TiCMe

TIME CRITICAL MEDICAL EDUCATION

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 managment 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

MANAGEMENT

- 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

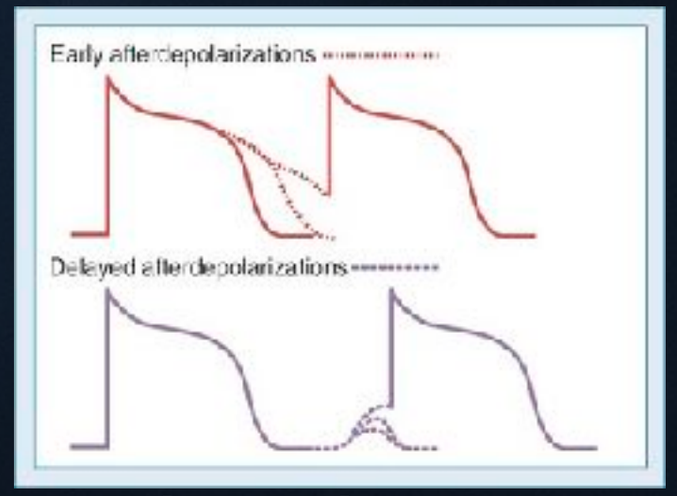
BUT HERE'S YOUR PROBLEM

- 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)

TINY BIT OF ELECTROPHYSIOLOGY NERDY STUFF



- 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 ysmpathetic 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. c AMP 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

Recurrent VT/VF (≥2 episodes or ≥3 appropriate ICD therapies during 24 hours) or shock-refractory VT/VF

Electrical or pharmacologic cardioversion/defibrillation
Sedation, respiratory, and circulatory assistance if necessary

Medical and drug history
12-lead ECG, transthoracic echocardiography
Routine labs (electrolytes, thyroid function, etc.)

Structurally normal heart

Monomorphic VT

OT-VT
PM-VT
Annular VT
Focal Purkinje VT

Beta-blockers
Ca^{2+} antagonists
Class IC or III AADs
Ablation

Fascicular VT

Verapamil
Ablation

Polymorphic VT/VF

Congenital LQTS

Beta-blockers
Magnesium
Verapamil
CSD
Late Na^+ blockade (LQT3)

Acquired LQTS

Discontinue offending drugs
Magnesium
Pacing

SQTS

Class IA or III AADs
Isoproterenol

Brugada syndrome, ERS

Isoproterenol
Quinidine
Cilostazol, bepridil
Ablation (Brugada)

CPVT (Normal baseline ECG)

Beta-blockers
Verapamil
CSD

IVF (Normal baseline ECG)

Verapamil
Ablation

Structural heart disease

Monomorphic VT

Beta-blockers
Procainamide (unless heart failure)
Class III AADs
ICD reprogramming
Ablation
CSD

Polymorphic VT/VF

Ischemic heart

Beta-blockers
Amiodarone
Revascularization
Ablation
CSD

With QT prolongation

Discontinue offending drugs
Magnesium
Pacing

Heart failure

Amiodarone
Beta-blockers
Heart failure treatment
Ablation

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 QT syndrome; OT-VT = outflow ventricular tachycardia; PM-VT = papillary muscle ventricular tachycardia; SQTS = short QT syndrome; VF = ventricular fibrillation; 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

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THANKS

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