

# Evidence-Based Performance Measures

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**It is time to stop  
Doing things TO patients  
And start doing things  
FOR patients.**

**- Benedict Arnold, oops, I mean Paul Hinchey**



# The History

- ✚ We all got a collective bee in our bonnet several years ago because we were measured only on speed of ALS response and cardiac arrest survival
- ✚ The unintended consequence is that time trumped treatment



# NNT Table

Clinical Area	Elements	NNT	Harm Avoided
ST-Segment Elevation Myocardial Infarction (STEMI)	Aspirin 12-lead electrocardiograph (ECG), direct transport to percutaneous cardiac intervention (PCI) interval from ECG to balloon < 90 minutes <sup>46,47</sup>	15	Either a stroke, 2nd myocardial infarction, or a death
Seizure	Administration of benzodiazepine for status epilepticus <sup>66</sup>	4	Persistent seizure activity
Pulmonary edema	Noninvasive positive pressure ventilation (NIPPV) <sup>59</sup>	6	Need for an endotracheal intubation
Trauma	Patients with an Injury Severity Score (ISS) > 15 to trauma center <sup>72</sup>	11	1 death
Trauma	Patients over 65 years of age with ISS > 21 to trauma center <sup>69</sup>	3	1 death
Cardiac arrest	Defibrillator to the scene < 5 minutes rather than < 8 minutes <sup>15</sup>	8	1 death

# A Recent Local Experience

- ✦ A suburban town council believed they may be receiving poor EMS treatment
- ✦ This had clinical, operational, and budgetary implications
- ✦ Used part of the EBM to address the issue



# Cardiac Arrest

Clinical Measure	National Average	Wake EMS System	Holly Springs
All rhythms survival	7%	13%	25%
Shockable	15%	37%	40%

NOTE: Due to the small number of events in Holly Springs, this a trend comparison but does not reach statistical significance.

# Heart Attack

Clinical Parameter	Goal	EMS System	Holly Springs
Treatment Bundle	> 90% compliance	87%	100%
9-1-1 to hospital	< 60 minutes, 90%	50 minutes	53 minutes

NOTE: Due to the small number of events in Holly Springs, this a trend comparison but does not reach statistical significance.

# Major Trauma

Clinical Parameter	Goal	EMS System	Holly Springs
Scene Time	<10 mins on average	11 mins	7 mins
Golden Hour	9-1-1 to trauma center, 90%	50 mins	48 mins

NOTE: Due to the small number of events in Holly Springs, this a trend comparison but does not reach statistical significance.

# Response Time Performance

## July 1, 2009 to October 30, 2009

Response Parameter	Goal	System	Holly Springs
Non-Emergency	<19:59 at 90 <sup>th</sup> percentile	15:22	12:32
Emergency	<11:59 at 90 <sup>th</sup> percentile	12:19	12:05

Response time = 9-1-1 center processing + out-the-door + drive time

# The Result

- ✦ Town council was pleased that an analysis of more than response time was performed
- ✦ They were (appropriately) satisfied that they were receiving good EMS service



# Potential New Items

+ Stroke Care

+ Post-resuscitation Care

+ Participation in the Continuum of Care



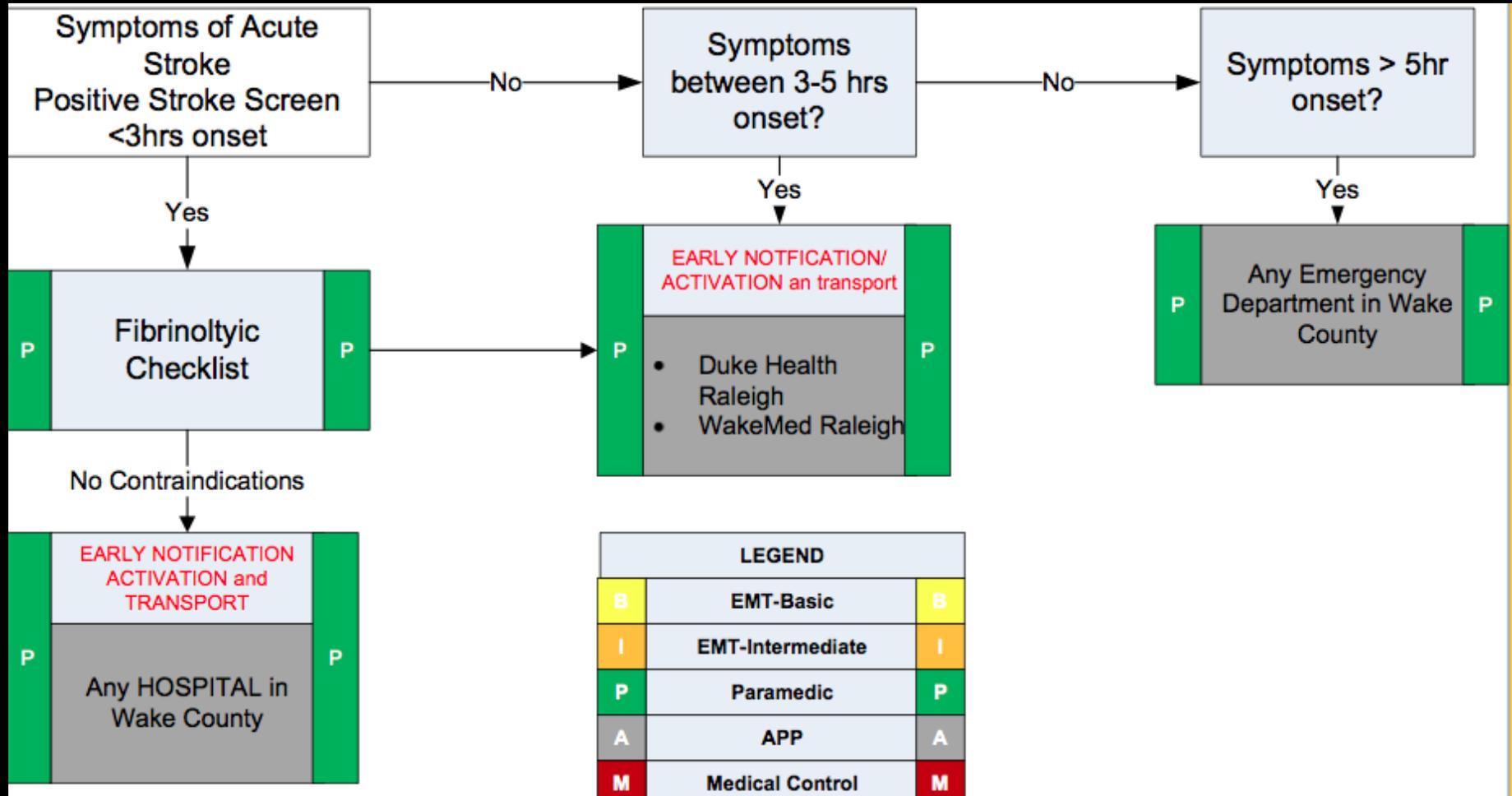
# Going Forward -- Stroke

## ✦ Proposed measures:

- ✦ Utilization of a validated pre-hospital screen
- ✦ Screen for blood glucose
- ✦ If possible (? < 30 minutes drive), transport to primary stroke center that is capable of thrombolysis as well as percutaneous intervention if symptoms <5 hours
- ✦ If not and less than <3 hours, transport to hospital capable of thrombolysis



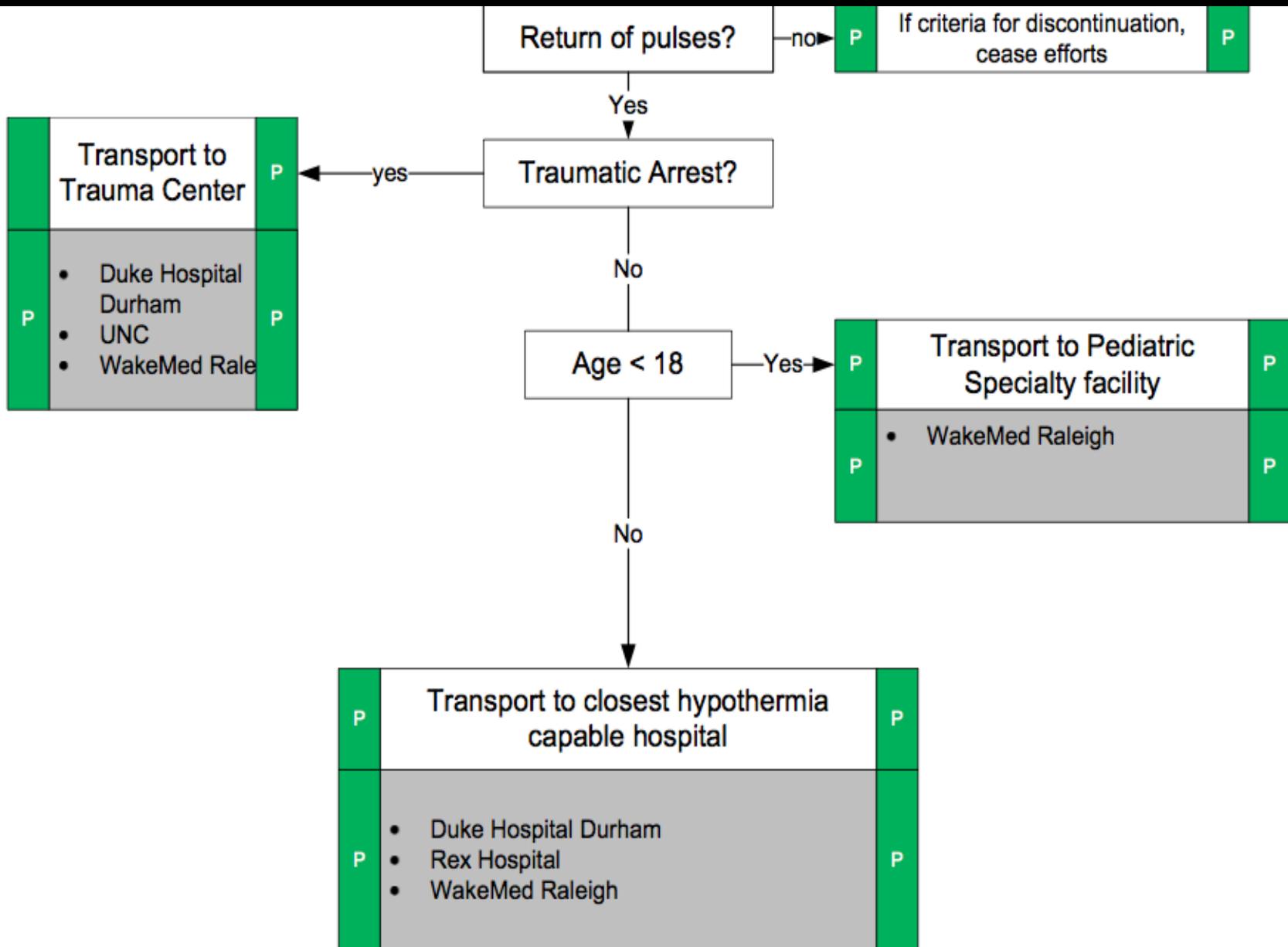
# Stroke Destination Guide



# Post Resuscitation Care

- ✦ Paper on Resuscitation Centers is out now on PEC
- ✦ As you heard yesterday, this concept is gaining acceptance
- ✦ NNT to produce neurologically intact survivor from VF/VT is 4 to 6



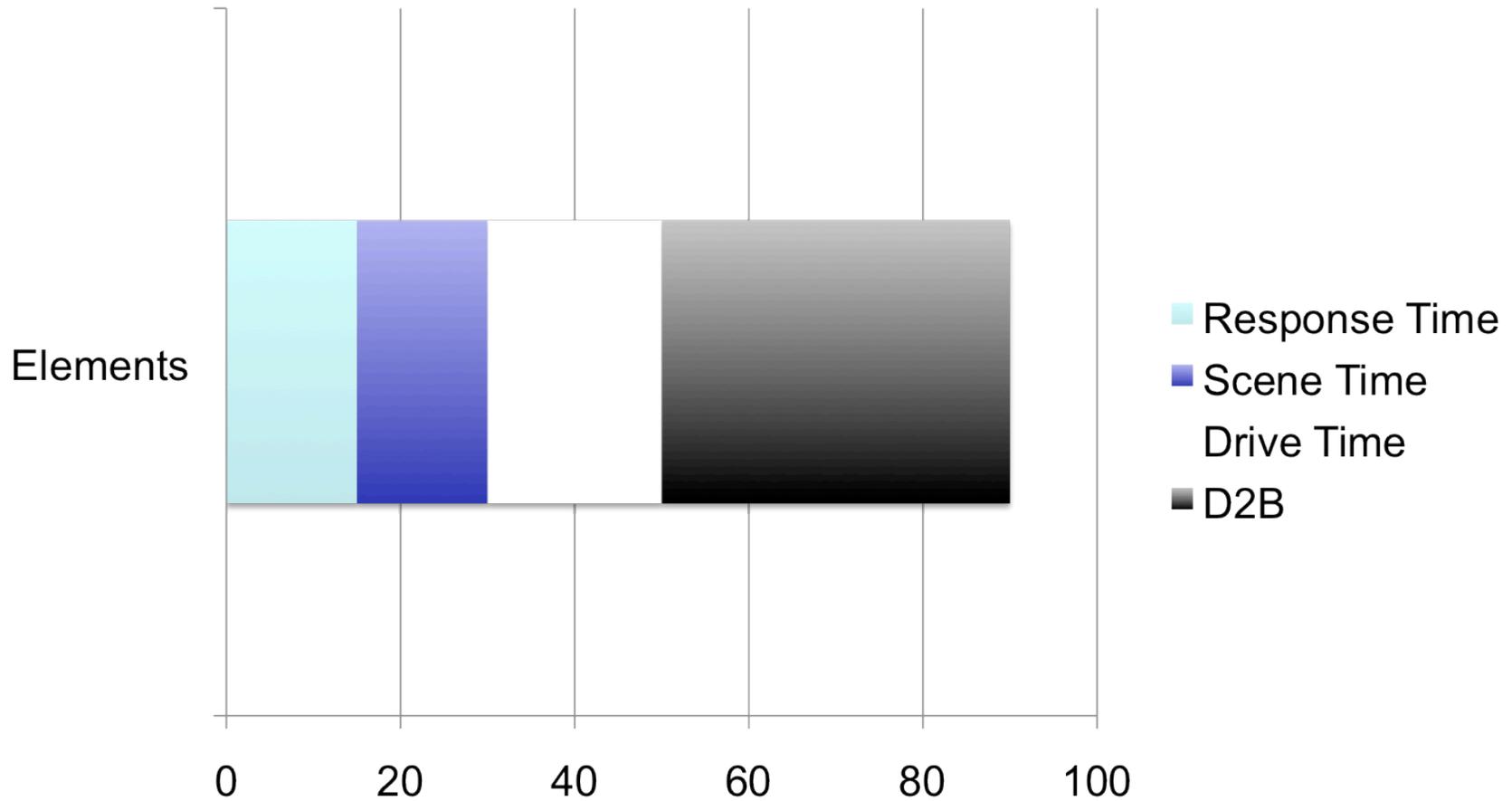


# Time of Care Continuum

- ✦ Hard to see benefit from EMS response time except for arrival of AED (Dr. Richmond's talk, Dr. Blackwell's paper)
- ✦ Time critical emergencies, however, where we participate in the continuum of care is important:
  - ✦ Time to reperfusion for STEMI
  - ✦ Time to reperfusion for stroke
  - ✦ Major trauma



# Elements of Continuum of Care



# Suggested Language

- ✦ “EMS response times should be developed at the community level in conjunction with receiving facilities to ensure 90% compliance with treatment guidelines for time critical emergencies such as STEMI, Stroke, and Major Trauma”



# Summary

- ✦ NNT concept can be used to quantify benefit of EMS activities
- ✦ Proposed additions:
  - ✦ Stroke
  - ✦ Post-resuscitation
  - ✦ Continuum of care time considerations





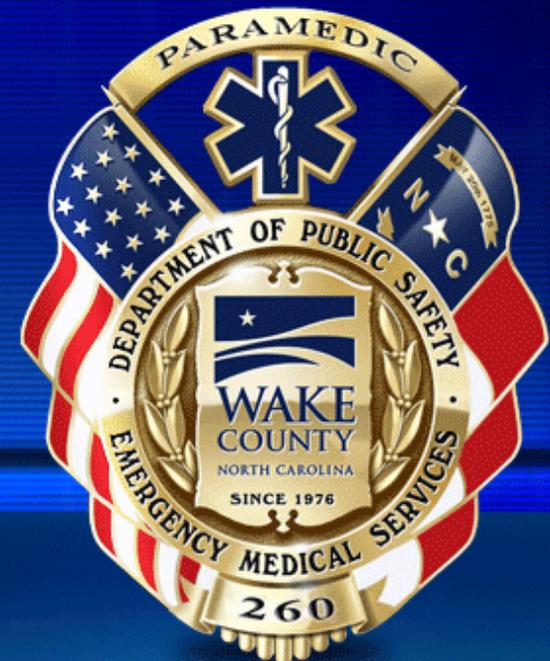
# Tourniquets and Goody Powders

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**Life is really simple  
But we insist  
On making it  
Complicated.**

**-Confucius**









# Causes of Renal Failure in North Carolina

✦ Untreated hypertension

✦ Uncontrolled diabetes

✦ Goody Powders

✦ SOURCE: My favorite nephrologist



# Wake County Experience

- ✦ Placed tourniquets on all units in February 2005
- ✦ Have been used on 31 patients
  - ✦ One train amputation of a lower leg
  - ✦ Gunshots and stabbings
  - ✦ 10 patients with indwelling catheters/fistulae/shunts for dialysis (one patient had 2 applications in a week)



# The Evidence

- ✦ Review of experience from the military experience in Iraq (165 patients)
- ✦ Evaluated the impact of tourniquets upon clinical status on arrival, blood products, and ultimate outcome
  - ✦ Beekley AC J of Trauma 2008;68:S28-37



**Table 2** Bleeding Control, Tourniquet vs. No Tourniquet

	Tourniquet (%)	No Tourniquet (%)	<i>p</i> *
No bleeding on arrival	83.3	60.7	0.033
No bleeding on arrival (injuries requiring primary or debridement amputations)	92	50	0.058 (NS)
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No bleeding on arrival (lower extremity injuries)	83	72	0.308 (NS)
No bleeding on arrival (ISS >15)	85	17	<0.0001

# Outcomes

- ✦ No significant difference between groups regarding need for blood transfusion
- ✦ There was no difference in mortality between the two groups
- ✦ Limited due to observational nature



# Recent Review

- ✦ The prehospital utilization of tourniquets is reviewed and encouraged
- ✦ Good reading for EMS providers, EM, and Trauma Surgery
  - ✦ Doyle G. PEC 2008;12:241-56



# Myths?

- ✦ Ischemia will be a problem
- ✦ Reperfusion will be a problem
- ✦ Neurologic damage will be a problem



## Routine EMS Tourniquet Use Algorithm

Significant Extremity Bleeding  
with need for other interventions?

Yes:

No:

Apply tourniquet to  
bleeding limb(s) on  
proximal segment

Transport 30 min expected?

Yes:

No:

Reassess  
for removal

Leave on  
and transport

# The Ten Bleeding Shunts

- ✦ Mean lowest SBP = 117
- ✦ Mean highest pulse = 86
- ✦ Mean estimated blood loss = 970
- ✦ Mean number of “soaked” towels = 2.5
- ✦ Mean number of hyperbolic terms in the narrative = 2.5



# Quotes from Charts

- ✦ **“Gently placed the tourniquet”**
- ✦ **“Did not completely cut off blood flow but tightened only to control bleeding”**
- ✦ **“Tried to release the shunt and the bleeding started again”**



# Patient # 9 – Case Report

- ✦ 58 year old female with PMH significant for ESRD with HD
- ✦ Femoral AV fistula was in place
- ✦ ~30 minutes prior to calling EMS, bleed from fistula began
- ✦ Blood was “on the gown, on the kitchen floor, in the bed room”



# Patient #9 Case Report

- ✦ Blood was “squirting 2 feet in the air” from the right upper thigh
- ✦ Initial assessment:
  - ✦ Respirations – agonal at 4 breaths/min
  - ✦ Pulse = 48 and weak at carotid
- ✦ Two minutes and 15 seconds after arrival, the tourniquet was in place



# Patient #9 Case Report

- Scene time <10 minutes
- After tourniquet placement:
  - Pulse increased from 48 to 84
  - Blood pressure increased to 78/58
  - Respirations increased from 4 to 18
  - SaO2 = 88%
- Patient alert and interactive after 8 minute transport to ED



# Summary

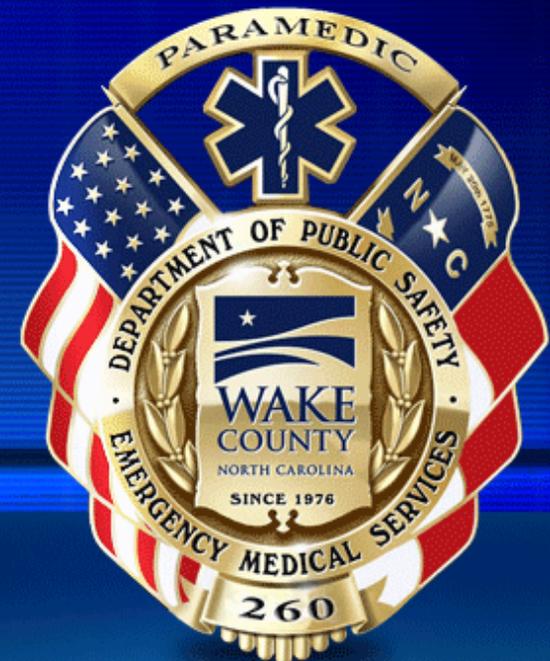
- ✦ Tourniquet use is inexpensive
- ✦ It can be lifesaving, and when it is not, it will help calm the EMS providers and the patient
- ✦ No demonstrable harm in the first 30 minutes





# What To Do with Refractory Ventricular Fibrillation?

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**“However beautiful the strategy, you should occasionally look at the results.”**

**-- Winston Churchill**



# The Plan

- ✦ Two Brief Case Reviews
- ✦ Review of the Evidence (and the Anecdote)
- ✦ A Modest Proposal



# Case #1

- ✦ 82 year-old male
- ✦ Pseudo-witnessed cardiac arrest in his home
- ✦ No bystander CPR but FR arrival in <6 mins

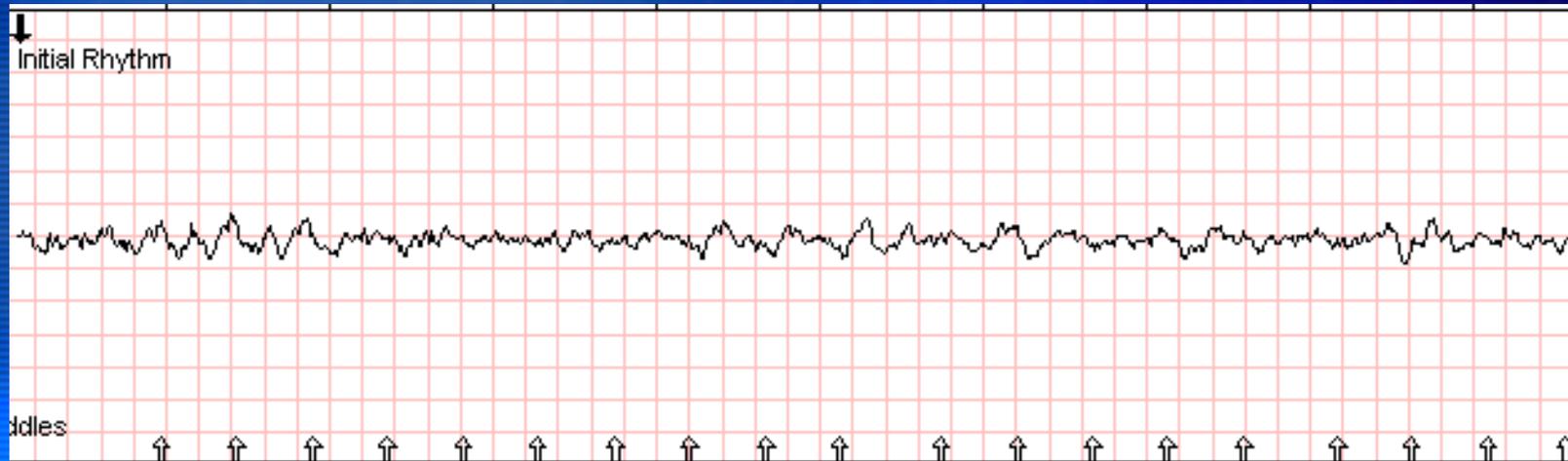


# Case #1

- ✦ Firefighters begin uninterrupted compressions
- ✦ AED advised shock and one is delivered prior to EMS arrival



# Case #1 Initial Rhythm

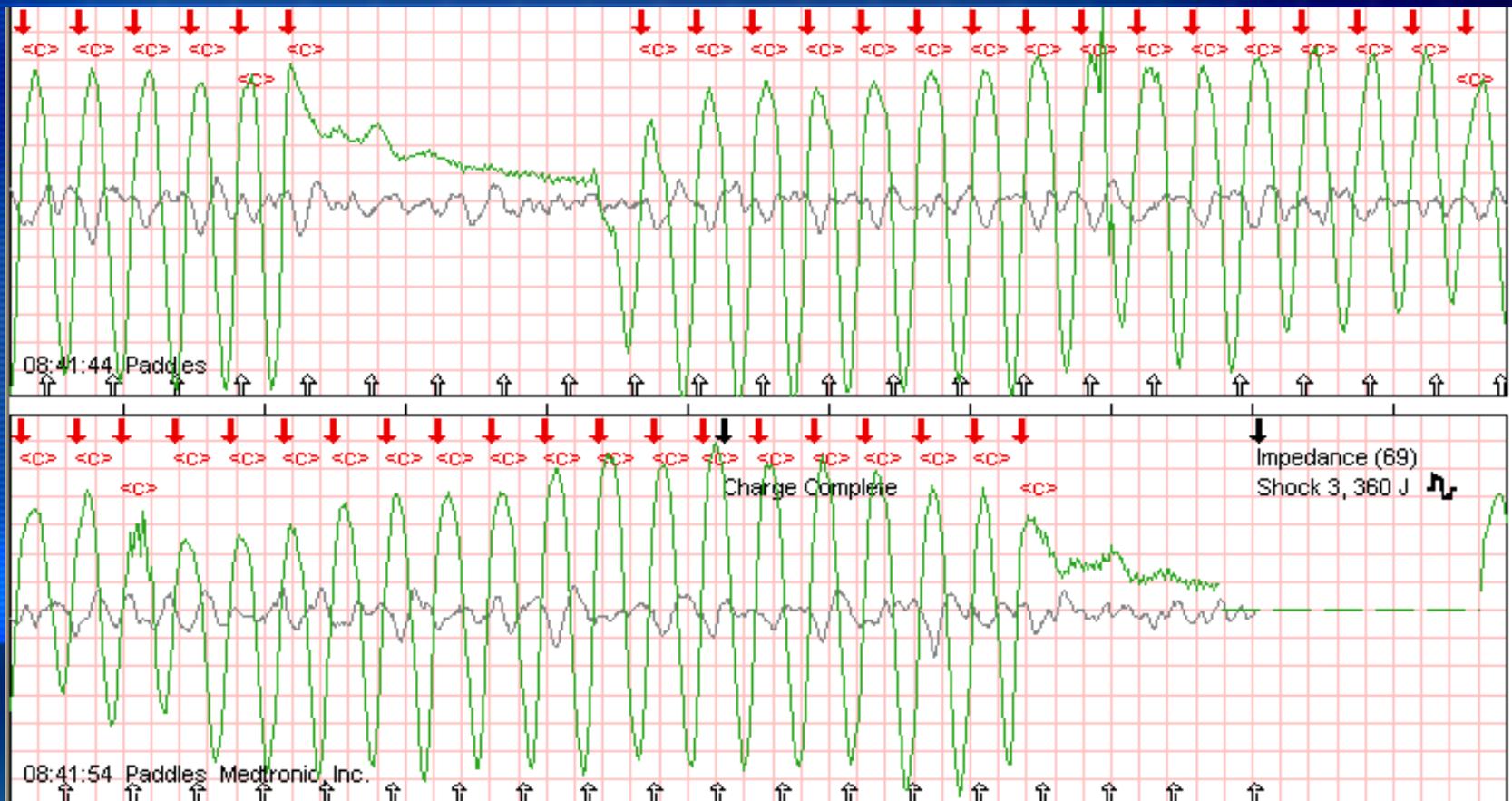


# Case #1

- ✦ EMS arrives just as first defibrillation is being provided
- ✦ BVM EtCO<sub>2</sub> = 44 with good wave form
- ✦ IO is placed in tibia
- ✦ King Airway is placed
- ✦ Vasopressin and epinephrine are administered



# Case #2 Third +10 mins

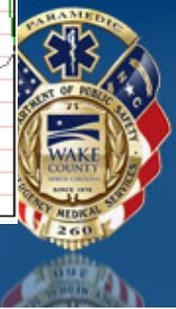


# Case #2

- ✦ Bicarbonate, amiodarone, procainamide are administered
- ✦ Magnesium is also administered
- ✦ At ~ 25 minutes, EtCO<sub>2</sub> = 35



# Case 1 Shock 7 +23 mins

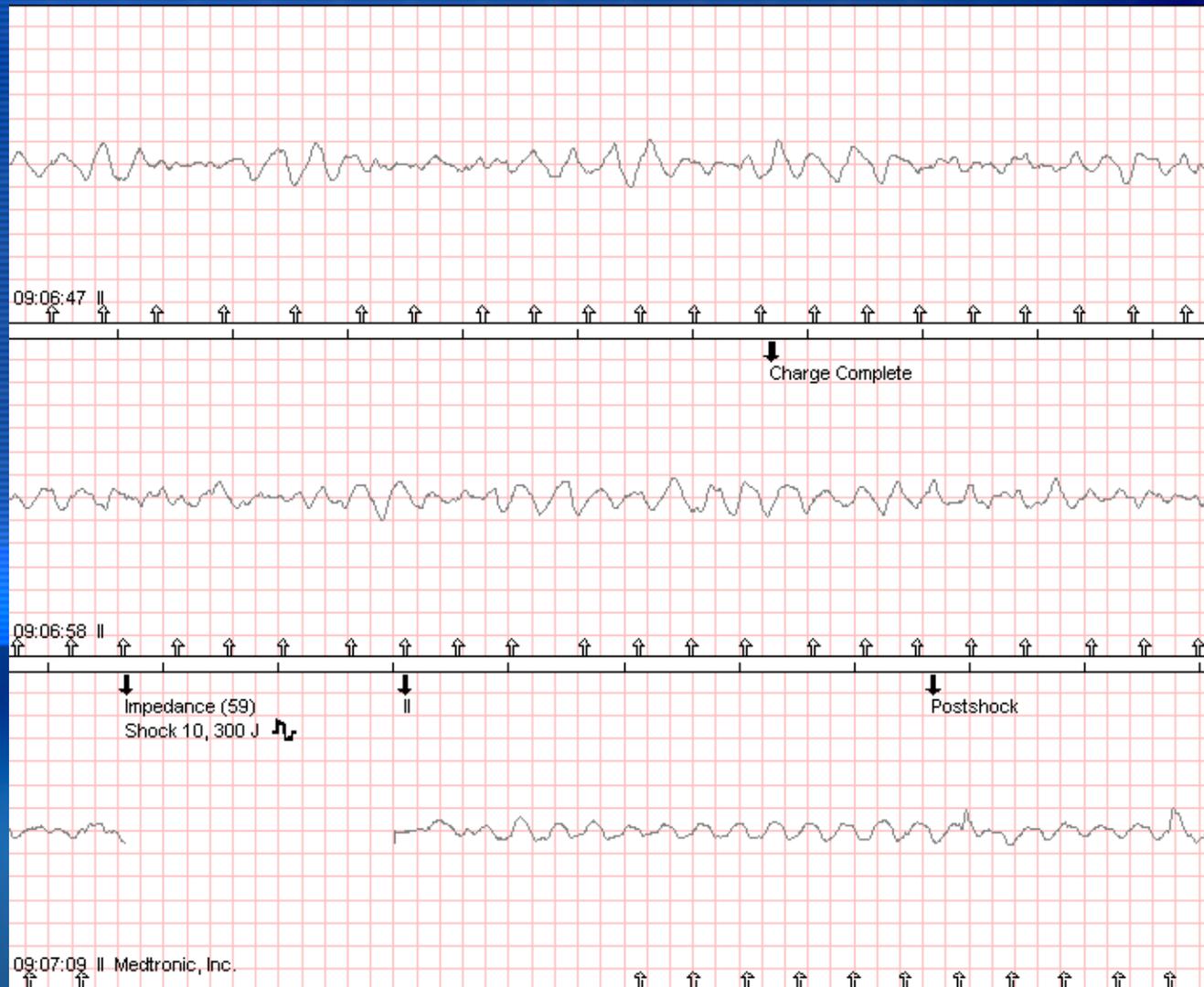


**Insanity: Doing the same thing  
Over and over again and  
Expecting different results**

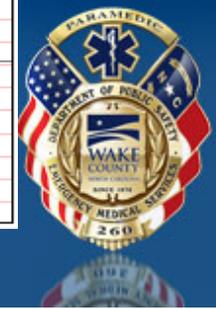
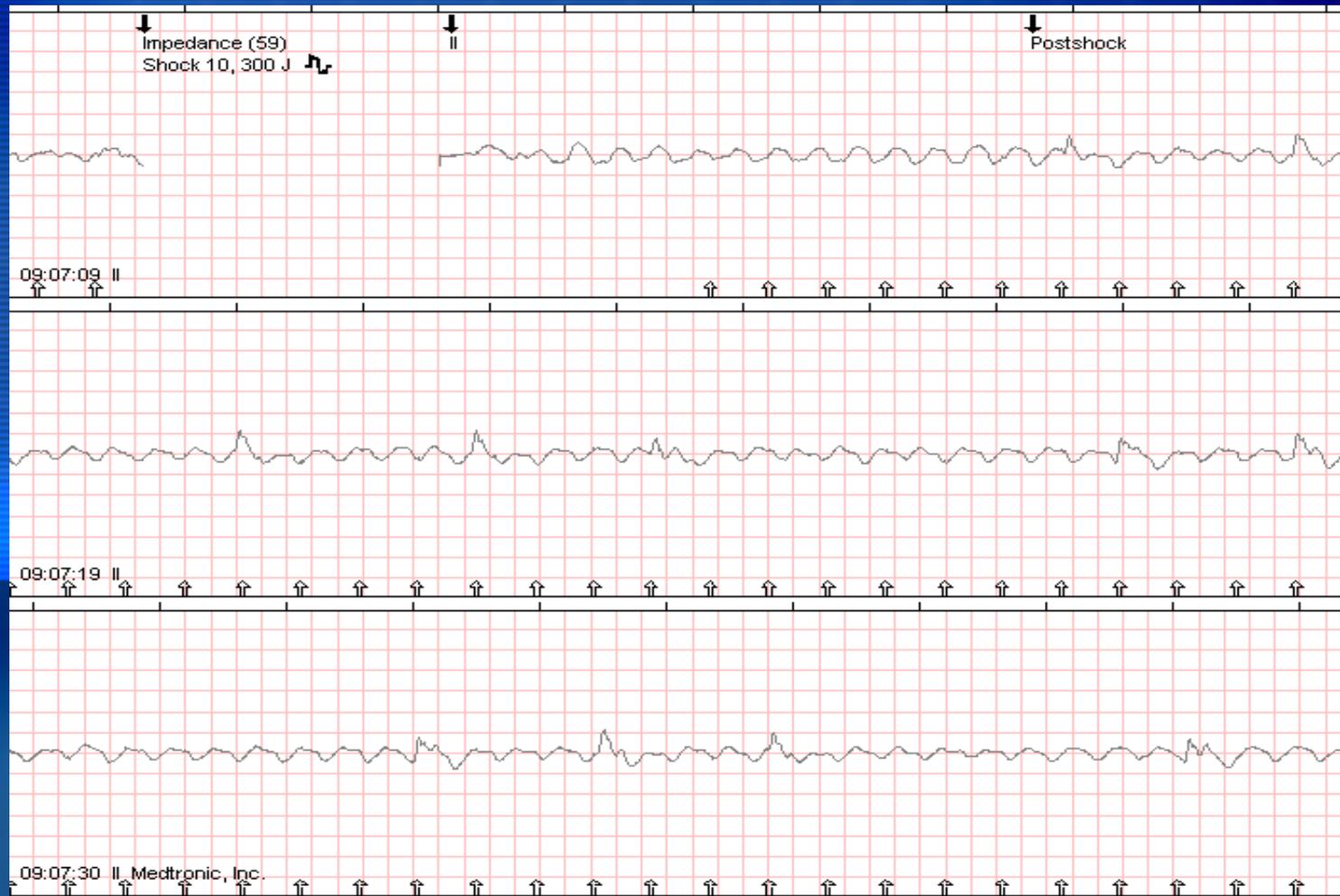
**-Albert Einstein**



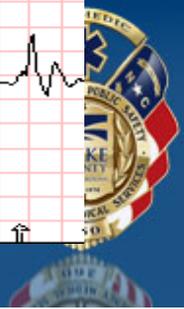
# +36 mins First DSED



# Case #1 DSED post-rhythm



# Case #1 DSED #1 Monitor #2



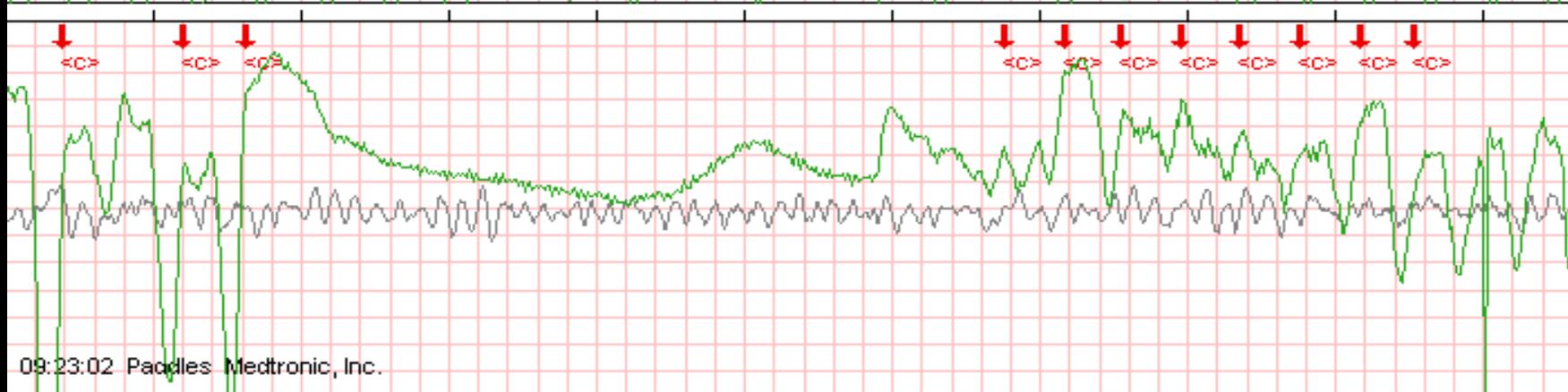
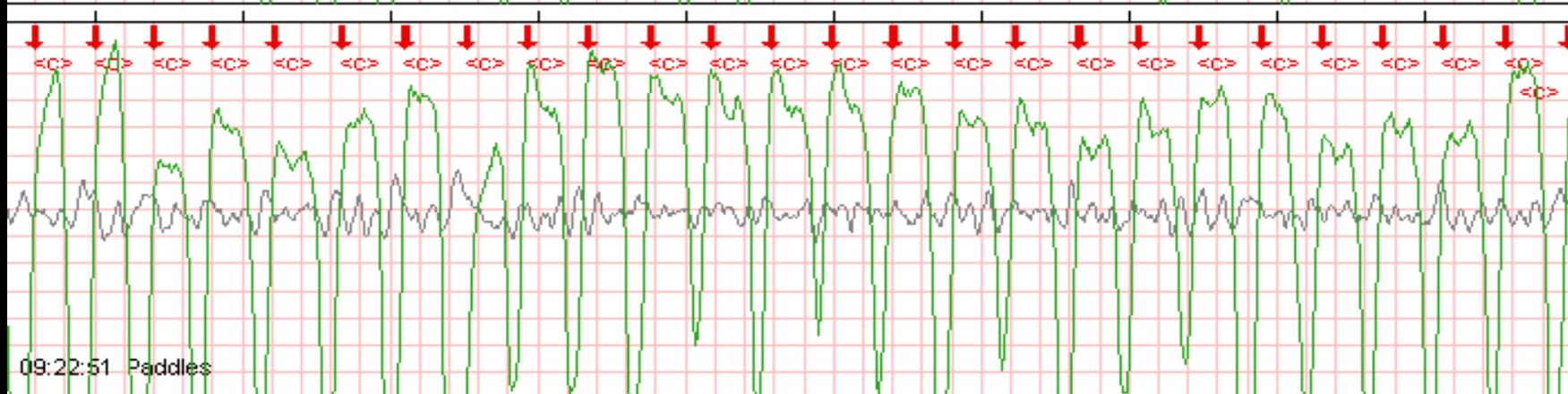
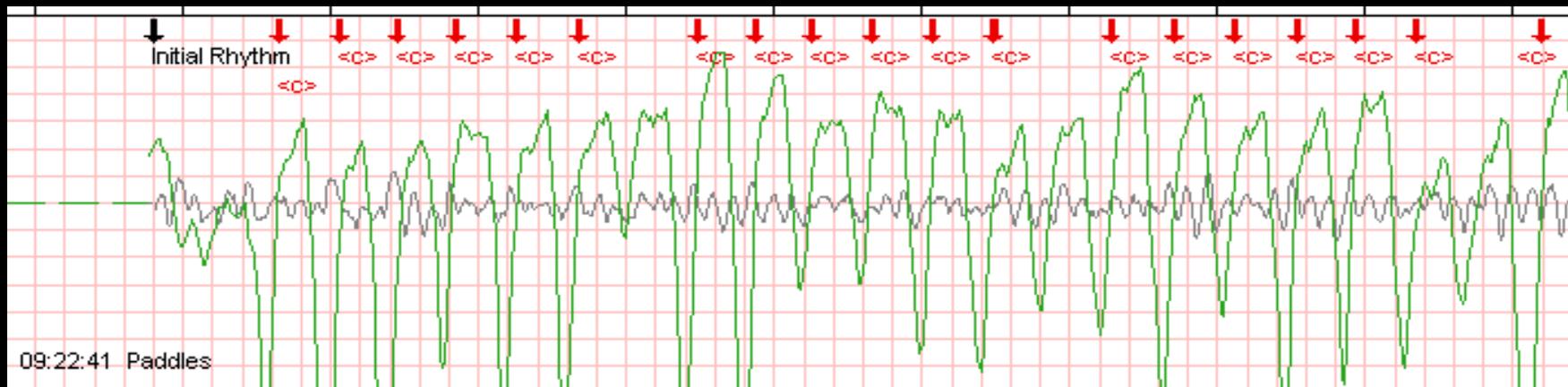
# DSED 5, Shock 15 +56 mins



# End of the Story

- ✦ Patient arrives in emergency department with EtCO<sub>2</sub> of 50 and good wave form
- ✦ After additional resuscitative efforts in the emergency department, work is terminated

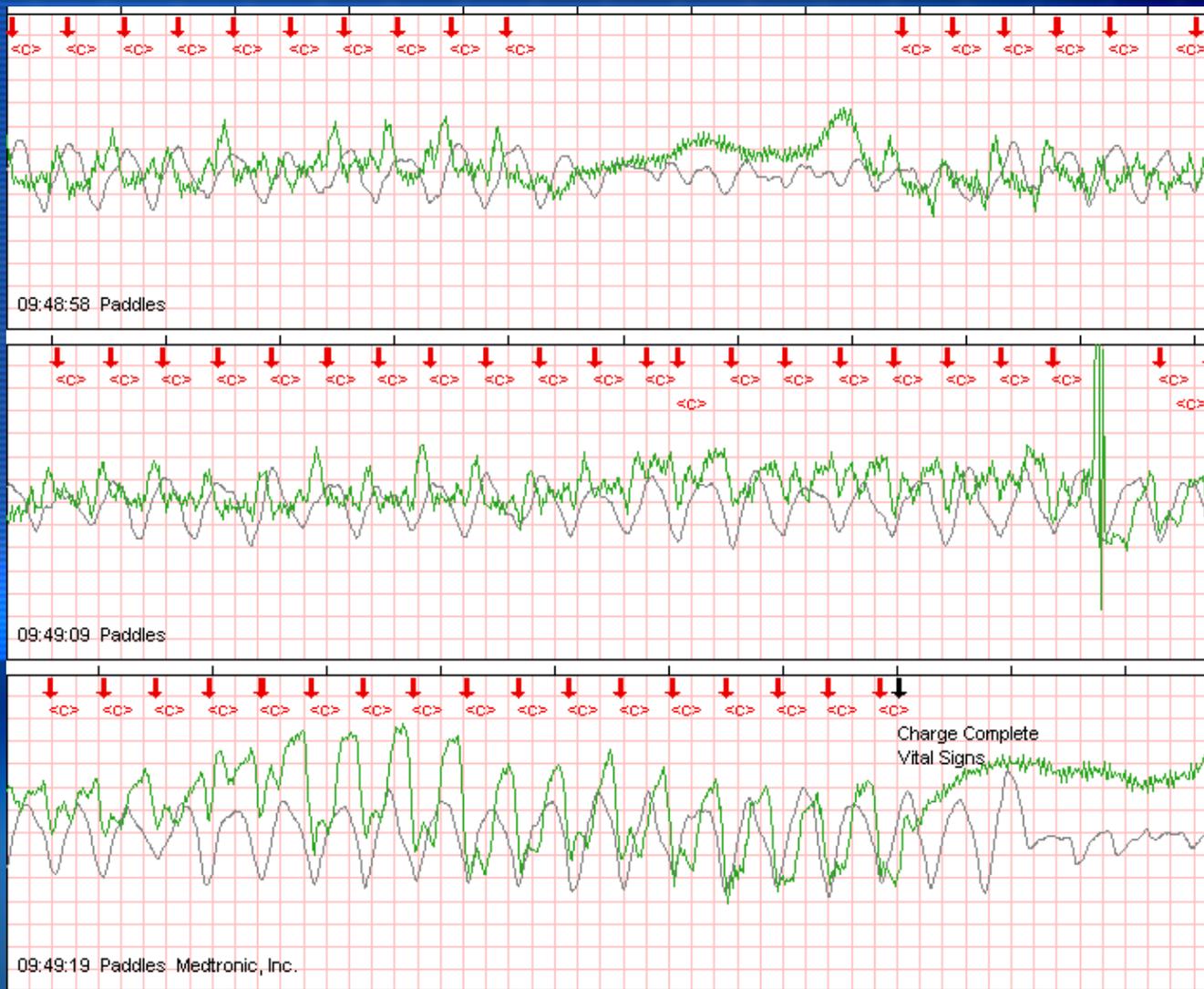




# Case #2 First Shock at + 103 seconds



# 9<sup>th</sup> shock at + 27 mins



# Vince's 12<sup>th</sup> shock, +38 mins (5 mins before transfer)



# Follow-Up

- ✦ Patient achieved ROSC shortly after arrival in the community ED
- ✦ Witnessed by ED staff and wife, patient had purposeful movement in an attempt to remove his ETT
- ✦ Prior to transfer for PCI, patient suffered repeat ventricular fibrillation arrest and could not be resuscitated



# A Little Evidence

## ✦ Observations:

- ✦ Refractory ventricular fibrillation is not new, particularly in the EP lab
- ✦ Current ACLS guidelines are superior to all previous ACLS guidelines
- ✦ The following discussion is “post-ACLS” and not “anti-ACLS”



# There Are Five Things

- ✦ **Electrical reversion at 200 wsec, 300 wsec, 360 wsec**
- ✦ **Intubation, hyperventilation, epinephrine**
- ✦ **Aggressive use of IV lidocaine with 360 wsec to follow**
- ✦ **Bretylium and magnesium IVP with 360 wsec to follow**
- ✦ **Repeat 360 wsec**

✦ Slovis and Wrenn, J Critical Illness, 1994



 Apply non-rebreather with 1 or more OPA or NPA as soon as other care activities will not be interrupted

<b>P</b>		<b>IO Procedure</b>	<b>P</b>
<b>I</b>		<b>Epinephrine 1 mg IV/IO repeat every 3-5 minutes</b>	<b>I</b>
<b>I</b>		<b>Vasopressin 40 U IV/IO</b>	<b>I</b>

 After 5 cycles of CPR check rhythm and pulse



 Repeat **Defibrillation**  
After defibrillation resume CPR without pulse check

<b>P</b>		<b>Amiodarone 1<sup>st</sup> dose is 300 mg and may be repeated once at 150 mg.</b>	<b>P</b>
<b>P</b>		<b>Sodium Bicarbonate</b>	<b>P</b>
<b>I</b>		Establish a secondary circulatory access point	<b>I</b>

 After 5 cycles of CPR check rhythm and pulse



 Repeat **Defibrillation**  
After defibrillation resume CPR without pulse check

<b>P</b>		<b>Magnesium Sulfate</b>	<b>P</b>
<b>I</b>		Consider <b>Epinephrine</b> drip	<b>I</b>



 Repeat **Defibrillation**  
After defibrillation resume CPR without pulse check

<b>P</b>		<b>Sodium Bicarbonate</b>	<b>P</b>
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 **Airway Protocol**



 Repeat **Defibrillation**  
Pause 5 secs max to check rhythm/pulse, resume CPR



# Recurrent – a Beta Blocker?

- ✦ The antiarrhythmic properties of beta blockade are often overlooked
- ✦ Like lidocaine, giving beta-blockade to prevent dysrhythmia or “clean up” PVCs in the ischemic heart appears unwarranted
- ✦ But what about “post-ACLS”?



# Why Might This Work?

- ✦ Block the deleterious effects of beta stimulation from exogenous epinephrine and/or endogenous catecholamines
- ✦ “Membrane stabilization”
- ✦ Class II antidysrhythmic properties
  - ✦ Bourque D et al. Resuscitation 2007;75:434-444



# Human Case Series

- ✦ 11 reports with 20 total observational patients in VF
- ✦ 17 patients with successful termination of VF (all 3 non-survivors in one series)
- ✦ 11 of 17 survived to discharge

Bourque D et al. Resuscitation 2007;75:434-444



# Can We Reach a Conclusion?

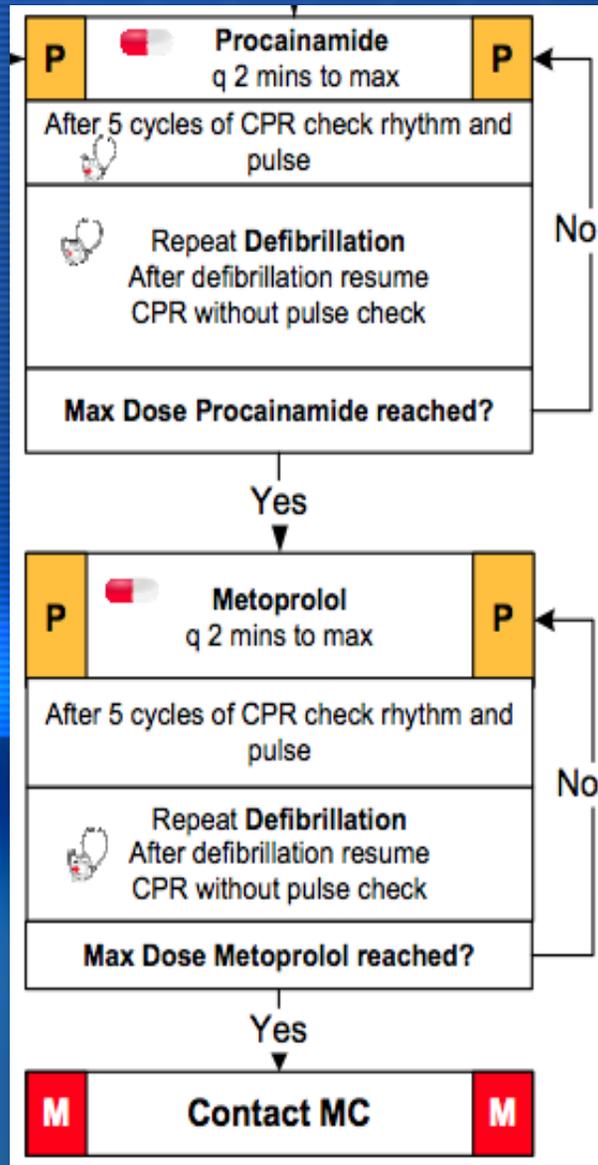
✦ NO

✦ Authors of literature review call for a randomized trial

✦ Meanwhile, we have individuals who are fibrillating “post-ACLS”



# Recurrent Pathway



# What About Persistent VF?

- ✦ Working hypothesis is that this is an electrical/mechanical problem
- ✦ Vectors, waveforms, and total energy each seem to play a role
- ✦ Not smart enough to talk about biphasic, reticulinear, etc.



# What Evidence Do We Have?

- ✦ **Atrial fibrillation patients**
  - ✦ **Propofol and up to 2 “standard” single monitor/defibrillator cardioversions were provided from April 1998 and January 2003**
  - ✦ **99 patients failed to cardiovert after these 2 standard cardioversions**
  - ✦ **They were enrolled in the study**



# What Evidence Do We Have?

- ✦ These 99 patients underwent Double Sequential External Cardioversion with each Defibrillator charged to 360J
- ✦ 66 were cardioverted on the first double attempt
- ✦ 14 were cardioverted on the second double attempt
- ✦ 81% of the 99 were successfully cardioverted



# What Evidence Do We Have?

- ✦ 12 month period to remain in NSR is similar between the “standard” and the “high energy” group
- ✦ No incidence of CHF, no significant burns, no other known complications in this study associated with higher-energy shocks
  - ✦ Alaeddini J et al. PACE 2005;28:3-7



# Does Higher Energy Cause Myocardial Damage?

- ✦ Atrial fibrillation patients who failed traditional cardioversion were enrolled in the study and treated with the “quadruple pad approach”
- ✦ Measured success of cardioversion, post-treatment CK-MB and troponin
  - ✦ Marroughe NF PACE 2001;24:1321-24



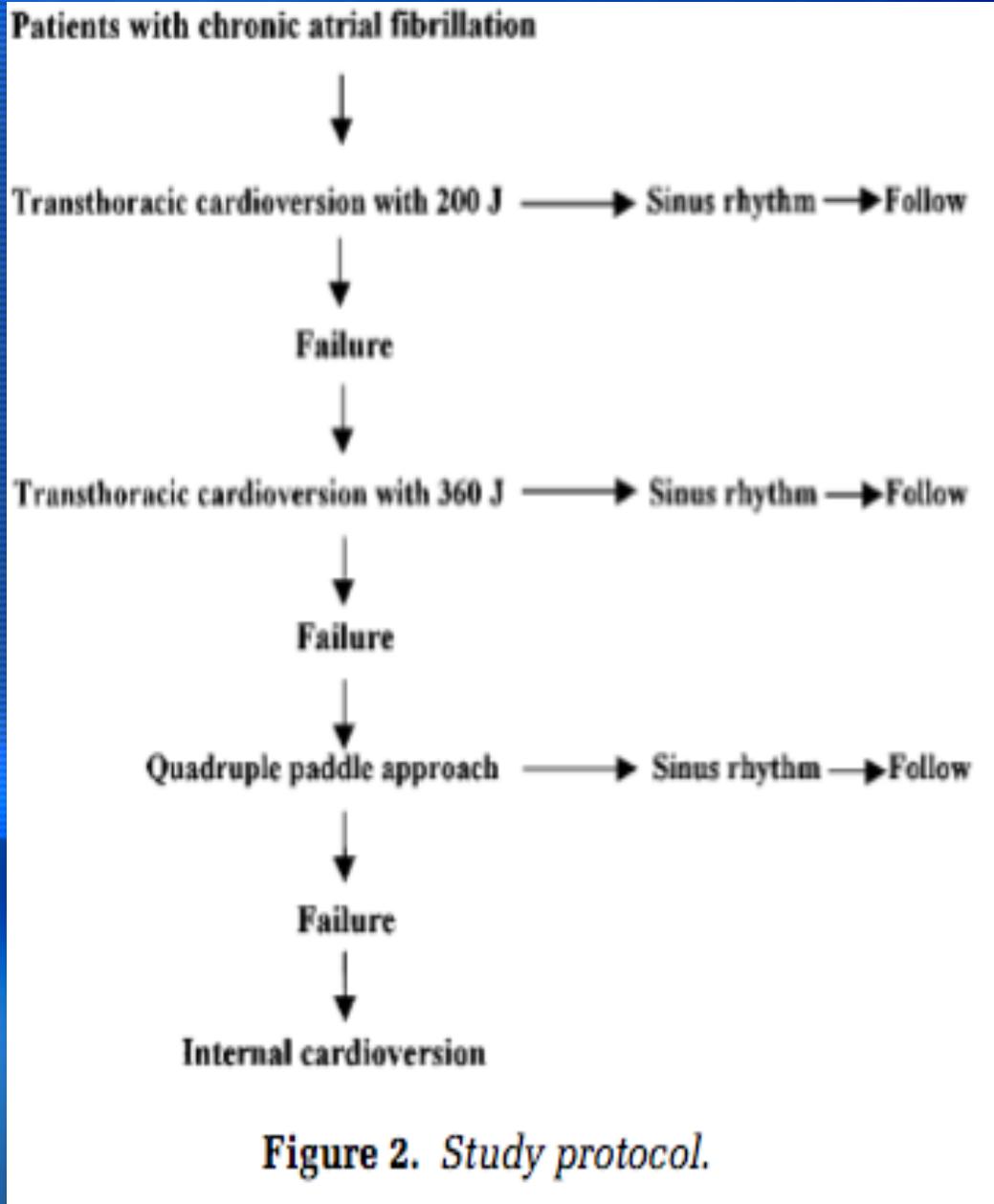


Figure 2. Study protocol.

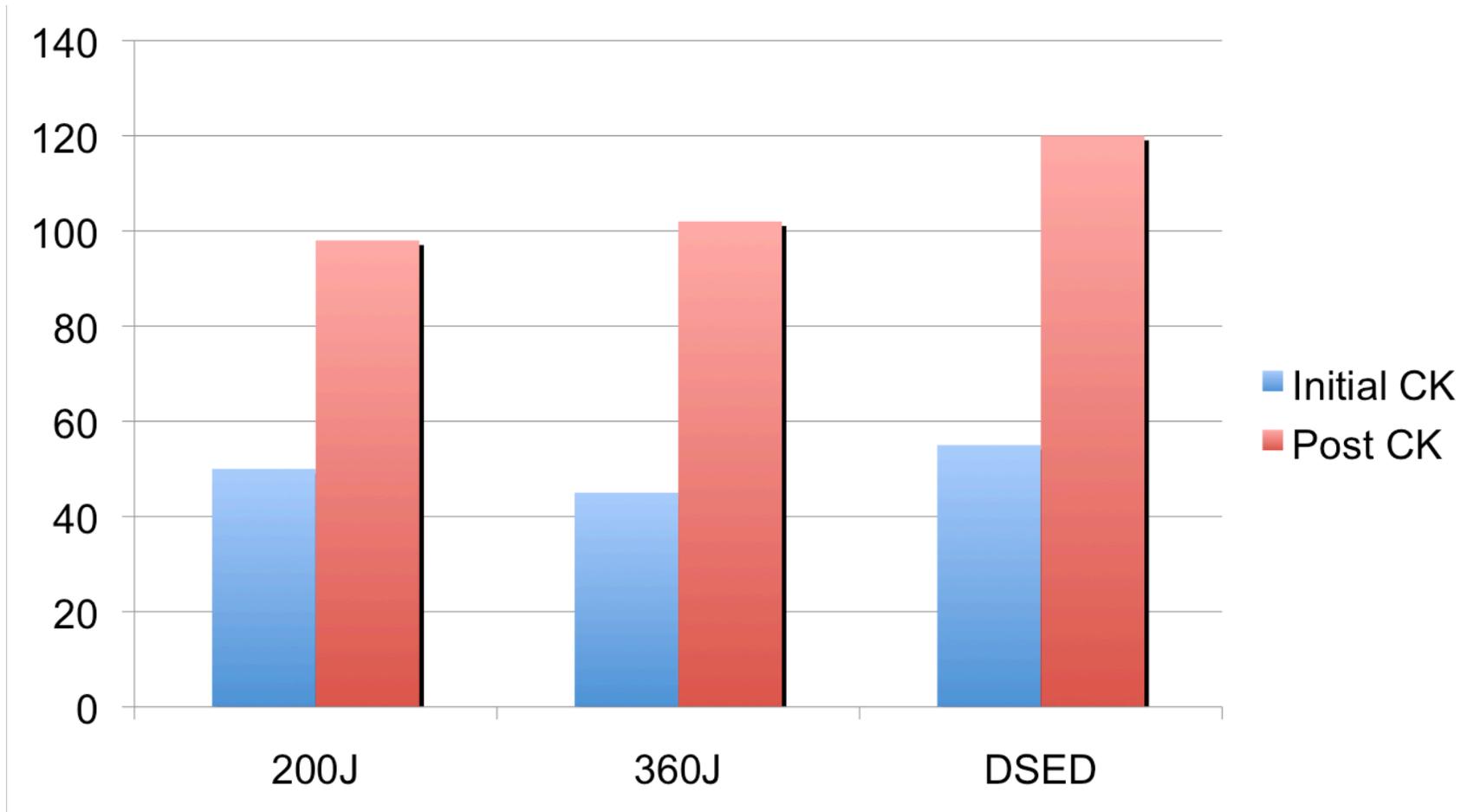


# Results

- + 46 patients failed chemical cardioversion
- + 27 of these were successfully cardioverted after 200J + 360J
- + 19 then underwent DSEC
- + 14 were successfully cardioverted
- + 4 of the remaining 5 failed transvenous cardioversion



# Results



# Here It Is – The Big Study

- ✦ 1994 study by Hoch et al
- ✦ 2,990 consecutive patients in 3 year EP lab experience with 5,450 total EP studies
- ✦ Treatment described was applied to 5 total patients



# What Did We Say About 5 Things?

- ✦ Pre-DSED attempts ranged from 7 to 20 attempts with single device
- ✦ VF, VT, WPW, and AF were dysrhythmias encountered
- ✦ EF ranged from 10 to 60%
- ✦ Range between defibrillations was 0.5 to 4.5 seconds

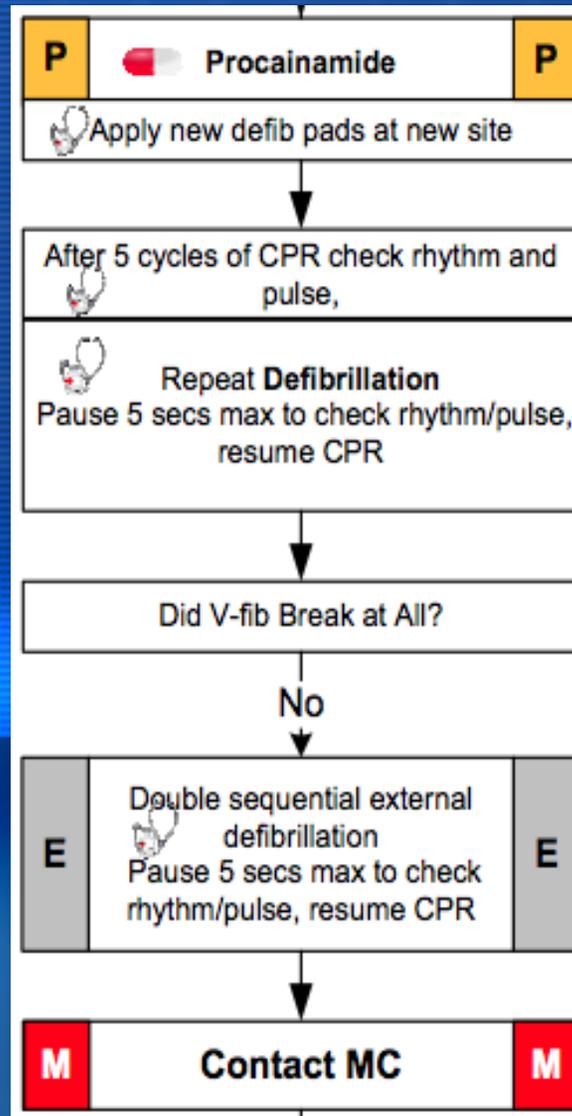


# So What Happened?

- ✦ All five patients were successfully cardioverted on the first DSED
- ✦ “This finding, combined with its ease and limited morbidity, warrants further study of this approach”
  - ✦ Hoch et al. J Am Coll Cardiol 1994;23:1141-5



# Persistent Pathway



# So What?

- ✦ Clearly, the greatest proportion of survivors are successfully defibrillated early (1 or 2 shocks) – 50% of our survivors never have an airway at all
- ✦ Should we, as Dr. Henry recently suggested, write off the rest?



# What We're Gonna' Do

- ✦ Continue with proven compression, minimal ventilation, and hypothermia strategy
- ✦ Add aggressive treatment for those patients who experience “post-ACLS” ventricular fibrillation



**Everybody gets so much  
Information all day long  
That they lose their  
Common sense**

**-Gertrude Stein**





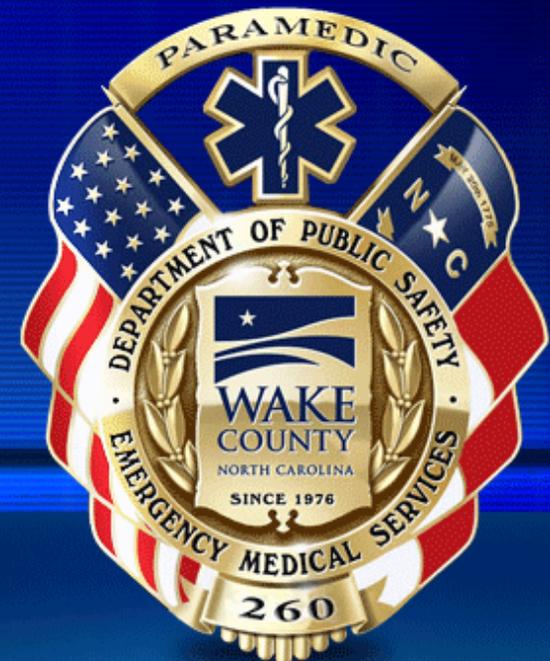
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# Causes of Renal Failure in North Carolina

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# Quotes from Charts

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- ✦ **“Did not completely cut off blood flow but tightened only to control bleeding”**
- ✦ **“Tried to release the shunt and the bleeding started again”**



# Patient # 9 – Case Report

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- ✦ Femoral AV fistula was in place
- ✦ ~30 minutes prior to calling EMS, bleed from fistula began
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- ✦ Initial assessment:
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  - ✦ Pulse = 48 and weak at carotid
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- Scene time <10 minutes
- After tourniquet placement:
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  - Respirations increased from 4 to 18
  - SaO2 = 88%
- Patient alert and interactive after 8 minute transport to ED



# Summary

- ✦ Tourniquet use is inexpensive
- ✦ It can be lifesaving, and when it is not, it will help calm the EMS providers and the patient
- ✦ No demonstrable harm in the first 30 minutes



