HOW TO SURVIVE ELECTRICAL STORM

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OUTLINE

• What is electrical storm?
• Case intro
• ACLS
• Approaches to management
  • Dual axis defibrillation
  • Beta blockade
• Case summary
• Take home points
ELECTRICAL STORM

- Persistent VF or VT which does not resolve with standard ACLS protocol
- Varying definitions in the literature

- Gao et al. listed numerous definitions from the literature, citing sources which define electrical storm with varying durations of VF/VT, number of defibrillations, time between recurrent episodes of VT/VF, number of episodes of VF/VT (ranging from “at least four” to “at least 20”).

- Cabanas et al. performed a retrospective case series defining refractory VF as persistent VF following at least 5 unsuccessful single shocks, epinephrine administration and a dose of antiarrhythmic medication.

- Eiffling et al. defines ES as 3 or more sustained episodes of Vf/VT or appropriate ICD shocks within a 24 hr period. (Sustained VF/VT refers to at least 30 seconds, hemodynamic instability, or unresolved without intervention.)
CASE REPORT

- 67 yo male presents to the ED for evaluation of chest pain and has witnessed VF cardiac arrest.
- High quality CPR initiated and subsequent ACLS protocol without ROSC.

ACLS PROTOCOL
Keys to successful resuscitation using ACLS protocol.

1. Early defibrillation

2. High quality CPR with minimal interruptions

IMPROVING ACLS

Utilization of End Tidal CO2 monitoring
- Ensures quality of CPR
- End tidal CO2 of >10 (ideally 12-15) indicates high quality CPR

Arterial line placement
- Diastolic BP of <40, then give 1 mg epinephrine if within the 3-5 min as per ACLS
- Diastolic BP >40, do not administer dose of 1 mg epinephrine
EPINEPHRINE PITFALLS

• Beta stimulation in addition to the desired alpha stimulation.
• Increased myocardial oxygen demand due to increased chronotropy and inotropy.
• Decreased VF/VT threshold.
• Increased myocardial dysfunction.

WHEN ACLS FAILS, WHAT NEXT?

• Two approaches to consider
  • Dual axis defibrillation
  • Sympathetic blockade
DUAL AXIS DEFIBRILLATION

• There are theories why VF/VT sometimes doesn’t respond to single defibrillator shock.
  1. vector of energy across myocardium (i.e. pad placement)
  2. energy required to defibrillate 95% of the myocardium (i.e. habitus)

• Ultimately the goal of dual axis defibrillation is to reset the electrical activity of the myocardium.
DUAL AXIS DEFIBRILLATION

• Hoch described double sequential external shocks as a successful intervention for refractory v-fib as early as 1994. These five cases, all performed in the electrophysiology suite, had standard single axis defibrillator shocks administered over twenty times without success, but were converted back to a normal sinus rhythm after dual-axis defibrillation.

• In 2013, Leacock described the first case of successful RVF conversion in the ED after failure of ACLS protocols with two dual-axis defibrillation shocks.

• In 2015, Cabañas reported on ten cases of refractory VF treated with double sequential external defibrillation in the prehospital setting. Three of these patients had return of spontaneous circulation (ROSC), but none survived to discharge with their protocols.

SYMPATHETIC BLOCKADE

- Beta blocker use has been studied since the 1960s in cardiac arrest, and is known to decrease VF and sudden cardiac death after MI.

- Nademanee et al. compared sympathetic blockade in ES with beta blocker or left stellate ganglion blockade (LSGB) to standard ACLS guidelines

- Driver et al. wrote a retrospective observational analysis of 25 patients in RVF
  - Compared patients who received esmolol to those who did not
  - Required at least 3 defibrillation attempts, 300 mg amiodarone, and 3 mg epinephrine for inclusion
SYMPATHETIC BLOCKADE

- Nademanee et al. found increased survival rates at 1 week (21 of 27 treated with sympathetic blockade and 4 of 22 treated with standard ACLS protocol) and 1 year.

- Driver et al. found 6 of 25 received esmolol and all 6 achieved at least temporary ROSC
  - 4 of 6 had sustained ROSC with 3 surviving to hospital DC with good neurologic outcome
  - Compared to 19 of 25 did not receive esmolol, 6 sustained ROSC and 2 surviving to DC with good neurologic outcome

Nademanee et al; Treating Electrical Storm Sympathetic blockade versus advanced cardiac life support-guided therapy
CASE SUMMARY

• Patient found to be in refractory VF/electrical storm.
• Second set of defibrillation pads applied in AP fashion with dual simultaneous shock administered of 300J from each device.
• No change from VF; CPR continued.
• 80 mg esmolol administered and allowed to circulate with a round of CPR; esmolol drip at 0.1 mg/kg/min.
• Second dual axis shock administered with ROSC and pulse ox 90%.
• Intubation attempted and patient yelled, “Stop that!”
CASE REVIEW

• Post ROSC EKG showed STEMI and patient was taken to cardiac cath.
  • LAD stented and ultimately patient discharged home neuro intact 3 days later.

• This case is quite unique in that it describes the first successful use of dual-axis defibrillation and esmolol administration with the patient surviving to outpatient follow up.

TAKE HOME POINTS

• Refractory VF/VT
  • Consider Electrical storm and think outside of the box.

• Dual Axis Defibrillation
  • “Reset” the electrical activity of the heart through multiple vectors and higher energy.

• Suppress adrenergic response with Beta Blockade
  • Decrease VF/VT threshold
  • Decrease myocardial O2 demand
THINGS TO CONSIDER

• Although there have been no doubled-blinded randomized control studies supporting use of dual axis defibrillation and beta blockade, literature available shows benefit to patient outcomes using dual axis defibrillation and beta blockade.

• Consider use of dual axis defibrillation in conjunction with beta blockade as a last stitch effort for patients in electrical storm.

REFERENCES


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