How many deployments?

- 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?

- 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

- 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

- Topic first appeared in medical literature in 1980s


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

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

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

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

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)

Front

Back
Cocaine infusion: In 5 pigs, high dose cocaine was infused intravenously at 8 mg/kg over 30 minutes. Plasma cocaine and benzoylcegonine levels 30 minutes after infusion were 557±280 U/L and 462±123 U/L.
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

- 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.

<table>
<thead>
<tr>
<th>Loc</th>
<th>B-MaxSM</th>
<th>C-MaxSM</th>
<th>p</th>
<th>B-MinVFIM</th>
<th>C-MinVFIM</th>
<th>p</th>
<th>B-VFT</th>
<th>C-VFT</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>4.2±1.10</td>
<td>8.6±6.88</td>
<td>0.192</td>
<td>8.0±2.74</td>
<td>15.0±10.00</td>
<td>0.135</td>
<td>6.1±1.92</td>
<td>11.3±8.79</td>
<td>0.260</td>
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<tr>
<td>P2</td>
<td>12.0±7.58</td>
<td>28.0±4.47</td>
<td>0.030</td>
<td>20.0±10.0</td>
<td>38.0±4.47</td>
<td>0.037</td>
<td>14.5±9.59</td>
<td>33.0±4.47</td>
<td>0.032</td>
</tr>
<tr>
<td>P3</td>
<td>22.0±8.37</td>
<td>50.0±18.71</td>
<td>0.009</td>
<td>32.0±8.37</td>
<td>60.0±18.71</td>
<td>0.009</td>
<td>27.0±8.37</td>
<td>55.0±18.71</td>
<td>0.009</td>
</tr>
<tr>
<td>P4</td>
<td>30.0±7.07</td>
<td>48.0±17.89</td>
<td>0.070</td>
<td>40.0±7.07</td>
<td>58.0±17.89</td>
<td>0.070</td>
<td>35.0±7.07</td>
<td>53.0±17.89</td>
<td>0.070</td>
</tr>
<tr>
<td>P5</td>
<td>38.0±4.47</td>
<td>60.0±14.14</td>
<td>0.011</td>
<td>48.0±4.47</td>
<td>70.0±14.14</td>
<td>0.011</td>
<td>43.0±4.47</td>
<td>65.0±14.14</td>
<td>0.011</td>
</tr>
</tbody>
</table>
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

Results:
Differences in VF vulnerability at the 5 tested positions

![Diagram showing differences in VF vulnerability at 5 positions](image)
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

- 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
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.
A bluntly created “virtual tunnel” was between the 3rd and 4th 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.
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.
“In 10 pigs, we were able to cause VF in all animals.”

The mean dart-to heart distance for VF was 17 mm ± 6.48 (SD). The median was 18 mm.
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

- Animal models
- Are they surrogates for humans?
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

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

- 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
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
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

<table>
<thead>
<tr>
<th></th>
<th>Mean (bpm)</th>
<th>95% C.I.</th>
<th>Range (bpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR pre</td>
<td>122</td>
<td>118-127</td>
<td>66-175</td>
</tr>
<tr>
<td>HR post</td>
<td>137</td>
<td>134-141</td>
<td>75-190</td>
</tr>
</tbody>
</table>


Human studies

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
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

<table>
<thead>
<tr>
<th>Time</th>
<th>Mean pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>7.45</td>
</tr>
<tr>
<td>T+1 minute</td>
<td>7.42</td>
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<tr>
<td>T+10 minutes</td>
<td>7.43</td>
</tr>
<tr>
<td>T+30 minutes</td>
<td>7.43</td>
</tr>
<tr>
<td>T+60 minutes</td>
<td>7.44</td>
</tr>
</tbody>
</table>
# Preliminary Results

<table>
<thead>
<tr>
<th>Time</th>
<th>Mean lactate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>1.31</td>
</tr>
<tr>
<td>T+1 minute</td>
<td>2.66</td>
</tr>
<tr>
<td>T+10 minutes</td>
<td>2.52</td>
</tr>
<tr>
<td>T+30 minutes</td>
<td>1.43</td>
</tr>
<tr>
<td>T+60 minutes</td>
<td>1.32</td>
</tr>
</tbody>
</table>
Preliminary Results

- Bicarbonate with minimal transient changes
- PCO2 with no significant changes
In Conclusion

- 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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