Disclosure

- I do not possess any financial interest in Taser International
- I do not own a Taser
- I have been “Tasered” three times (training purposes, not criminal)
- Tactical Medicine training with Palm Springs PD, US Navy, Edmonton Police Service & EMS, Canadian Forces
“Don’t Tase Me, Bro!”

- On Sept. 17, 2007, US Senator John Kerry was addressing a forum at the University of Florida in Gainesville when a 21-year-old communications student, Andrew Meyer, interrupted the proceedings and was subsequently subdued and removed from the building.

- A campus security officer used a Taser to drive stun the student just after he shouted “Don’t tase me, bro!”
“Taser-related” deaths in the news...

**Rash of deaths linked to taser use**

**INGRID PERITZ**

October 19, 2007

MONTREAL -- Quilem Registe was agitated and intoxicated, police say, when he was hit with a taser on a Montreal street last Sunday. Now the 39-year-old is in a critical condition after an electrical discharge from a police taser.

Mr. Registe became the third person in a month to die in Canada after being hit by a police taser.

"We're waiting for answers. We're in shock," the victim's sister said yesterday. "The information has given us some answers."

Details about Mr. Registe's brush with police are sketchy, but the run-in left him in a coma in hospital, plugged with life-sustaining tubes, in the days that followed.

His death comes four weeks after the death of Claudio Castagnetta. Mr. Castagnetta, during an altercation with police in Quebec, was shot with a taser from self-inflicted head wounds while in a hospital, five times before being declared dead early Sunday.

**Print Edition - Section Front**

THE GLOBE AND MAIL

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Dziekanski’s mother hopes for truth

**By Cheryl Chan**

VANCOUVER • The mother of a Polish immigrant who was Tasered at Vancouver International Airport says she hopes the inquiry into his death will uncover the truth.

Zofia Cisowski, whose son Robert Dziekanski, 40, died in October, 2007, after being shocked five times with a Taser by an RCMP officer, said on the last day of testimony at the Braidwood inquiry that she is "expecting to know the truth."
CEWs in Canada

- While CEWs are legal for civilian use in 43 states of the USA, they are considered to be a prohibited weapon in Canada except for law enforcement use.
- Canadian law enforcement agencies have used the CEW since 1999.
CEWs in Canada

- By 2010, 129 law enforcement agencies in Canada (including the RCMP) use CEWs under different provincial and national regulations (CBC)
- In 2008, RCMP used (presentation & presentation/fire) a CEW 1,016 times
- The CBC reports that there has been 26 deaths associated with police CEW application (since March 2003)
- Most cases involved illicit drug use and/or an agitated state
Robert Dziekanski

- On Oct. 14, 2007, Robert Dziekanski, 40, of Poland died at Vancouver International Airport shortly after being physically restrained and shocked five times with a Taser by RCMP officers.
Objectives

• 1. Understand the properties and electrical physics of CEWs.
• 2. Acquire an overview of the current medical literature on the effects and complications of CEW use.
• 3. Consider some of the suggested guidelines around the assessment and management of individuals subjected to CEW use.
Outline

- Conducted Energy Weapons overview
- Taser focus
- Taser studies
- Post-CEW application patient assessment and management
- “Excited Delirium”
- CEW FAQs
Case Example

- A 45 year old male with a psychiatric condition and a lengthy criminal history was brought to a local police station after he was apprehended for assaulting his common-law spouse.
- At the police station, the man became combative and tries to escape.
- After a prolonged struggle with police officers, he is receives CEW exposure twice and restrained.
- He was brought to an ED. He was asymptomatic, assessed, observed for 3 hours and then released to police custody.
Case Example

- The man was transferred to a correctional facility where he was examined by a nurse.
- He had a history of paranoid schizophrenia, non-compliant with meds, CAD, and obesity.
- He became combative again and was required to be physically restrained in two separate struggles during the night.
Case Example

- In the last struggle, the man lost consciousness, and then went into cardio-respiratory arrest
- CPR was initiated and EMS was called
- 30 hours after being tasered, the man arrives into your ED with vital signs absent...
On Nov. 21, 2007, Howard Hyde, 45, a man with a history of schizophrenia, was arrested and while being booked at Halifax Regional Police Headquarters he became agitated. While subduing Hyde, the Taser was used at least twice. He died at the Central Nova Scotia Correctional Facility 30 hours later.
Conducted Energy Weapons (CEWs)

- A device that delivers electricity in rapid pulses
- Causes involuntary muscle contraction, briefly incapacitating a subject and facilitating definitive restraint
CEW History

• First developed and used in the 1970s for airline security
• Wider law enforcement use in 1980s
• Subsequent medical case reports and studies of physiological effects
How does a CEW work?

- When the trigger is pulled, a blast of compressed nitrogen propels two barbed darts at 55 m/s toward the target.
- Each dart weighs 1.6 g and has a 9 mm long tip with 10.5 m of thin wire trailing behind it.
- The CEW generates a series of arcing pulses at a rate of 19/sec.
Electricity Physics 101

- Voltage is the amount of force that is driving a flow of electrons (water pressure in a pipe)
- Current is the rate of flow of electrons through a conductive medium (rate of water flow in a pipe) – measured in amps
- High voltage & low current is like a dental water pik
- Low voltage & high current is like a storm sewer – lots of water moving but at low pressure
• High voltage, low current electrical discharge between two electrodes
• Immobilization by inducing involuntary muscle spasm (tetany)
• The low current must be “propelled” by a relatively high voltage to overcome the electrical resistance of body skin tissue and clothing
• Either based on oscillating DC or AC discharge
• Maximum “safe” voltage 900,000 volts and maximum “safe” current 10 milliamps
Voltage & Current Comparisons

- CEW: 50,000 volts from source but decreases to 1200 volts at dart tips with an average of 0.002 amps
- Household electrical outlet has 120 volts:
  - 60-watt light bulb has 0.5 amps
  - A typical toaster has 5 amps
  - A direct contact with an outlet can deliver 15 amps (can be fatal)
CEW Effects

- Actual current delivered dependent on:
  - Device voltage and current
  - Inter-electrode distance
  - Degree of direct skin contact & penetration
  - Moisture
  - Tissue salinity
  - Clothing
CEW Effects

- **Duration:**
  - 0.5 - 1 sec: Intense pain and muscle contraction (tetany)
  - 2 - 3 sec: Subject will be dazed and fall to the ground
  - > 3 sec: Disorient and drop the subject for several seconds and possibly up to 15 minutes
Types of CEWs

- Electrical Capture Shields
- Remote Activated Electrical Barriers
- Remote Activated Electrical Belts
- Contact Shock Devices
- Stinger
- TASER
**Stinger**

- Projectile electrodes
- 13 ounces
- Laser guidance
- 32 pulses / sec
- 0.1 - 4.0 sec duration
- 63,000 volts, DC 5 milliamps
- 0.60 Joules energy delivery
- 22 ft range
- 2 or 4 darts
- Discharge data logging
TASER

- First designed in 1969 by Arizona inventor Jack Cover - he named it after science fiction teenage adventurer Tom Swift
- TASER is an acronym for “Thomas A. Swift’s Electric Rifle”
Most law enforcement agencies use the X26 model

- 10 ounces
- Laser guidance / optional video/audio recording
- 19 pulses / sec
- 0.1 sec - 5 sec duration
- 50,000 volts, mean current 2.1 mAmps
- 0.36 to 1.76 Joules energy delivery
- 35 foot range (10.6 metres)
- 2 darts with muzzle velocity of 170 ft/sec
- Discharge data logging
Taser C2 (the “consumer” model)

- Comes in 5 colors (Black Pearl, Electric Blue, Titanium Silver, Metallic Pink, Graphite)
- 5 ounces, laser guidance, 17 pulses/sec, 5 seconds
- 50,000 volts, current 2.1 mAmps
- 15 foot range
Tasers in the Medical Literature

• Topic first appeared in medical journals in the 1980s
Taser - A less lethal alternative

- Retrospective review of 218 Taser patients compared with 22 patients shot by police with a .38 special revolver
- Morbidity 0% (Taser) vs. 50% (gun)
- Mortality 1.4% (Taser) vs. 50% (gun)
- Bottom line: Getting tasered better than getting shot.
Taser - maybe a little lethal?


- 75 cases of Taser associated deaths
  - 37 autopsies available for review
  - No deaths found to occur directly from Taser use
  - 27% specified Taser injury as being potentially contributory or contributory to cause of death
  - “Excited Delirium” was the diagnosis given in 76%
  - Association with pre-existing cardiac disease (54%) and cocaine or methamphetamine use (78%)
Medical Uncertainty around Taser use

- Association between CEWs and sudden death
  - Cardiac dysrhythmias?
  - Metabolic / acid-base changes?
  - Respiratory effects?
  - Exacerbation of concurrent toxicological effects?
Animal Studies

- Several studies have examined CEW effects on mice, rabbits, canines and swine
  - Generalizability to humans uncertain and possibly irrelevant
  - Variability in cardiac physiology, energy levels, current type, and energy to body mass ratios
  - No lack of human volunteers!
**Swine Model**

- Stinger S-400 exposure to 10 healthy anesthetized swine via probes attached to sternal notch and anterolateral thorax (20 4-sec shocks over 31 minutes)
- Significant changes in pH (mean 7.34), blood lactate (mean 4.0 mmol/L), and pCO2 (mean 52.5 mm Hg) - all returned to baseline within 4 hours
- A few PVCs in one animal
- Troponin I, PO2, pulse rate, MAP, CVP, & airway pressure had no changes
Swine Model

- 8 anesthetized & paralyzed swine exposed to two 40-sec discharges from a Taser X26 with transcardiac leads
- 1 had fatal ventricular fibrillation
- Remaining subjects all had 1-17 sec of ventricular tachycardia
Swine Model

- 150 Taser transthoracic discharges in 6 pigs with 74 cases of electrical cardiac capture
- Post epinephrine infusion resulted in 13 out of 16 discharges showing electrical cardiac capture
- Nanthakumar et al, CMAJ, 2008; 178(11):1451-7
Cardiovascular Effects

• Arrhythmias
• Several animal & human studies with conflicting results
• Generally, single CEW exposures on healthy subjects yield no significant arrhythmias immediately after exposure or up to 24 hours later
• Some animal studies have shown that repeated CEW exposures lower VF threshold and indeed induce VF
UCSD ECG Study

- 115 subjects
- 105 interpretable quality ECG tracings
- No change in cardiac rhythm morphology or conduction
Cardiovascular Effects

- Implantable Cardiac Devices
- Only a few case reports available
- Most notable case was a 53 yr old male with a dual chamber pacemaker that was exposed to a Taser discharge
- Pacemaker inquiry showed normal sensing, pacing thresholds and lead impedence but a high ventricular rate during Taser discharge
- Swine model with ICDs exposed to Taser discharge demonstrated no device malfunction and no defibrillation shocks
Sudden Cardiac Death: A new theory?

- Acute Stress Cardiomyopathy (aka Tako-Tsubo cardiomyopathy) involves findings consistent with ACS but with patent coronary vessels.
- Echocardiography shows characteristic ventricular wall motion abnormalities.
- Triggered by high catecholamine release secondary to an emotional or physical stress.
- Syndrome first described in pheochromocytoma and SAH patients and then found in people with emotional shocks.
Tasers & Acute Stress Cardiomyopathy

- Hypothesis: Criminal suspects usually involved in physical exertion, fear/anxiety of impending capture, possible stimulant use, and CEW application contribute to catecholamine excess and subsequent acute stress cardiomyopathy.

Respiratory Effects

- Animal & human studies examining various respiratory parameters including minute ventilation, tidal volume, respiratory rate, end tidal and arterial PCO2, oxygen saturation and PO2 found no clinically significant changes.
Several studies have examined the effects of CEWs on various biochemical parameters. Most subjects had levels within normal range post-CEW exposure and those few subjects that had abnormalities (usually CK, myoglobin, & lactate), the changes were minor and would return to baseline.
Hennepin County Medical Center Study

- Hennepin County Medical Center
- Prospective human study funded by Taser International
- 66 human volunteers
- Taser X26 activation for 5 seconds from 7 ft away with darts in the upper back and subjects assisted to the ground
- 24-hour monitoring
  - Blood samples (troponin, myoglobin, CK, lactate, lytes, glucose, BUN, creatinine) drawn at baseline, immediately after activation, 16 hours and 24 hours post activation
  - 32 subjects received 12 lead cardiac monitoring
Hennepin County Study

- **Mean results over the 4 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 for a single value of 0.6 at the 24 hr draw
- The subject was evaluated by a cardiologist and no evidence of MI or significant cardiac damage found - Troponin returned to normal within 8 hours after the abnormal level
Hennepin County Study

- Conclusion: “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.”

Physiological Effects Study

- Prospective trial of applying a standard 5-sec Taser X-26 exposure to 32 healthy police trainees
- Minute ventilation increased (16 to 29 L/min), tidal volume increased (0.9 to 1.4 L), and RR increased (19 to 23 breaths/min) 1 minute post-exposure but returned to baseline in 10 minutes
- Pulse rate and BP were highest before Taser exposure than anytime afterward
Physiological Effects (continued)

- Blood lactate increased (1.4 to 2.8 mmol/L at 1 min), pH decreased (by 0.03), and bicarbonate decreased (by 1.2 mEq/L) at 1 minute and returned to baseline at 30 minutes.
- All Troponin I values were normal and there were no EKG changes.
- No hypoxemia or hypercarbia.
- Conclusion: no clinically significant changes of physiological stress to healthy police trainees.
Interesting Taser Case Reports

- 37 yr old male police recruit subjected to Taser X-26 5 sec deployment while supported by colleagues
- He sustained an acute thoracic vertebral compression fracture
Interesting Taser Case Reports

- 32 year old woman 8-10 weeks pregnant
- Taser applied for compliance issues while incarcerated
- Apparently no drug use for 7 days prior to Taser incident
- Darts lodged over abdomen and thigh
- Next day, patient started spotting for 7 days and then had a miscarriage
Case Reports

- 27 year old male agitated and violent
- Taser activated
- EMS called
- In back of the ambulance, the patient swallowed one of the Taser darts so that when the autopsy was performed on him “they would know it was the police” that killed him
- No adverse effects
Case Reports

- 21 year old had Taser applied during the commission of a violent crime
- One Taser dart perforated the left globe causing vitreous hemorrhage, traumatic cataract, and retinal tear
- Patient had operative repair and had regained visual acuity
- 9 months later, the patient developed a retinal detachment with proliferative vitreoretinopathy
Case Reports

- A 16-yr old male resisting arrest was subject to a Taser X26 deployment
- 1 of the 2 Taser darts hit his right forehead
- 5 minutes of unconsciousness
- CT head showed the dart penetrated through the skull and into the frontal lobe of the brain
- The patient was taken to the OR for operative removal of the dart
- Uneventful post-operative course and no neurological deficits
Prospective observational human study

- Tracking of CEW use on criminal suspects by 6 US LE agencies
- 1201 subjects; 1198 (99.75%) subjects with mild or no injuries
- 3 subjects (0.25%) had significant injuries (2 intracranial injuries from falls & 1 case of rhabdomyolysis)
- 2 other subjects died in police custody 20 and 5 minutes after Taser use
Most Common Post-CEW Exposure Injuries

- **Minor Trauma**
  - Abrasions / friction burns
  - Minor lacerations
  - Contusions
  - Sprains
Taser Patient Management

• Determine the underlying reason the patient had a Taser used on him/her

• Approach the patient with caution - ensure your own safety and security first

• Complete a thorough history and physical exam including full vitals
  – Include cardiovascular, neurological, and musculoskeletal exams
  – Most common findings are contusions, abrasions, and first degree burns and soreness around the dart insertion sites
Have a higher index of suspicion for other co-morbidities if the following are present:

- Incontinence
- Pre-syncopal feeling
- Vertigo-type sensation
- Chest pain
- Palpitations
- Dyspnea
- Vomiting
- Headache
- Persistent confusion or combativeness
- Hyperthermia
- Persistent, abnormal vital signs
Higher-Risk Groups

- Drug and/or alcohol intoxicated patients
- Mental health patients
- Pre-existing cardiovascular disease, pacemaker or ICDs
- Age < 15 or > 60 years
- BMI < 18
- Pregnant > 24 weeks gestation
- Greater than 3 successive CEW exposures
- History of prolonged physical struggle and restraint
Taser Patient Assessment

- Keep in mind of concurrent toxicological aspects
- Pay attention to the signs of Excited Delirium
- Determine tetanus status and provide prophylaxis as needed (low risk)
Taser Dart Management

- Taser darts are essentially standard, Eagle Claw, #8 fishhooks
- Wires can be easily cut with trauma shears
- Place one hand on the patient in the area where the probe is embedded and stabilize the skin around the puncture site
- Use forceps to grasp the probe and pull it straight out with one fluid motion
- Cleanse puncture site and apply an antibiotic ointment bandage
- Treat Taser darts as if they were biomedical sharps!
Taser Dart Management

• Be cautious when darts penetrate the following areas:
  – Face / scalp
  – Anterior neck
  – Groin
  – Breast
  – Hands / Feet

• Operative removal of darts may be required when penetration occurs at:
  – Eye
  – Throat
  – Oropharynx
  – Major superficial vasculature
  – Penis / scrotum
Taser Patient Assessment

- Keep in mind that Taser patients were usually involved in some sort of violence - do a full trauma assessment as needed
- Taser activation will cause a fall - check for head, C-spine, and orthopedic injuries
Cardiac Monitoring & EKG

• Not typically needed for CEW exposure in an otherwise asymptomatic, awake, and alert patient with a short duration (<15 sec) of CEW exposure.

• May be indicated in patients with history of cardiovascular disease, significant risk factors, or cardiac symptoms.
Laboratory Testing

- Not typically indicated for an otherwise asymptomatic, awake, and alert patient with a short duration (<15 s) CEW exposure
- Consider electrolytes, BUN, creatinine, CK, troponin, lactate, ABG in patients with ongoing higher risk symptoms and/or factors
Evaluation of Patients Post-CEW Drive Stun

- Typically nothing needed beyond standard care for local skin effects at the exposure site
  - Skin irritation
  - Minor contact burns
Excited Delirium

- A poorly understood syndrome that occurs in in-custody individuals involving significant struggle, physical restraint, cardiovascular decompensation and frequently, death.
Taser FAQs

• Electrocution will not occur if the subject was wet or standing in water.
• If the patient has flammable liquid on their clothing, the Taser may ignite it (vapour ignition).
• Body armour will likely not protect the wearer from a Taser shock (depends on thickness - < 2 inches of armour will allow electricity to penetrate).
Taser FAQs

- Taser will not disrupt a patient’s implanted pacemaker - such devices need to withstand shocks from external defibrillators
- Unlikely for a Taser shock to induce ventricular fibrillation (threshold for v.fib. thought to be at least 50 mAmps) - some swine studies have shown induced v.fib. by Taser
The Big Picture

- Amnesty International reports 334 taser-related deaths from 2001 – 2008 in the US (Taser used shortly before death, but not necessarily the cause of death)
- In November 2007, the UN Committee Against Torture issued a statement saying “use of the Taser X26 weapons, provoking extreme pain, constituted a form of torture, and ... in certain cases, it could also cause death.”
The Big Picture

• Over 7000 US law enforcement agencies use CEWs
• Over 150,000 training deployments and over 100,000 field deployments
• Taser International claims that there has been over 1.5 million Taser applications worldwide
• Increasingly, governments have restricted law enforcement to using CEWs for situations of violent or aggressive resistance or active threat that may cause serious injury, NOT for lack of compliance of police instructions.
Future Research

- Studies that incorporate more “real world” circumstances
- Post-CEW exposure effects in physically exhausted humans
- Post-CEW exposure effects in ethanol-intoxicated adults
  - Moscati et al. 2010. AJEM, 28:582-587
- The IDEAL STUDY?!