ELECTRICAL STORM

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WHAT IS IT?

- Current Arbitrary Definition

- 2/3 or more separate VF/VT episodes leading to DCCV or ICD therapies (including ATP) in 24 hours
WHY DO WE CARE?

- Increased incidence since AICD have become commonplace
- 10-30% of pts with ICD for secondary causes get it
- 4% of those with ICD for primary prevention (MADIT-II)
WHY DO WE CARE 2?

- Independent adverse prognostic factor (AVID, MADIT-II, Gatzoulis)
- At least 3 fold risk death/transplant/hospital in next 12 months
- Unclear if its the storm or the underlying pathology
WHY DO WE CARE 3?

- Pathophys and management from the storm EP literature can help inform ED management of refractory arrhythmias
WHAT CAUSES IT?

▸ STRUCTURAL HD

▸ ABNORMAL ELECTRICAL SUBSTRATE
STRUCTURAL HD

- IHD
- Non Ischaemic Cardiomyopathy (DCM, HCM, ARVC)
- Valvular
- Infiltrative: Sarcoidosis, Chagas, myocarditis)
- Congenital
ABNORMAL ELECTRICAL SUBSTRATE

- Primary
  - Idiopathic
  - Brugada
  - ER
  - LQTS, SQTS
  - CPVT

- Secondary
  - Electrolytes
  - Toxins
  - Endocrine eg TFT
  - Periop CSx
  - R on T pacing
Issue with standard ACLS is Storm Rx can be vastly different depending on cause

- eg High dose B Blocker vs chemical pacing
- eg Amiodarone in LQTS
- eg Verapamil in WPW
BUT HERE'S YOUR PROBLEM

- Working out which one it is can be very difficult during a recurrent arrest situation

- Use a management strategy based on likely cause from rhythm, POCUS, ECG
THUS

- Check known PHx
- Do a bedside echo ASAP
  - best in sinus but obvious abnormality seen even in arrhythmia
- Do a blood gas
- Check an ECG ASAP (hopefully sinus)
EADs (Early After Depolarisations): secondary depol occurring before full repolarisation. Happen when AP prolonged (eg loss of Repol K+ currents)

DADs (Delayed) when elevated Ca2+ load increases Protein Kinase II activity eg tachycardia or Beta Adrenergic stim. If big enough, INa is activated and a new AP occurs

Automaticity: spontaneous AP generation

Re-entry: Needs vulnerable substrate and a trigger
MONOMORPHIC VT IN STRUCTURAL HD

- Most common storm
- Usually re-entry (myocardial scars)
- Often focal ectopy from DAD (enhanced by Beta adrenergic activity)
- Standard Rx is Class 1 Na+ blockers but not as good if bad LV, so Amiodarone used
- However given sympathetic role, B1 blockade is important e.g. esmolol
- RSI/sedation can also suppress sympathetic activity
WHAT IF DRUGS DON'T WORK

- RFCA is the indicated next step
- 3D mapping to find area of substrate first
- 4% major complication rate
MONOMORPHIC VT IN ICD

- ATP (burst overdrive pacing) prior to internal defib
- ATP most appropriate to avoid unnecessary shocks particularly for fast VT
MONOMORPHIC VT IN NORMAL HEARTS

- Rare: “Idiopathic VT”
- Usually Outflow tract VT (LBBB) or Fascicular VT (narrow RBBB)
- OT-VT is usually cAMP mediated DADs. cAMP increased by sympathetic stimulation.
  - Rx thus B blockade or Ca2+ 1st or Class III 2nd. RFCA 3rd
- F-VT usually verapamil responsive. 2nd: RFCA
POLYMORPHIC VT/VF IN STRUCTURAL HD

- IHD most common cause (if no LQT)
- Revascularisation is a priority
- B blockade or stellate ganglion sympathetic denervation is better than Class 1 agents.
- Amiodarone still a useful agent and is first line
- In heart failure patients, Amiodarone by its effect on I(KAS) currents seems best
POLYMORPHIC VT/VF IN STRUCTURALLY NORMAL

- Rare but includes all the genetic causes
- Most important group for DDx
LONG QT SYNDROME

- Usually Torsades rhythm (T de P = polymorphic VT + long QT)
- Congenital vs Acquired
- Caused via EADs (early after depolarisations)
  - Fix electrolytes ASAP
  - Magnesium safe but ?effective
- Beta blocker 1st line in congenital, Verapamil may be second line
- Temporary overdrive pacing works in acquired because bradycardia prolongs QT. Beta Blockers may worsen acquired
BRUGADA

- Storm can be brought on by fever, hypoK, bradycardia and high vagal tone
- VT/VF caused by loss of AP dome in RV epicardium leading to STE and reentry
- Class 1 agents worsen this but quinidine OK
- Isoprenaline reduces STE and recovers AP dome (also used in Early Repolarisation)
OTHER

- CPVT: normal ECG
- Bidirectional VT (alternating RBBB and LBBB)
- Rx with IV Beta Blockers (dec Ca2+ and DAD)
- 2nd line verapamil. 3rd line left cardiac sympathetic denervation
- Idiopathic VF: Verapamil
BUT NOTHING IS WORKING

- ECMO:
  - Main use is as a bridge to getting RFCA done or surgical sympathetic blockade
  - May also have a role in toxic causes when storm is time dependent or as a bridge to transplant
Fig. 1. Management of electrical storms. AAD = antiarrhythmic drugs; CPVT = catecholaminergic polymorphic ventricular tachycardia; CSD = cardiac sympathetic denervation; ERS = early repolarization syndrome; ICD = implantable cardioverter defibrillator; LQTS = long Q-T syndrome; OT-VT = outflow ventricular tachycardia; PM-VT = papillary muscle ventricular tachycardia; QT-P = short QT syndrome; VT = ventricular tachycardia.
TAKE HOME MESSAGE

- Rx of Storm is sympathetic blockade
- Only exceptions where this is likely to be unhelpful is Brugada and Acquired LQTS
- Does Adrenaline still make sense??
- see Should Adrenaline Use Be Arrested? and Sudden Cardiac Death for more!
REFERENCES

- Amazing summary of management

- Very Detailed Pathophysiology

- Relatively simple overview
THANKS