Cardiac, Physiologic, and Real World Effects of Taser Use

1 June 2017
Conducted Energy Device Meeting
San Francisco Police Department

Zian H. Tseng, M.D., M.A.S.
Murray Davis Endowed Professor
Associate Professor of Medicine in Residence
Cardiac Electrophysiology Section
University of California, San Francisco
Disclosures

Research Support:

• National Heart, Lung, Blood Institute (NHLBI), National Institutes of Health (NIH), Centers for Disease Control (CDC)
• PI: San Francisco POST SCD Study (POstmortem Systematic InvesTigation of Sudden Cardiac Death)
• Site PI: CDC/NHLBI Sudden Death in the Young Registry

Consulting:

• Medical Consultant for Taser policy Braidwood Commission, 2008-09, Government of British Columbia, Canada
• Medical Consultant for Taser policy UCSF Police Department, 2016

Legal:

• NONE
Induction of Cardiac Arrest (VF) with T shock

Heart Function and Electric Shock

Normal Heart Function

Ventricular Fibrillation

ECG

Blood Pressure

Electric Shock

400 ms

mm Hg
Resuscitation from Cardiac Arrest (VF)
Resuscitation from VF

- Time to defibrillation is key for survival:

Risk Factors for Cardiac Arrest

- **Underlying cardiac disease**
  - Previous myocardial infarction (heart attack)
  - Heart failure

- **High adrenaline**
  - Cardiac arrests most common early in AM when adrenaline highest
  - Cardiac arrests surge with stressful events: earthquakes, disasters

- **Illicit drugs: cocaine, methamphetamines**

- **Acidosis (diabetics)**

- **Thin body habitus**
Physiologic Effects of Taser Application

- Effects increase with duration of application
- Electrically overwhelming voluntary control of muscles = “induced seizure”
- Intense pain
- Dazed, immobilized, weak for 5-15 min after application
- Eye injury, miscarriage, brain penetration
- Acidosis from rhabdomyolysis (muscle death and injury)
Physiologic Effects of Taser Application

- **Immediate effects: Due to electrical cardiac capture**
  - Cardiac arrest and sudden death (VF)
  - May be no autopsy findings for death due to VF

- **Indirect/delayed health effects: Due to pain, adrenaline, acidosis**
  - Myocardial infarction = “heart attack” = death of heart muscle
  - asthmatic attack
  - “excited delirium”
  - seizures
Taser Animal Studies

  - Taser simulator used

- 3 independent animal studies show VF induction during Taser discharge (Nanthakumar et al, JACC 2006; Dennis et al, J Trauma 2007; Walter et al, AED 2008)
  - Vector over heart is critical, up to 81% VT/VF rate
Taser Human Studies

- 3 studies in resting, healthy police volunteers, typically Tasered in the back show tolerability
- Taser-induced rapid ventricular arrhythmia demonstrated by pacemaker (Cao et al, JCE 2007)
  - University funded
  - Vector across chest
  - Myocardial capture at >240 bpm
• Reports reviewed in a use of force database to identify cases in which Taser was used
• Found 178 uses from 6 cities in which Taser was used across chest
• No reported sudden deaths or fatal cardiac rhythms
8 cases of Taser-induced sudden arrest were analyzed.

Rhythm was VF in 7 cases, asystole in 1.
In the real world setting, do Tasers impact rates of:
- In-custody sudden deaths, firearm deaths, officer injuries

Surveys and Public Records Request were distributed to 126 cities in California using Tasers

Analyzed data from 50 California cities using Tasers
- 9 of 10 largest US cities refused to provide data

Event rates recorded for each city over a 10-year period: 5 y before through 5 y after Taser use
Rates of In-Custody Sudden Death

Mean rate of in-custody sudden deaths in pre-deployment period = $0.93/100,000$ arrests

Mean rate of in-custody sudden deaths in post-deployment years $2 - 5 = 1.44/100,000$ arrests

Lee BK…Tseng ZH. American Journal of Cardiology 2009
Rates of Lethal Force (Firearm) Deaths

Mean rate of lethal force deaths in pre-deployment period = 6.66/100,000 arrests

Mean rate of lethal force deaths in post-deployment years 2 - 5 = 9.1/100,000 arrests

Lee BK…Tseng ZH. *American Journal of Cardiology* 2009
Rates of Officer Injuries

p=0.28
p=0.80
p=0.56

Lee BK...Tseng ZH. American Journal of Cardiology 2009
Insufficient statistical power to examine rare events (Taser-induced sudden deaths)

If in-custody sudden deaths occur at a rate of 1-6/100,000 arrests, then a study in 178 suspects would have to be repeated 500x before an fatal event might occur.

Confirms low absolute risk of cardiac arrest but does not prove safety.
Funding source and author affiliation in TASER research are strongly associated with a conclusion of device safety

Peyman N. Azadani, MD, Zian H. Tseng, MD, Simon Ernakov, BA, Gregory M. Marcus, MD, and Byron K. Lee, MD
San Francisco, CA


• 50 studies reviewed for funding source and conclusions
• 23 studies were affiliated or funded by TASER
• 27 independent studies
• A study with any TASER affiliation was 18 times more likely to conclude that the device is likely safe
Implications of Taser Research

• Rare events: low absolute risk for sudden death, but not non-lethal

• Vector across heart important for cardiac arrest risk but indirect/late health risks independent of vector

• Dart-to-heart distance important for cardiac arrest risk, therefore should be avoided in thin or small-frame persons, children

• Taser use is associated with significant early increase in sudden death rates

• Number of discharges increases risk of cardiac arrest and indirect/late health effects
Recommendations for Taser Use

• Tasers may serve a useful role in law enforcement, but policy should be designed taking into account the risks of sudden death and indirect/late health effects
  – Goal to avoid initial spike in in-custody sudden deaths, but rate will still be higher than before Tasers

• Tasers should be considered a potentially lethal weapon

• Tasers should only be deployed for situations in which subjects are in imminent threat of significant, potentially lethal harm to self or others

• Trainers and other policy consultants should be independent of Taser Inc.
Recommendations for Taser Use

- Avoid vector across chest if possible
- Avoid use in thin persons, children, pregnant women
- Avoid repeated shocks if possible
- AEDs should be mandated to allow for rapid resuscitation if cardiac arrest occurs
  - *Side benefit:* Police officers are often first responders to medical emergencies and research shows lives can be saved if police are trained in AED use
- Continuous observation for up to 6 hours for medical consequences of Taser
  - *Immediate:* cardiac arrest
  - *Delayed:* MI/“heart attack”, asthmatic attack, “excited delirium”, seizures
- Consider evaluation by EMS or MD, esp for higher risk persons:
  - Drug use, past cardiac history, diabetics, thin persons, shock across chest, repeated shocks