

**For Whom Will Shocking Duet do it?  
New Observations in Double Sequential  
Defibrillation Attempts**

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## Question

- What is the optimal electrical therapy for refractory ventricular fibrillation?

## Strategies In Treatment of Refractory Ventricular Fibrillation

Strategies	Effect
High performance + vasopressors CPR	Optimize coronary blood flow
Anti-arrhythmics	Decrease irritability of myocardium
Defibrillation Strategies	Optimize defibrillation
Fix the ischemia : AKA Coronary catheterization	Definitive treatment for ischemic VF
E-CPR / ECMO	Keeps patient alive until definitive therapy can be administered

# Double Sequential External Defibrillation

## Definition of Refractory VF

- **Refractory** VF/VTACH
  - Rhythm NEVER converted with defibrillation
  - Example : VF, VF, VF, VF
  
- **Recurrent** VF/VTACH
  - Rhythm converted successfully with defibrillation but recurred
  - Example : VF, PEA, VF, Asystole, VF

## Double Sequential Defibrillation: Proposed Mechanisms

- Vectors
  - Changing the orientation of electrical vector within the myocardium
- Coverage
  - Sequential pulses may apply a larger current density and more even distribution over the fibrillating myocardium.
- Duration of shock
  - Double sequential prolongs shock duration thus depolarizing more myocytes in different electrical phases
- More Energy

## Double Sequential Defibrillation: Background

Date	Author	Study	Conclusion
1994	Hoch	2,990 consecutive patients undergoing procedures in EP lab over 3 years.	5 patients with refractory VF with multiple shocks by single defibrillator. <b>All 5 successfully defibrillated on 1<sup>st</sup> attempt</b> with double sequential and all 5 survived.
2014	<b>Cabanas (Wake Co, NC)</b>	Retrospective case series 10 patients with OHCA (6-10 single shocks)	Successful conversion to normal rhythm in 7/10 patients. None survived however.
2014	Gerstein	DSD in IHCA	Successful defibrillation with DSD after 74 minutes of resuscitation
2015	<b>Lybeck (St. Louis, Mo)</b>	40 yo OHCA after striking against pole playing basket ball	DSD on 8 <sup>th</sup> attempt in ED. CT cardiac contusion to apex and distal lateral wall. <b>Cardiac catheterization revealed normal coronary anatomy.</b> DC with full neurological function.

## Double Sequential Defibrillation: Background

Date	Author	Study	Conclusion
2104	<a href="#">Leacock</a> (St. Louis, Mo)	51 yo male, STEMI, cardiac arrest, witness by EMS, BMI 40	5 normal energy shocks, DSD x 1, conversion, VT second DSD successful, Cath LAD, <b>stent</b> , balloon pump, DC alive with full neurological recovery
2016	<a href="#">Johnston</a> (Toronto, Ca)	28 yo female, witnessed arrest by husband, DSD on #7 shock, after 6 normal shocks, with ROSC	Remained stable in hospital, normal <b>Cath with normal coronary angiogram</b> , with severe hypokinesia and EF < 10% (later normalized), found to have prolonged QTc 594 milliseconds. DC to SNF with modified Rankin score 2 (but later improved to 1). Now caring for 16 month old daughter.

## Double Sequential Defibrillation: Background

Date	Author	Study	Conclusion
2016	<b>Cortez (Columbus, Ohio)</b>	Retrospective case series 12 patients with OHCA 2010 to 2014	Successful electrical conversion 9/12, ROSC 3/12, <b>3 DC alive</b> (2/3 with CPC score of 1 (good performance))



# Multnomah County EMS : ALS Response



# Double Sequential Defibrillation



## Multnomah County EMS Double Sequential Protocol

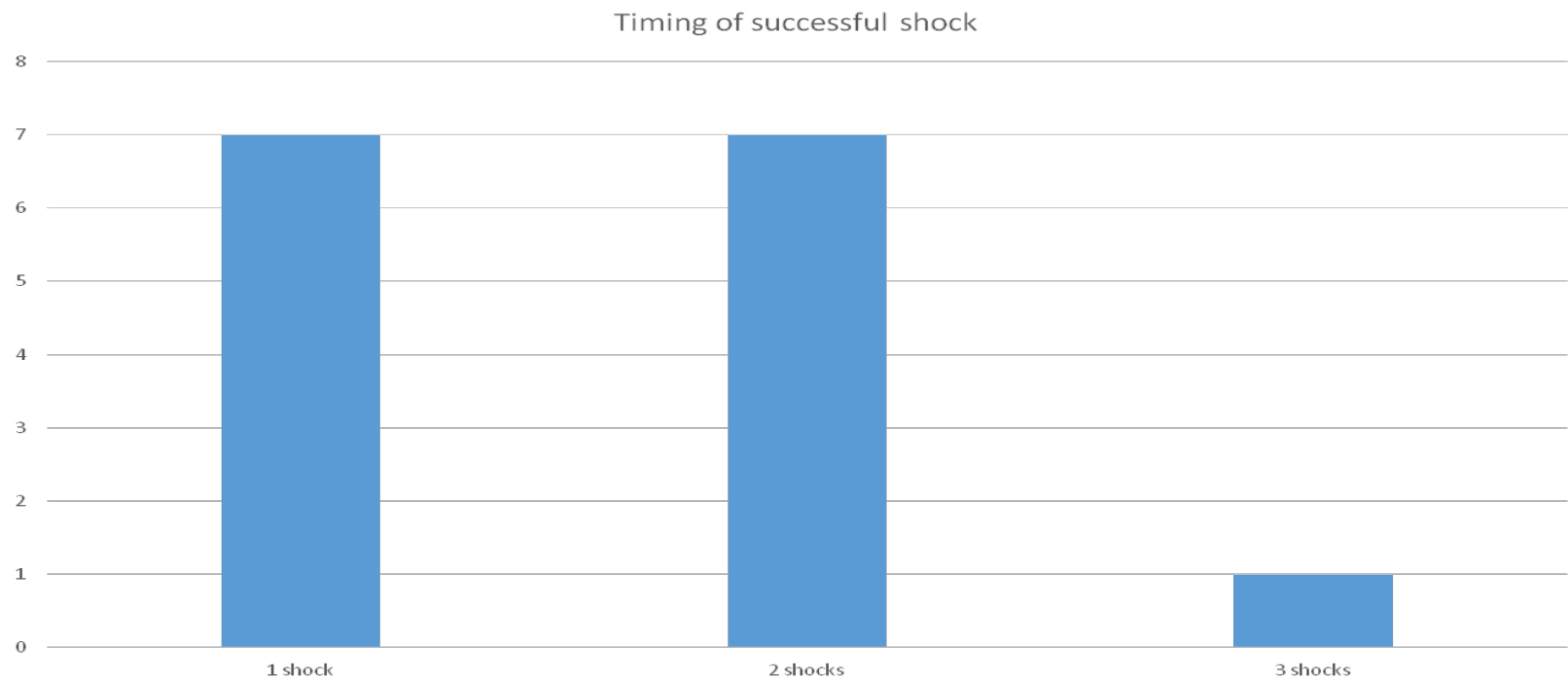
- Shock
  - EPI
- Shock
  - Amiodarone 300 mg
- Shock
  - Amiodarone 150 mg
- Shock
  
- If refractory, Double sequential
- (usually 5<sup>th</sup> or 6<sup>th</sup> shock)

## Double Sequential Defibrillation: Summary Outcomes 2014 - 2017

Outcomes	Number	Percent
Unsuccessful	19	53%
Electrical Success	23	47%
ROSC	15	31%
Total	48	100%

# MCEMS Double Sequential VF : ROSC cohort

## Number of Shocks Required



# Double Sequential Defibrillation: ROSC Patients

INC DATE	SEX	AGE	First Known Rhythm	Electrical Success	ROSC	last known Blood Pressure	Comments
1/9/2014	Female	54	Pulseless Electrical Activity	yes	YES	75 / 56	8 shocks total, 6,7,8 DS Success PEA
5/15/2014	Female	27	Ventricular Fibrillation	yes	YES		6 shocks total, #5,6 DS converted to SVT <b>Survivor</b>
8/16/2014	Male	79	Asystole	yes	YES	111 / 76	7 total shocks, #6,7 DS, Successf ROSC
9/29/2014	Male	78	Ventricular Fibrillation	yes	YES	195 / 94	7 Total, #5.6 DS, 7 SS Success PEA but back to VT
1/8/2015	Female	81	Ventricular Fibrillation	yes	YES		8 total shocks, #7,8 DS, VF to idiovent to <b>NSR Survivor</b>
4/20/2015	Male	47	Ventricular Fibrillation	yes	YES	106 / 84	7 total shocks, #7 DS, immediate organized rhythm <b>Survivor</b>
4/22/2015	Male	71	Ventricular Fibrillation	yes	YES	84 / 54	9 total shocks, #8,9 DS bradycardia with ROSC
5/21/2015	Female	62	Ventricular Fibrillation	yes	YES	161 / 128	4 total shocks, #4 ds VF to accelerated junctional ROSC
11/12/2015	Male	78	Ventricular Fibrillation	yes	YES		8 total shocks, #7 DS, #8 SS, PEA with ROSC
1/21/2016	Male	75	Ventricular Fibrillation	yes	YES	135 / 101	8 total shocks, #8 asystole converting to perfusing rhythm with BP
5/12/2016	Male	74	Ventricular Fibrillation	yes	YES		DS #5 to PEA, to ROSC, died in ED
6/17/2016	Female	50	Ventricular Fibrillation	yes	YES	121 / 95	5 SS 1 DS successful <b>Discharge alive moderate cerebral performance</b>
6/29/2016	Male	51	Ventricular Fibrillation	yes	YES	106 / -	5 total shocks, DS 4 and 5, NSR after #5. Lucas, <b>Discharge alive good cerebral performance</b>
7/3/2016	Male	87	Ventricular Fibrillation	yes	yes	93 / 30	DS #8 with ROSC, however transient PEA after #3 Admitted to hospital made DNR
12/6/2016	Male	80	Ventricular Fibrillation	yes	yes		VF arrest, DSD #6 to PEA, ROSC in ED, died in hospital

## Double Sequential Survivors N=5

	Initial Rhythm	Defib Sequence	ROSC	Outcome
27 yo F	VF	4 single shocks, 2 DSD, converted on 2nd	Yes	Discharge alive, Cath normal ICD
81 yo F	VF	6 single shocks, 2 DSD converted on 2 <sup>nd</sup>	Yes	DC alive, K = 2.0, normal coronary arteries
47 yo M	VF	6 single shocks, 1 DSD shock converted on 1 <sup>st</sup> shock	Yes	DC alive, non “obstructive CAD”

## Double Sequential Survivors N=5

	Initial Rhythm	Defib Sequence	ROSC	Outcome
50 yo F	VF	5 single shocks, 1 DSD, converted on 1st	Yes	Discharge alive (moderate CNS) Cath normal ICD, ICD
51 yo M	VT	3 single shocks, 2 DSD converted on 2 <sup>nd</sup>	Yes	DC alive, normal coronary arteries, arrhythmogenic RV cardiomyopathy, ICD



## Summary

- Double Sequential Defibrillation may be a viable therapy option for patients in refractory VF cardiac arrest.
- Our data currently indicate that most patients who will convert will convert by the 2<sup>nd</sup> shock.
- The vast majority of our patients who survived were **young, witnessed cardiac arrest and had normal coronary arteries.**
- DSD should be **integrated with aggressive definitive intervention** (Cardiac Cath/E-CPR) when appropriate.

**The END**