 4 associated with hogtie position

**1992 Reay:** 3 cases of positional asphyxia in individuals placed in prone restraint position in back of patrol cars

**1993 O'Halloran and Lewman:** 11 cases of sudden death in subjects in prone position (9 of them hogtied)

**1998 Hick, et al:** 5 cases of restraint-associated deaths resulting in profound acidosis suggesting acidosis exacerbated by hypoventilation as a result of body position

# Case Report

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1995 Stratton et al: Two cases of unexpected death in restrained individuals during ambulance transport

Conclude death caused by positional asphyxia from restraint for excited delirium

# Case report similarities

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Cases involved agitated, psychotic individuals in a state of “excited delirium” usually from recreational drug use (cocaine, methamphetamines, ETOH)

Most cases involved traumatic struggle before and during apprehension

No clear evidence of any other specific cause of death on autopsy – diagnosis of positional asphyxia

# Autopsy

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Pathologists base diagnosis of positional asphyxia on temporal relationship of restraint to sudden death and lack of other obvious cause of death on autopsy

*Similar Sudden In-Custody Deaths reported in prone, supine and sitting restraint positions*

# Physiologic Studies - UCSD

## Annals of Emergency Medicine

NOVEMBER 1997  
VOLUME 30 NUMBER 5  
Journal of the  
American College of  
Emergency Physicians

### ORIGINAL CONTRIBUTIONS

#### GENERAL CLINICAL INVESTIGATION

- 563 Prediction of Early Complications of Myocardial Infarction by Calculation of the ST-T Segment Product  
W Schreiber, H Kitter, M Binder, B Hohler
- 571 ED Use of Rapid Lactate to Evaluate Myocardial Ischemia  
NJ Schmiechen, C Han, DP Miltman
- 578 Restraint Position and Positional Asphyxia  
T Neuman, JL Clausen

#### TOXICOLOGY

- 587 Prevention of Gastrointestinal Iron Toxicity by Orally Administered Premixed Deferoxamine  
HF Gomez, HH McClafferty, D Flory, J Brennan
- 593 Intoxicated ED Patients: A 5-Year Retrospective Study of Mortality  
P Davidson, J Kazior-McLain
- 598 Injuries Caused by Hazardous Materials: A Retrospective Study  
GN Polyhronopoulos, MJ Castro, RH Goldstein
- 604 Regional Intravenous Infusion of Calcium Chloride for the Treatment of Acid Burns of the Upper Extremity

## Restraint Position and Positional Asphyxia

**Theodore C Chan, MD\***  
**Gary M Vilke, MD\***  
**Tom Neuman, MD\*‡**  
**Jack L Clausen, MD†‡**

**Study objective:** To determine whether the "hobble" or "hog-tie" restraint position results in clinically relevant respiratory dysfunction.

**Methods:** This was an experimental, crossover, controlled trial at a university-based pulmonary function laboratory involving 15 healthy men ages 18 through 40 years. Subjects were excluded for a positive urine toxicology screen, body mass index (BMI) greater than 30 kg/m<sup>2</sup>, or abnormal screening pulmonary function testing (PFT). Forced vital capacity (FVC), forced expiratory volume in 1 second (FEV<sub>1</sub>), and maximal voluntary ventilation (MVV) were obtained with subjects in the sitting, supine, prone, and restraint positions. After a 4-minute exercise period, subjects rested in the sitting position while pulse, oxygen saturation, and arterial blood gases were monitored. The subjects repeated the exercise, then were placed in the restraint position with similar monitoring.

# Physiology Studies - UCSD

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1995 study funded by grant from the County of San Diego

Randomized cross-over controlled trial in 15 healthy subjects

**Phase 1:** PFTs (pulmonary function testing) in different positions: sitting, supine, prone, hogtie restraint

**Phase 2:** Serial ECG, oximetry, *arterial blood gases*, and PFTs during 4' stationary bicycle exercise followed by 15' in the sitting and hogtie restraint

Chan TC, Vilke GM, Neuman T Clausen J: Restraint position and positional asphyxia. *Ann Emerg Med* 1997;578-86.

# Physiology Studies - UCSD

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In healthy subjects, the restraint position resulted in a restrictive pulmonary function pattern but did not result in clinically relevant changes in oxygenation or ventilation.

We found no evidence to support the theory of positional asphyxia as a result of hogtie restraint body position



# Subsequent studies

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Randomized cross-over controlled trial of 18 healthy subjects

**Phase 1:** Exercised on bicycle up to HR 120 bpm, then measured HR and oximetry in the sitting and hogtie positions. No difference in HR recovery and no evidence of hypoxia

**Phase 2:** Simulated vigorous pursuit and struggle (ran 250m), followed by wrestling for 1', then rest in sitting or restrained position (lateral). No physiologic differences or hypoxia noted in recovery

Schmidt P, Snowden T: The effects of positional restraint on heart rate and oxygen saturation. J Emerg Med 1999, 17(5): 777-82.

# Physiologic studies

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- No study, including the original Reay study, has shown that the prone restraint position results in hypoxia

# Change in position

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“The hogtied prone position should be viewed as not producing significant physiologic respiratory compromise, and it does not produce any serious or life-threatening respiratory effects”

Reay DT: Death in custody. Clinics Laboratory Medicine 1998; 18(1):1-22.

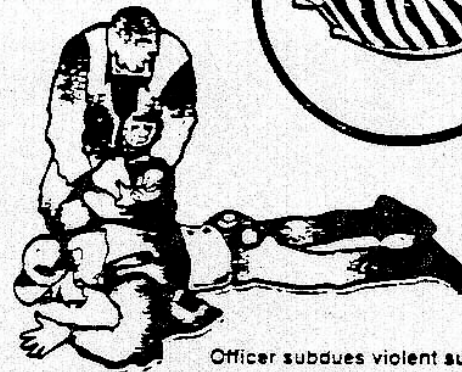
# Weight Force during Restraint?

## Officer Subduing a Violent Suspect and How It Can Interfere With Breathing

Subject's chest fully extended.

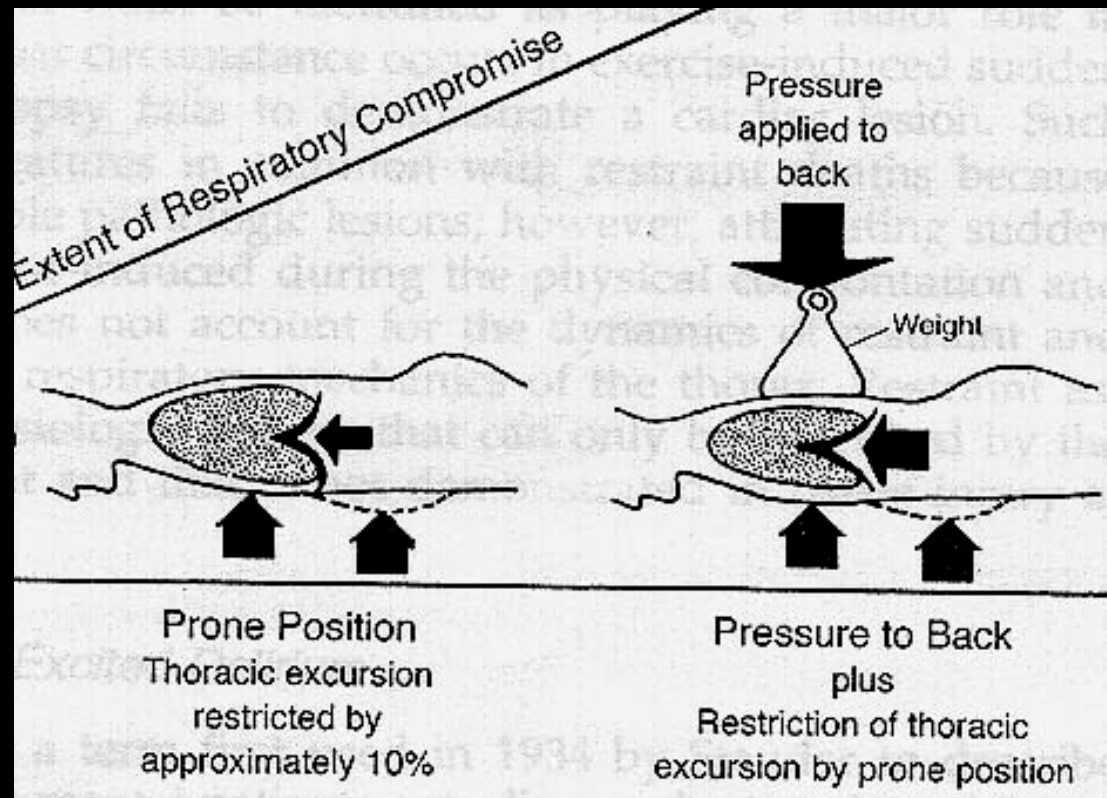


Breathing becomes labored due to pressure being exerted on subject's back.



Officer subdues violent suspect.

# Weight Force during Restraint?



# Physiologic Study Weight Force

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Chan TC, Neuman T, Clausen J, Eisele J,  
Vilke GM: Weight force during prone  
restraint and respiratory function. Am J  
Forensic Med Pathol 2004;25:185-9.

# Weight Force Study

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- 10 subjects placed in sitting, PMRP, PMRP with 25 lbs on back, and with 50 lbs on back for 5 minutes
- PFTs, oxygen saturation, etCO<sub>2</sub> measured

Chan TC, Neuman T, Clausen J, Eisele J, Vilke GM:  
Weight force during prone restraint and respiratory  
function. Am J Forensic Med Pathol 2004;25:185-9.

# Outcomes

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Conclusion: Weight force of 25 and 50 lbs on the back does not result in evidence of hypoxia or hypoventilatory respiratory compromise in our healthy subjects.

Chan TC, Neuman T, Clausen J, Eisele J, Vilke GM: Weight force during prone restraint and respiratory function. Am J Forensic Med Pathol 2004;25:185-9.



# Weight Force

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- Recent UCSD/SDSU study looking at weights up to *225 lbs* on back in prone position
  - PFT decreases to 85% (71.6-97.5% of predicted)
  - No associated hypoxia

# OC spray

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- Inhalation can result in gagging, sob, cough, inability to vocalize
- Symptoms transient (15-30')
- Respiratory symptoms have led some to suggest role in SDIC syndrome
  
- AI claims over 90 deaths following OC spray use in 1990s
- Granfield: 30 deaths following OC
- O'Halloran: 21 SDIC, 10 of which involved OC.
- Pollanan: 21 deaths, 4 of which occurred after OC exposure

# Similar deaths with OC spray

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Cases involved agitated, psychotic individuals in a state of “excited delirium” usually from recreational drug use (cocaine, methamphetamines, ETOH)

Most cases involved traumatic struggle before and during apprehension

# OC spray

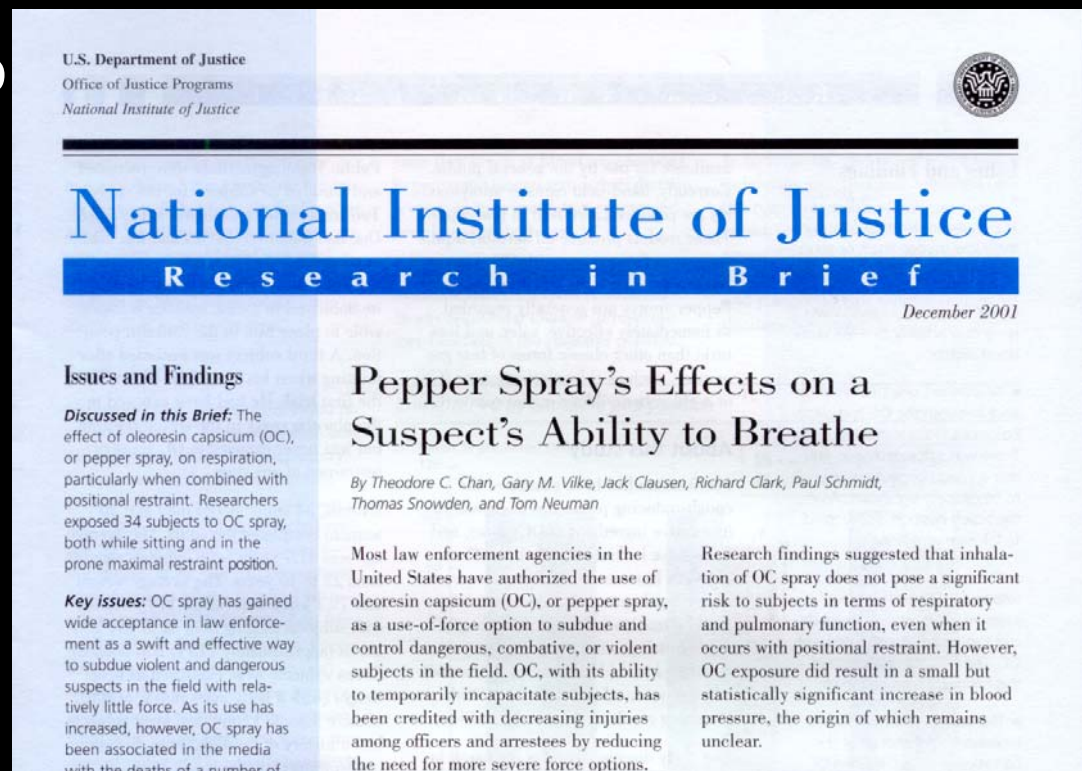
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- Few studies on OC spray as opposed to capsaicin
  - California AG report on 23,000 uses: No fatalities
  - Watson: 908 OC exposures, 10% required medical care, <1% resp sx, no fatalities
  - 2-year joint study of FBI & Army: No long-term health effects seen with OC spray exposure
- Very few studies on respiratory effects of OC spray inhalation in humans

# NIJ funded UCSD study

Crossover controlled trial of 35 volunteers to following:

- a. Placebo spray followed by sitting position
- b. Placebo spray followed by restraint position
- c. OC spray followed by sitting position
- d. OC spray followed by restraint position



# NIJ funded UCSD study

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## Conclusions:

- OC exposure did not result in any evidence of hypoxia, hypoventilation, or respiratory compromise
- OC did not result in any further change in pulmonary function (FVC, FEV1) in either sitting or restraint positions as seen in the original UCSD restraint study



# Conductive Energy Devices

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- Conductive Energy Device (CED)
- Human Electro-muscular Incapacitation (HEMI)
- Neuromuscular Incapacitation Device (NMID)
- Conductive Electrical Weapon (CEW)
- Projectile Stun Gun

# How many deployments?

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- As few as necessary to bring into custody
- Unfair for medical personnel to dictate police procedures
- Can offer recommendations
- Blanket policies can be hazardous



# How many deployments?

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- As few as necessary to bring into custody
- Unfair for medical personnel to dictate police procedures
- Can offer recommendations
- Blanket policies can be hazardous
- Consider the options

# The Big Picture

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- Amnesty International reports “152 taser-related deaths” since 2001 (as of 3/31/06)
- Arizona Republic reports “167 cases of death following stun-gun use” since 1999 (as of 5/57/06)
- 7000 law enforcement agencies have deployed Taser products
- Over 150,000 training deployments and around 100,000 field deployments

# Medical Literature

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- Topic first appeared in medical literature in 1980s



Koscove E: The Taser Weapon: A New Emergency Medicine Problem. *Ann Emerg Med* 1985; 14(12):1205-1298.

Sternbach G: Tasing the Literature. *J Emerg Med* 1987; 5:551-2.

O'Brien D: Electronic Weaponry-a Question of Safety. *Ann Emerg Med* 1991; 20(5):583-587.

Bleetman A, Steyn R, Lee C: Introduction of the Taser into British Policing. Implications for UK emergency departments: an overview of electronic weaponry. *Emerg Med J* 2004; 21:136-140.

Ordog G, Wasserberger J, Schlater T, et al: Electronic Gun (Taser) Injuries. Ann Emerg Med 1987; 16(1):73-78.

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- 218 Taser patients compared with 22 patients shot by police with a .38 special
- Morbidity 0% vs. 50%
- Mortality 1.4% vs. 50%

Strote J, Campbell R, Pease J, Hamman MS, Hutson R. The role of tasers in police restraint-related deaths. *Ann Emerg Med* 2005;46:S85.

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- 71 cases of taser associated deaths
  - 39 autopsies available for review
    - No deaths found to occur directly from Taser use
    - 6 (21%) had Taser injury as possibly being contributory
    - Direct causes of death included drugs (57%), excited delirium (57%).
    - Association with pre-existing cardiac disease (46%) and cocaine or meth use (68%)

# Case reports & series

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- Role of CEDs in sudden death
  - Cardiac dysrhythmias ?
  - Metabolic/Acidosis changes ?
  - Respiratory effects ?

# Animal studies

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- Several looking at rabbits or canines
  - Difficult to determine human applicability
- Older models of CEDs used that had much higher energy levels
  - Difficult to determine applicability to current CEDs

McDaniel W, Stratbucker R, Nerheim M, Brewer J: Cardiac Safety of Neuromuscular Incapacitating Devices. PACE Jan 2005, Supplement 1, s284-s287.

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- Nine anesthetized pigs
- Safety index evaluated for ventricular fibrillation
  - Increased from 15X -42X as weight of pigs increased from 30 to 117 kg



Jauchem JR, Sherry CJ, Fines DA, Cook MC: Acidosis, lactate, electrolytes, muscle enzymes, and other factors in the blood of *Sus Scrofa* following repeated TASER exposures. *Forensic Science International* Oct 2005.

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## ■ Air Force Study

- 6 anesthetized swine exposed to Taser discharges 5 seconds on, 5 seconds off, for 3 minutes.
- pH, lactate, troponin, hematocrit were measured at pre, immediately, 30 minutes and 60 minutes post activation
- In five of the swine, the protocol was repeated 60 minutes later

Jauchem JR, Sherry CJ, Fines DA, Cook MC: Acidosis, lactate, electrolytes, muscle enzymes, and other factors in the blood of *Sus Scrofa* following repeated TASER exposures. *Forensic Science International* Oct 2005.

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## ■ Results

- Elevations of myoglobin and CPK but not in CK-MB nor troponin I
- Blood pH decreased but recovered over an hour (7.4 to 7.0 to 7.2+ by 60 minutes)
- Blood lactate elevated
- Respiration ceased during application of electrical current

Jauchem JR, Sherry CJ, Fines DA, Cook MC: Acidosis, lactate, electrolytes, muscle enzymes, and other factors in the blood of Sus Scrofa following repeated TASER exposures. Forensic Science International Oct 2005.

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## ■ Conclusions:

- Although 3 minutes of Taser repeated-exposure scenario resulted in significant changes in blood chemistry, most levels (with the exception of lactate) returned to pre-exposure ranges within one hour after exposure.

Dhanunjaya Lakkireddy MD, Andrea Natale MD & Patrick Tchou MD  
Cardiovascular Safety Profile of Electrical Stun Guns (TASER-X26):  
Effects of Cocaine Intoxication on Induction of Ventricular Fibrillation –  
Cleveland Clinic accessed from Taser Website

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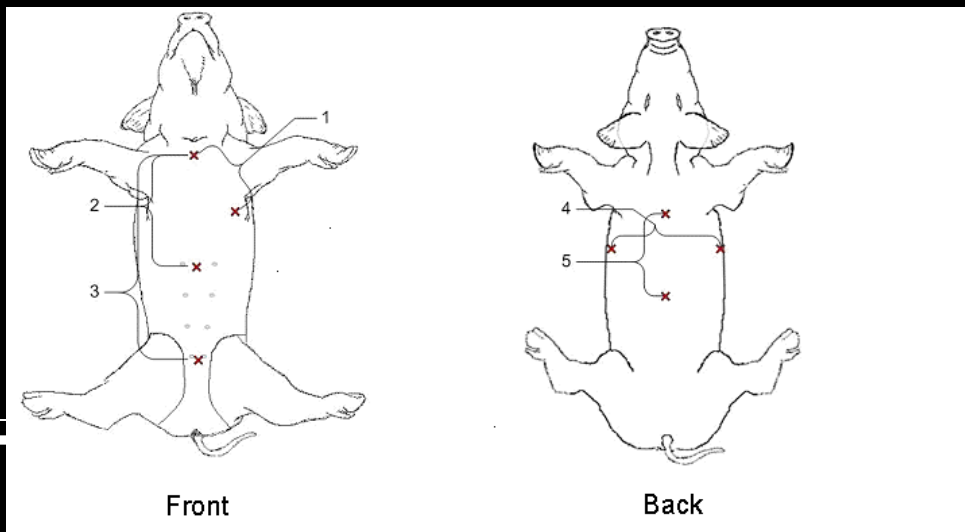
Recent unpublished data released as PowerPoint on Taser website (funded by Taser)

- Purpose
  - To assess VF vulnerability
- Methods
  - 13 anesthetized adult pigs
  - 5 second Taser activation
  - Five positions of lead placements
  - Pre- and post- cocaine infusion

Dhanunjaya Lakkireddy MD, Andrea Natale MD & Patrick Tchou MD  
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Cleveland Clinic accessed from Taser Website

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- 1) Sternal notch (SN) – point of maximum cardiac impulse (PMI) (**Position-1**),
- 2) SN – supra-umbilical region (**Position-2**),
- 3) SN – infra-umbilical region (**Position-3**),
- 4) Side to side across the chest (**Position-4**),
- 5) Upper to mid posterior region (**Position-5**)



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Effects of Cocaine Intoxication on Induction of Ventricular Fibrillation –  
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- Cocaine infusion: In 5 pigs, high dose cocaine was infused intravenously at 8 mg/kg over 30 minutes. Plasma cocaine and benzoylecognine levels 30 minutes after infusion were  $557 \pm 280$  U/L and  $462 \pm 123$  U/L

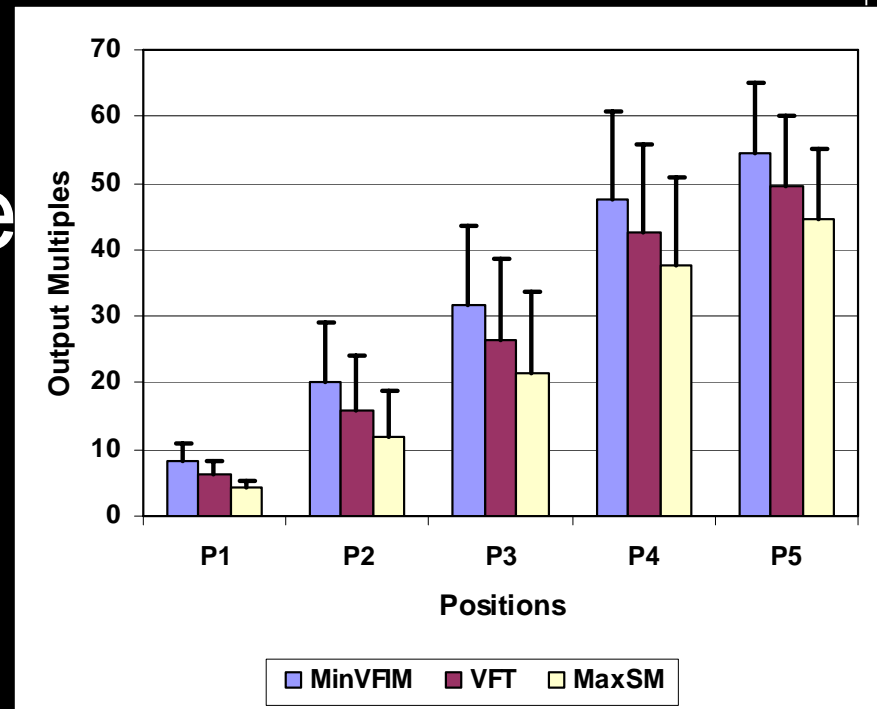
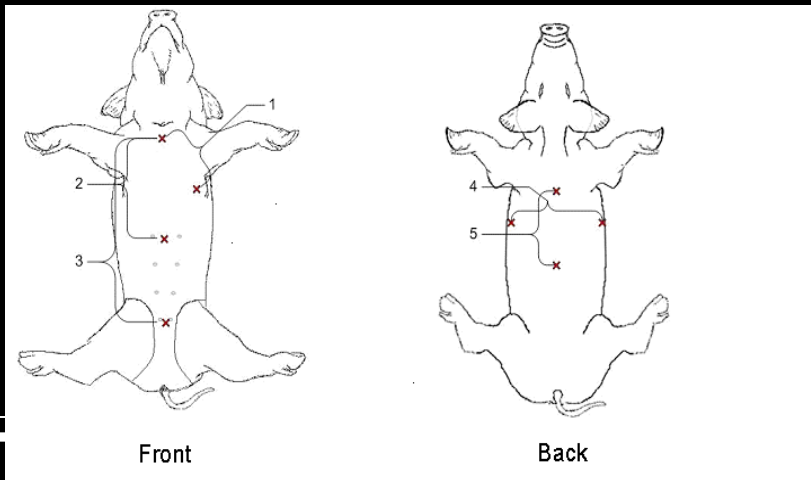
Dhanunjaya Lakkireddy MD, Andrea Natale MD & Patrick Tchou MD  
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- Differences in Maximum Safety Multiple (MaxSM), Maximum Ventricular Fibrillation Induction Multiple (MinVFIM) and Ventricular Fibrillation Threshold (VFT) at different positions before (B) and after (C) cocaine infusion.

Loc	B-MaxSM	C-MaxSM	p	B-MinVFIM	C-MinVFIM	p	B-VFT	C-VFT	p
P1	4.2±1.10	8.6±5.88	0.192	8.0±2.74	15.0±10.00	0.135	6.1±1.92	11.3±8.79	0.260
P2	12.0±7.58	28.0±4.47	0.030	20.0±10.0	38.0±4.47	0.037	14.5±9.59	33.0±4.47	0.032
P3	22.0±8.37	50.0±18.71	0.009	32.0±8.37	60.0±18.71	0.009	27.0±8.37	55.0±18.71	0.009
P4	30.0±7.07	48.0±17.89	0.070	40.0±7.07	58.0±17.89	0.070	35.0±7.07	53.0±17.89	0.070
P5	38.0±4.47	60.0±14.14	0.011	48.0±4.47	70.0±14.14	0.011	43.0±4.47	65.0±14.14	0.011

Dhanunjaya Lakkireddy MD, Andrea Natale MD & Patrick Tchou MD  
Cardiovascular Safety Profile of Electrical Stun Guns (TASER-X26):  
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Cleveland Clinic accessed from Taser Website

# Results: Differences in VF vulnerability at the 5 tested positions





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Cardiovascular Safety Profile of Electrical Stun Guns (TASER-X26):  
Effects of Cocaine Intoxication on Induction of Ventricular Fibrillation –  
Cleveland Clinic accessed from Taser Website

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## Conclusions:

- Standard discharge from a TASER X-26 weapon did not induce VF at any of the five tested locations and cocaine **increased** the safety margin by 50-150% above the baseline safety margin
- Applications away from the cardiac axis and cardiac apex have higher VF safety margins than those close to it.

# Animal studies

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- Recent work commented on in ***New York Times*** that questions safety of Taser.
- Presented as an abstract

**James A. Will**, AHABS, SVM; Animal Sciences, CALS; Jiu-Yan Wu, Honyu Sun, Electrical & Computer Engineering, COE, Ann O'Rourke, Surgery, School of Medicine and Public Health, Shane Huebner, Nutritional Sciences, CALS and **John G. Webster**, Biomedical Engineering, COE, University of Wisconsin-Madison, Madison Wisconsin

James A. Will, AHABS, SVM, Jiu-Yan Wu, Honyu Sun, Ann O'Rourke, Shane Huebner, CALS and John G. Webster, University of Wisconsin-Madison, Madison Wisconsin

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- Ten anesthetized 50-71 kg pigs
- An incision was made over the sternum and the skin and underlying tissues were reflected to allow direct access to the ribs and intercostal musculature.

James A. Will, AHABS, SVM, Jiu-Yan Wu, Honyu Sun, Ann O'Rourke, Shane Huebner, CALS and John G. Webster, University of Wisconsin-Madison, Madison Wisconsin

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- A bluntly created “virtual tunnel” was between the 3rd and 4<sup>th</sup> ribs at their junction with the sternum.
- A Taser dart was affixed to a piece of catheter tubing and then to a 6 cc plastic syringe used to maintain the proper dart-to-heart distance.

James A. Will, AHABS, SVM, Jiu-Yan Wu, Honyu Sun, Ann O'Rourke, Shane Huebner, CALS and John G. Webster, University of Wisconsin-Madison, Madison Wisconsin

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- The dart apparatus is shown in the 3-4 intercostal space over the “virtual tunnel”. The air gap created by the tunnel was filled with a muscle-impedance matching gel made from agar and saline.



James A. Will, AHABS, SVM, Jiu-Yan Wu, Honyu Sun, Ann O'Rourke, Shane Huebner, CALS and John G. Webster, University of Wisconsin-Madison, Madison Wisconsin

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- “In 10 pigs, we were able to cause VF in all animals.”
- The mean dart-to heart distance for VF was 17 mm  $\pm$  6.48 (SD). The median was 18 mm.

James A. Will, AHABS, SVM, Jiu-Yan Wu, Honyu Sun, Ann O'Rourke, Shane Huebner, CALS and John G. Webster, University of Wisconsin-Madison, Madison Wisconsin

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**Conclusion: “It is possible to cause ventricular fibrillation in pigs using a Taser device. From these data we can now proceed to investigate the probability of Taser induced VF in humans.”**

# Other research

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- Animal models
- Are they surrogates for humans?



Ho JD, Miner JR, Dhanunjaya R, et al. Cardiovascular and physiologic effects of conducted electrical weapon discharge in resting adults. Acad Emerg Med, 2006

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## ■ Prospective human study

- 66 human volunteers
- 5 second Taser activation
- 24 hour monitoring
  - Blood draw at baseline, immediately after activation and at 16 and 24 hours
  - 32 subjects received 12 lead cardiac monitoring
- Funded by Taser

Ho JD, Miner JR, Dhanunjaya R, et al. Cardiovascular and physiologic effects of conducted electrical weapon discharge in resting adults. Acad Emerg Med, 2006

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- Blood tested for:
  - Troponin, myoglobin, creatine kinase
  - Lactate, electrolytes, glucose, BUN, creatinine
- EKGs to independent blinded cardiologist

Ho JD, Miner JR, Dhanunjaya R, et al. Cardiovascular and physiologic effects of conducted electrical weapon discharge in resting adults. Acad Emerg Med, 2006

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- Mean results over the four blood draws:
  - Electrolytes unchanged
  - Renal function unchanged
  - Bicarbonate: 22.6, 22.0, 24.6, 23.8
  - CK: 185.1, 184.1, 221.6, 242.3
  - Lactate: 15.8, 24.7, 18.3, 19.8
  - Myoglobin: 32.4, 45.5, 42.9, 51.3

Ho JD, Miner JR, Dhanunjaya R, et al. Cardiovascular and physiologic effects of conducted electrical weapon discharge in resting adults. Acad Emerg Med, 2006

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- Troponin I all were  $<0.3$  ng/ml, except a single value of 0.6 at the 24 hour draw.
- The subject was evaluated at the hospital by a cardiologist
- No evidence of MI or cardiac disability
- Returned to normal within 8 hours of this elevated level

Ho JD, Miner JR, Dhanunjaya R, et al. Cardiovascular and physiologic effects of conducted electrical weapon discharge in resting adults. Acad Emerg Med, 2006

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■ **Conclusions:**

“We were unable to detect any induced electrical dysrhythmias or significant direct cardiac cellular damage that may be related to sudden and unexpected death proximal to CEW exposure.”

# Human studies



- Few non-industry human studies
- SD START ECG Study
  - 115 subjects
  - 105 interpretable quality tracings
  - No change in cardiac rhythm morphology or conduction



	Mean (bpm)	95% C.I.	Range (bpm)
HR pre	122	118-127	66-175
HR post	137	134-141	75-190

Levine SD, Sloane C, Chan TC, Vilke GM, Dunford J. Cardiac monitoring of subjects exposed to the Taser. *Acad Emerg Med* 2005;12(5):71.

Levine S, Sloane C, Chan T, Dunford J, Vilke G. Cardiac monitoring of subjects exposed to the taser. *Prehosp Emerg Care* 2006;10(1):130.

# Human studies



Levine SD, Sloane C, Chan TC, Vilke GM, Dunford J. Cardiac monitoring of subjects exposed to the Taser. *Acad Emerg Med* 2005;12(5):71.

Levine S, Sloane C, Chan T, Dunford J, Vilke G. Cardiac monitoring of subjects exposed to the taser. *Prehosp Emerg Care* 2006;10(1):130.

# Human studies

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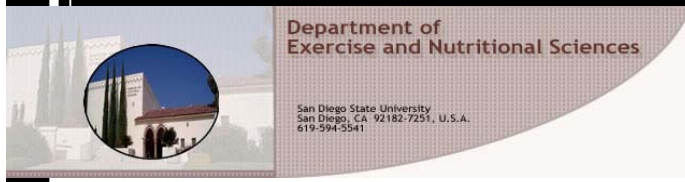
- SD START CED Troponin Study
  - Ongoing data collection to evaluate 6 hour troponin levels
  - 20 subjects underwent shock and rhythm monitoring
  - No significant changes as previous
  - All had troponin I level drawn at T+6 hrs
  - All had negative troponin I levels
  - No evidence of cardiac muscle damage



# NIJ SD START Taser Study



- The Physiological Effects of the Taser X-26 on Human Subjects
  - UCSD Department of Emergency Medicine
  - SDSU Dept of Exercise and Nutritional Sciences
- DOJ / NIJ Grant Funded



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# Study Overview

- Single 5 second CED Shock
  - Part of field training
- Monitor before, during and after
  - Cardiac and respiratory monitoring
  - Blood draw to evaluate metabolic responses





# Preliminary Results

- 13 subjects
- All 6 hour troponin  $<0.2$
- No EKG changes from baseline to 60 minute post activation





# Preliminary Results

Time	Mean pH
Baseline	7.45
T+1 minute	7.42
T+10 minutes	7.43
T+30 minutes	7.43
T+60 minutes	7.44



# Preliminary Results

Time	Mean lactate
Baseline	1.31
T+1 minute	2.66
T+10 minutes	2.52
T+30 minutes	1.43
T+60 minutes	1.32



# Preliminary Results

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- Bicarbonate with minimal transient changes
- PCO<sub>2</sub> with no significant changes

# In Conclusion

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- Animal data somewhat conflicting
  - Animal data difficult to extrapolate to humans
- Human research increasing
  - Much is industry sponsored
  - Seems to point away as the Taser having an obvious causative link
  - Making way into medical literature
  - Epidemiologic data is also important

This concludes the whirlwind tour!

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Gary M. Vilke, M.D., FACEP, FAAEM

Professor of Clinical Medicine

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