

Presenting Rhythm in Sudden Deaths After Use of TASER® Conducted Energy Devices

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Braidwood Inquiry

Vancouver, BC, Canada

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Swerdlow: Education and Training

- B.S., Physics, Stanford University, Stanford, CA
- M.D., Harvard-M.I.T. Program in Health Sciences and Technology, Boston, MA
- Intern & Resident in Medicine, Harbor - UCLA Medical Center, Torrance, CA
- Fellow in Cardiology and Cardiac Electrophysiology, Stanford University Medical Center, Stanford, CA

Swerdlow: Present and Prior Positions

■ Previous Positions

- 1984-1988 Assistant Professor of Medicine, Stanford University Medical Center, Stanford, CA
- 1984-1988 Director, Clinical Electrophysiology Laboratory, Stanford University, Stanford, CA
- 1988-1992 Clinical Assistant Professor of Medicine, University of California, Los Angeles
- 1993-2000 Clinical Associate Professor of Medicine, University of California, Los Angeles

■ Present Positions

- 2000 - Clinical Professor of Medicine, University of California, Los Angeles
- 1990 - Attending Physician, Cardiac Electrophysiology Laboratory, Cedars Sinai Medical Center, Los Angeles, CA

Swerdlow: Certification

■ Board Certification

- ABIM Internal Medicine
- ABIM Cardiology
- ABIM Cardiac Electrophysiology
- HRS: Special Competency in Cardiac Pacing & Defibrillation

■ Recognitions

- Fellow, American Heart Association
- Fellow, American College of Cardiology
- Fellow, Heart Rhythm Society

Swerdlow: Areas of Research

- Boundaries of cardiac vulnerable zone in humans.
- Applied vulnerable zone research to develop clinical method for determining the minimum shock strength that defibrillates the heart from VF without inducing VF.
- Determined minimal current strength required for adverse cardiac effects from 60 Hz AC leakage current originating in hospital electro-medical equipment.
- Optimization of ICD waveforms: mathematical modeling, animal research, and human research.
- Design and testing of algorithms used by ICDs to analyze heart rhythms.
- Prediction of VT/VF based on characteristics of ICD electrical signals during normal rhythm

Swerdlow Time Allocation

- Patient care 60%
 - Cardiac electrophysiology procedures & surgery
 - Consultative and follow-up care of patients with cardiac arrhythmias
- Teaching 20% (cardiac electrophysiology)
- Research 20%

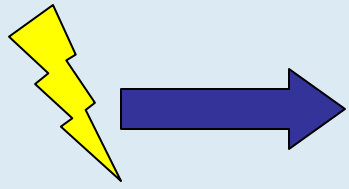
Disclosure

- ◆ I am a Member of TASER International's Scientific Advisory Board
- ◆ TASER International assisted in collating some of these data.

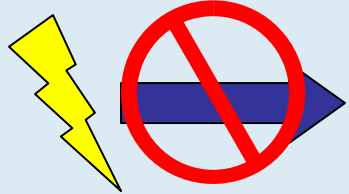
Background: TASER CEDs and Sudden Deaths

- ◆ Sudden deaths temporally-proximate to use of TASER CEDs receive wide attention.
- ◆ Under certain conditions, cardiac electrical stimulation can cause sudden death.
- ◆ The mechanism of death by cardiac electrical stimulation is immediate initiation of rapid heart rhythm disturbances, primarily ventricular fibrillation (VF).
- ◆ Research on sudden death after TASER CED use has focused on electrically-induced VF.

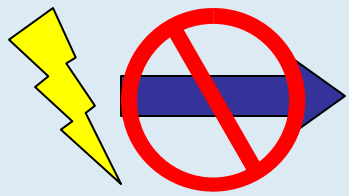
The Mechanism of Electrically-Induced Cardiac Arrest is Ventricular Fibrillation



Ventricular Fibrillation (VF)



Pulseless Electrical Activity (PEA)



Extreme bradycardia, asystole



Causes of Sudden Death Presenting as Asystole or Pulseless Electrical Activity

- ◆ Respiratory
- ◆ Neurological
- ◆ Toxic
- ◆ Metabolic
- ◆ Cardiac (not VF)

Hypothesis and Objective

- ◆ **Hypothesis:** If electrically-induced VF is the cause of sudden deaths proximate to use of TASER CEDs:
 - ◆ Initial post-arrest rhythm should be VF.
 - ◆ Subjects collapse rapidly after stimulation (< 1 min).
- ◆ ⇒ If either collapse is delayed or the initial post-arrest rhythm is not VF, the mechanism of death is not electrically-induced VF.
- ◆ **Objective:** Characterize the initial cardiac rhythms in sudden deaths proximate to use of TASER CEDs to determine if these deaths are caused by known, direct cardiac effects of electrical stimulation.

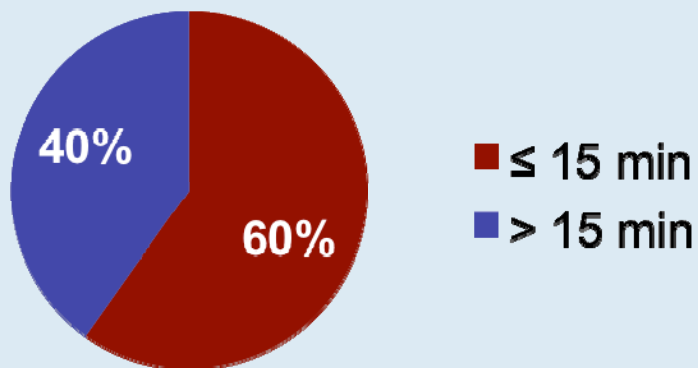
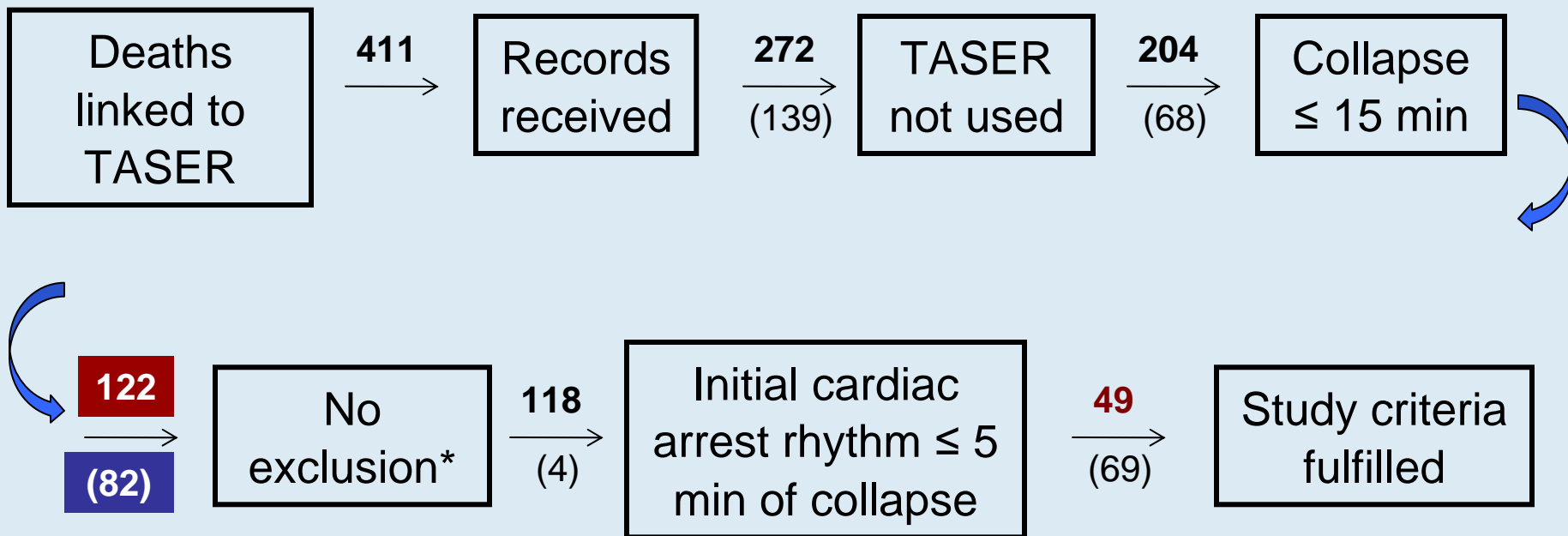
Methods (I): Record Review

- ◆ Study approved by IRB of Cedars Sinai Medical Center (Los Angeles)
- ◆ Internet search of deaths linked to TASER CEDs (2001-2008)
- ◆ Records requested
 - ◆ Police report
 - ◆ Emergency Medical Services (EMS)
 - ◆ ECG tracings: AED, hospital, ICD interrogation
 - ◆ Autopsy

Methods (II): Inclusion Criteria

- ◆ TASER CED discharged
- ◆ TASER discharge applied to subject
- ◆ Records confirm decedent collapsed within 15 minutes of last TASER discharge
- ◆ Death not caused by trauma
- ◆ EMS records indicate rhythm diagnosis
 - ◆ Within 5 minutes of collapse
 - ◆ Prior to treatment with drugs or defibrillation

Results: Subjects Analyzed



*Exclusions

- No energy to subject (1)
- Death from trauma (3)

Subject Clinical Characteristics (n = 49)

Age (yrs)	36 ± 10	
Gender (M:F)	47:2	
Stimulant Drugs (some double usage)	37 (76%)	
Methamphetamine		17
Cocaine		21
PCP		2
Ephedrine		2
MDMA (Ecstasy)		2
Significant heart disease	5 (10%)	
Coronary artery disease (≥ 70%)		2
Cardiomyopathy		3

Source Data for Rhythm Analysis

Source	N	%
EMS report of rhythm	49	100
ECG rhythm strip	6	12
Automatic Defibrillator (No ECG)*	10	20

*AED 9; ICD 1

- ◆ Classification of rhythms analyzed by AEDs
 - ◆ “No shock advised” – not VF
 - ◆ ”Shock advised” – VF

Results: Presenting Arrest Rhythm (n = 49)

Rhythm	N (%)	EMS (ECG)	AED
NO VF	46 (94%)		
Asystole/Bradycardia < 30/min*		27 (4)	
PEA ≥ 30 BPM*		10 (1)	
<i>AED[†] - No Shock Advised</i>			9
VF	3 (6%)		
VF		2 (1)	
<i>AED - Shock Advised</i>			1

* Normal rhythm prior to arrest (asystole 1; PEA 1)

[†]AED (n = 8); ICD (n = 1)

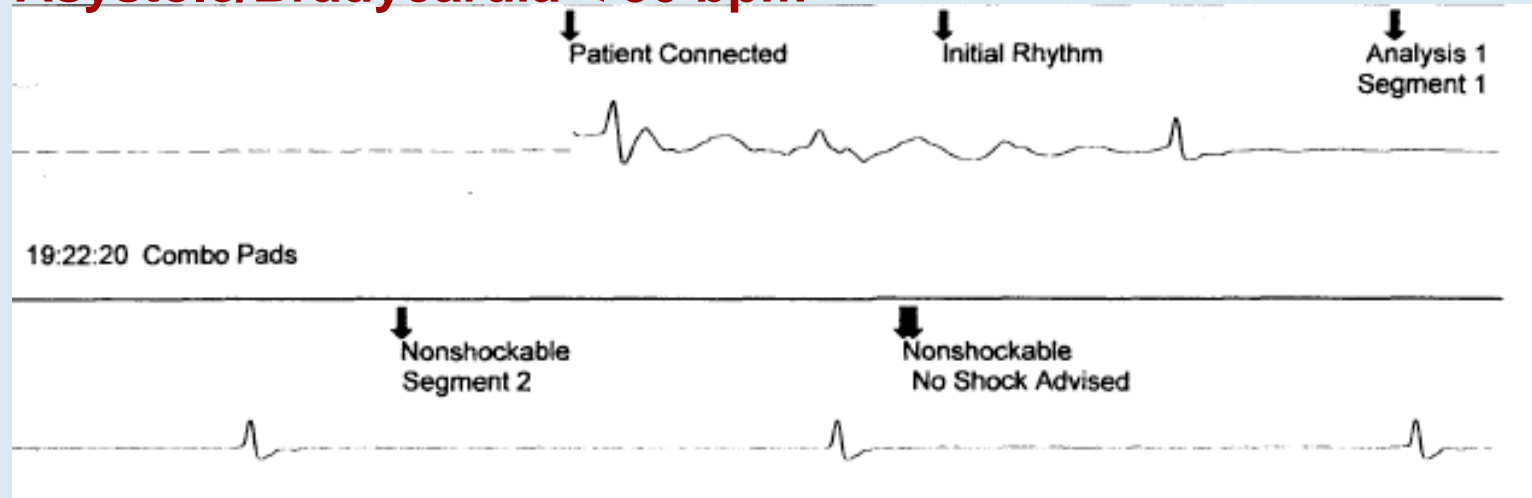
EMS Reports: N = 49

TIME	BP	PULSE	RESP.	PAIN 0-10	LUNGS	PUPIL	SKIN	LOC	ECG	SAT	DOSE/ROUTE/DRUG/DEFIB/D ² /OTHER	STAT
0911	0	0	0	—	—	F/D	Cold	UNE	—	—	ASSESSMENT	—
0912	0	0	0	—	H ₂ O KILLSA	F/D	Cold	UNE	ASYST	—	BVM, PR, CM WARMING	—
0914	0	OPR	BVM	—	H ₂ O KILLSA	F/D	Cold	UNE	ASYST.	—	SUCTION INTUBATION #7ETT O ₂ 24LPM	—
0916	0	OPR	BVM	—	ORA	F/D	Cold	UNE	ASYST	—	NO. 900NS WARM BOLUS	—

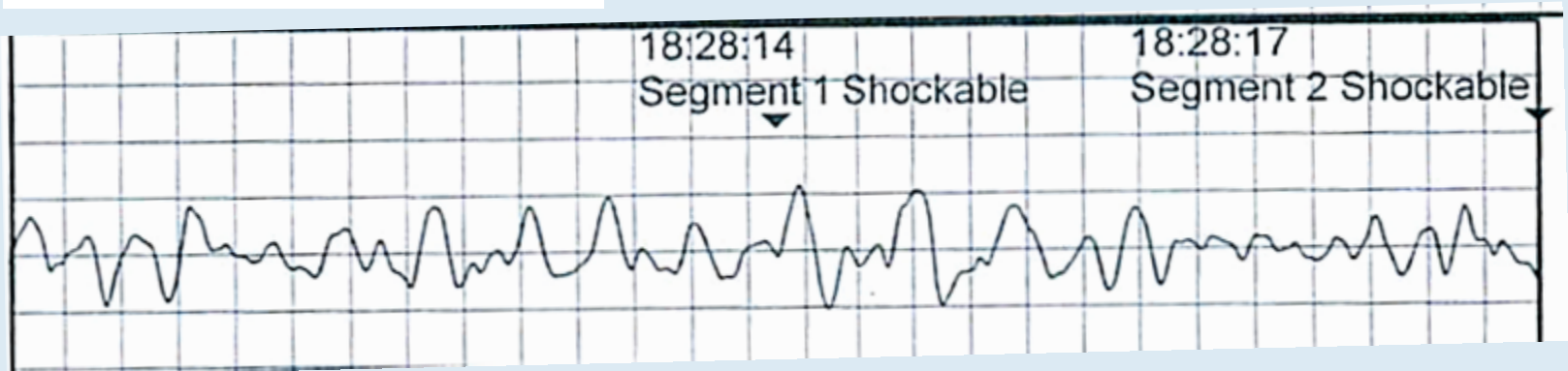
							<u>Vitals</u>	
Time	Pulse	B/P Cap	Resp	O2 By:	LPM	SaO2	EKG	
19:25	0	0	0	BVM	15	n/o	asystole	
19:30	0	0	0				asystole	
19:35	0	0	0				asystole	
19:50	0	0	0				asystole	
20:00	0	0	0				pacemaker placed	

ECG Recordings (n = 6)

Asystole/Bradycardia < 30 bpm



Ventricular Fibrillation



EMS Reports

Transition from perfusing sinus rhythm to PEA

TIME	GCS	LOC	ORIENT	B/P	POS.	EKG	PULSE	RESP
1850		AVPU	P/PTE	99/48		sinus	76 w/	48 shal
1855		AVPU	P/PTE	+		irreg	35 s/r	10 shal
1904		AVPU	P/PTE	+		as-140	40 s/r	30 shal

Presenting asystole; secondary VF

TIME	BP	PULSE	RESP.	PAIN 0-10	LUNGS	PUPIL	SKIN	LOC	EKG	SAT	DOSE/ROUTE/DRUG/DEFIB/D/OTHER	STATUS/CHANGE	TECH #
0911	0	0	0	—	—	F/D	Cold	UNE	—	—	ASSESSMENT	—	15/92
0912	0	0	0	—	H/O 2/10	F/D	Cold	UNE	Asyst	—	BUM, PR, CU WARMING	—	15/92
0914	0	CPR	BUM	—	H/O 2/10	F/D	Cold	UNE	Asyst.	—	SECTION INTUBATION #7ET 24CM TEEB	—	15/92
0916	0	CPR	BUM	—	CTA	F/D	Cold	UNE	Asyst	—	IV 0.9% NS WARM BOLUS	—	15/92
0922	0	CPR	BUM	—	CTA	F/D	Cold	UNE	VFIB	—	DEFIB 200, 300, 360	—	15/92
0926	0	CPR	BUM	—	CTA	F/D	Cold	UNE	Asyst	—	1mg EPI 1:10000 IVP	—	15/92
0930	0	CPR	BUM	—	CTA	F/D	Cold	UNE	Asyst.	—	50MG SODIUM BICARB 500ML IVP	—	15/92
0938	0	CPR	BUM	—	CTA	F/D	Cool	UNE	Asyst	—	500 CC WARM BOLUS NS	NS	15/92
0952	0	CPR	BUM	—	CTA	F/D	Cool	UNE	Asyt.	—	1000 CC BUN + REASSESS	—	15/92

*Complete this section on all patients with a mechanism of injury.

VENTRICULAR FIBRILLATION AND DEATH AFTER TASER INJURY

Srikanth Sadhu, MD, Sergio Leal, MD, Cesar J. Herrera, MD and Richard F. Kehoe, MD. Advocate Illinois Masonic Medical Center, Chicago, IL.

Case: A fifty year old agitated, combative man was immobilized with a TASER gun. The electric barbs penetrated his skin on anterior chest within one foot apart. He collapsed and went into cardiac arrest. Paramedics found the rhythm to be ventricular fibrillation (VF). Multiple defibrillation shocks were given without success.

Sadhu et al. *Heart Rhythm Journal* 3:S72; 2006 (abstract)

“Ventricular Fibrillation and Death after Taser Injury”

After numerous attempts by Sergeant O'REILLY to talk to the subject and calm him down, Sgt. O'REILLY then tased subject to subdue and control him. Subject was then handcuffed and placed on the CFD Ambulance Stair Chair.

Subject was placed in the elevator with his eyes open, alert and breathing. Once the elevator reached the ground floor, Paramedic Alvarez believed subject was going into cardiac arrest. Paramedics immediately administered CPR.

Police Report

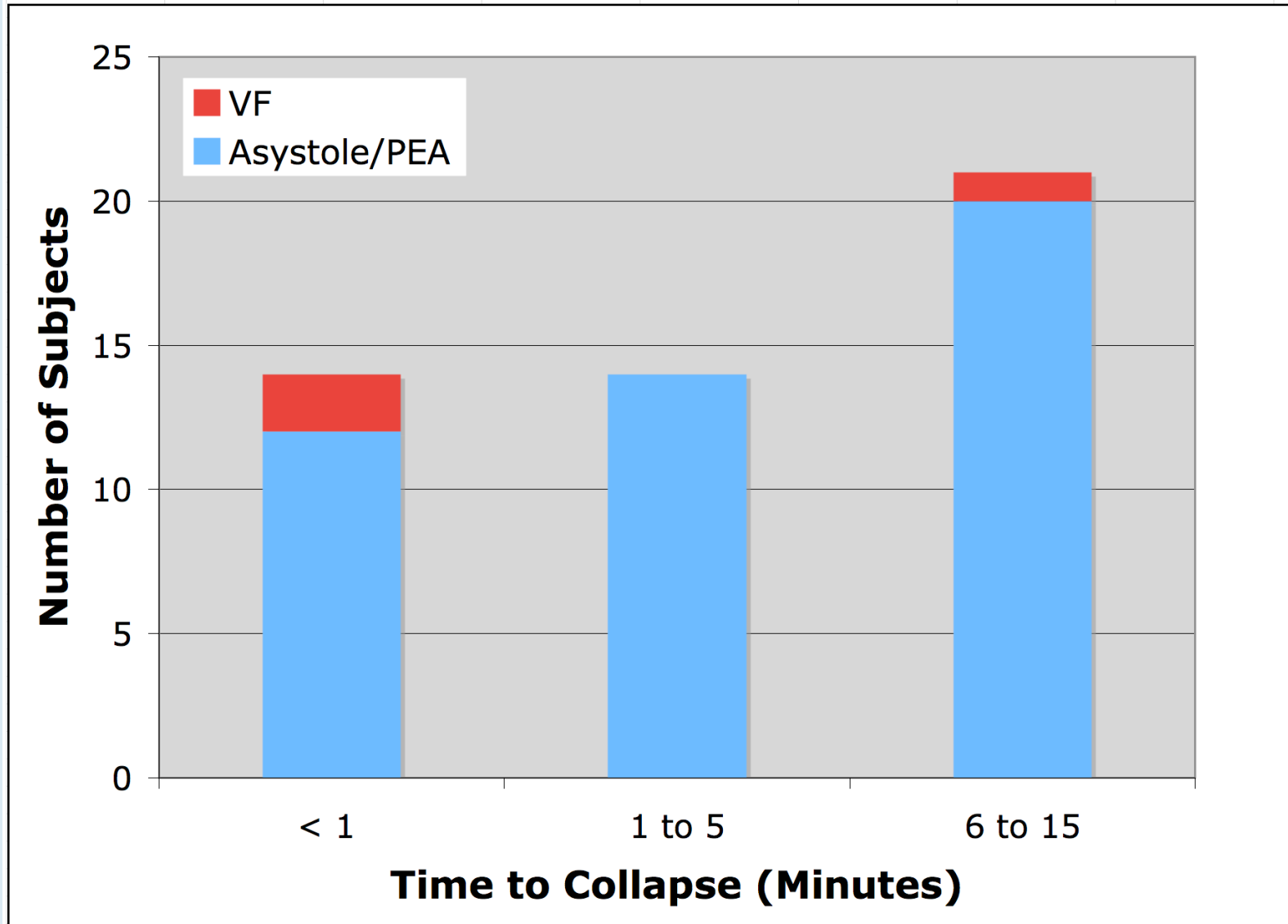
EMS Report

8 minute delay from last TASER discharge to VF

Violent patient
27A. Patient History/Concerns
Crew encountered
pt in hallway of 2nd
floor. Patient was
could not convince
came a crew called
VF. pt tased 10 ft
removed to ambulance
during descent

Sadhu et al. Heart Rhythm 3:S72; 2006 (abstract)

Time from TASER CED Stimulation to Collapse (n = 49)



Patients with VF: Summary

Age (yrs)/ Gender	41 M	25 M	50 M
Heart Disease	3 Vessel CAD	None	Cardiomyopathy
Drugs	Cocaine	[Only prior methamphetamine]	Methamphetamine
CED Discharge			
Electrodes	Drive stun	Darts	Darts
Body part	Right calf	Left chest	Left chest
Duration	1 s	3 x 5 s	1 X 57 s; 1 x 5 s
Time to collapse	< 1 min	< 1 min	8 min
Data source	AED shockable	AED ECG	EMS

Summary & Conclusion:

Presenting Rhythm in Sudden Death After TASER Discharge

- ◆ In the 40% of subjects who collapse more than 15 min after discharge, electrically-induced VF cannot explain cardiac arrest.
- ◆ In the 60% of subjects who collapse within 15 min the presenting rhythm is
 - ◆ VF in only 6%.
 - ◆ PEA or asystole in 94%, which cannot be explained by electrical stimulation of the heart.
- ◆ **Conclusion:** These findings exclude electrically-induced VF as the primary mechanism of death.

Implications: Presenting Rhythm in Sudden Death After TASER Discharge

- ◆ Future research should focus on causes of sudden death other than electrically-induced VF.
- ◆ Providing AEDs during deployment of TASER CEDs is unlikely to reduce sudden deaths significantly.