Detecting and Managing Ventricular Arrhythmias (from Wearable Patches, WCDs, to ICDs and Ablation)

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Lecture Outline

• Detecting Ventricular Arrhythmias
  • ECG
  • Holters and Event Monitors
  • Smartwatches
  • ILRs

• Managing Ventricular Arrhythmias
  • WCDs
  • ICDs
  • Antiarrhythmic Therapy
  • Ablation
ECG

• First diagnostic test in a pt with a stable wide QRS complex tachycardia on a monitor

• VT is the most common dx for adults with underlying structural heart disease

• Criteria supporting VT include: AV dissociation, a QRS complex >0.14 s, monophasic R wave in aVR, specific QRS morphologies, the absence of an RS complex in all precordial leads, and an RS interval >100 ms in at least 1 precordial lead

• Exceptions occur!

• For patients with preexisting bundle branch block, comparison with ECG during sinus rhythm is important
ECG

- ECG may indicate the presence of structural heart disease such as prior MI or chamber enlargement, or it may provide evidence of the underlying substrate for the arrhythmia.

- It may also reveal evidence of inherited arrhythmia disorders: long QT syndrome, Brugada syndrome, and ARVC.

- Microvolt T wave alternans and the signal averaged ECG are inconclusive, as such these tests are not routinely used.

- Exception is the potential use of signal averaged ECG in patients with ARVC.
Ambulatory ECG Monitoring

• A Holter monitor or an event recorder is helpful in diagnosing suspected arrhythmias, establishing their frequency, relating them to symptoms, and assessing the response to treatment
• VT is occasionally documented
• A Holter recording is appropriate when symptoms occur at least once a day or when quantitation of PVCs/NSVT is desired
• Adhesive patch monitors can record for weeks and allow for continuous short-term 1-lead monitoring and patient activation for symptoms
• Studies have shown satisfactory patient compliance, and arrhythmia detection - with some monitors, detected arrhythmias are not discovered until the patch is returned for analysis
• Importantly, when the suspicion of VA in a patient is high, outpatient monitoring is inappropriate
Smartwatches

- Multinational cardiovascular remote cohort study coordinated at the UCSF
- 9750 participants enrolled in the Health eHeart Study and 51 patients undergoing cardioversion at the University of California, San Francisco, were enrolled between February 2016 and March 2017.
- 9750 participants enrolled in the remote cohort.
- There were more than 139 million heart rate measurements on which the deep neural network was trained.
- Sensitivity was 98.0% and specificity was 90.2% for AF.
- Exploratory analysis of persistent AF in ambulatory participants, the sensitivity was 67.7% and specificity was 67.6%.
- Study found that smartwatch coupled with a deep neural network can passively detect AF but with some loss of sensitivity and specificity against a criterion-standard ECG.

Tison et al. JAMA Cardiology 2018
ILRs

• Provide continuous rhythm monitoring and stored recordings of EGMs based on patient activation or preset parameters, allowing a prolonged monitoring period of a 2-3 years

• In patients with sporadic symptoms, including syncope, implantable recorders are useful in diagnosing serious tachyarrhythmias (including VA) and bradyarrhythmias

• Generally reserved for patients in whom other ambulatory monitoring is nonrevealing

• A 25% added yield in diagnosis has been described after an unrevealing event monitor

• In a study of patients with syncope, the ILR had a greater diagnostic yield than “conventional” testing with external monitoring, tilt table testing and EP study
Echo

• Assessment of global and regional function, valvular fcn, along with assessment for adult congenital heart disease is required in patients with VA or SCD, including patients with cardiomyopathy, HF, prior MI, family history of cardiomyopathy or SCD, or an inherited structural heart disease associated with SCD.

• LVEF is a strong, independent predictor of SCD and cardiovascular mortality and a determinant of eligibility for ICD implantation for primary prevention of SCD.

• In SCD-HeFT (the Sudden Cardiac Death in Heart Failure Trial), the benefit of the ICD was not dependent on the modality (i.e., echo, radionuclide angiography, or contrast angiograms) by which the LVEF was assessed.
Cardiac Imaging

- VA or SCA can be an initial manifestation of ischemic heart disease, cardiomyopathic processes, or myocarditis. Cardiac CT and cardiac MRI allow for evaluation of structural heart disease and assessment of LV and RV function including quantification of LVEF, LV mass and volume, valvular structure and coronary anatomy including anomalous coronary origins. Cardiac MRI can be useful in the evaluation for myocardial scar and infiltrative processes evident as late gadolinium enhancement (5-9). Cardiac MRI also provides high quality assessment of LV and RV function, size, and degree of fibrosis and is particularly useful in arrhythmogenic right ventricular cardiomyopathy and HCM.
Biomarkers

• Elevated levels of natriuretic peptides—B-type natriuretic peptide (BNP) or N-terminal pro-BNP—are associated with increased risk of SCA and appropriate ICD therapies, even after adjustment of LVEF and other risk factors.

• In an older adult population, higher baseline levels of N-terminal pro-BNP were associated with SCD over a 16-year follow-up period.

• Use of biomarkers has not been shown to be useful for selecting patients for ICDs.

• A study of 4431 patients found high-sensitivity troponin to be only weakly predictive of SCD.

• There are no data on whether high-sensitivity troponin can improve the current SCD prediction algorithms.
Genetic testing

• The decision to proceed with genetic testing requires discussion regarding the clinical use of the information to be obtained for both the proband and family members, as well as consideration of the important psychological, financial, employment, disability, and life insurance implications of positive genotyping.

• Genetic counseling generally occurs before proceeding with genetic testing, and is optimally provided by genetic counselors in collaboration with physicians.

• A combined approach of genetic counseling with medical guidance may appropriately balance the decision on an individual basis.
Cardiac Catheterization or CT Coronary

- Although randomized studies are unavailable, coronary angiography has an important role in establishing or excluding the presence of significant obstructive ischemic heart disease in patients with SCA or those with life-threatening VA.

- Recurrent polymorphic VT or VF can be due to ongoing myocardial ischemia that resolves with coronary revascularization.

- A coronary angiogram may not be warranted if a nonischemic cause of SCA is established.

- Coronary and CT angiography also have an important role excluding the presence of anomalous origin of the coronary arteries that may cause SCD.
WCD

• A wearable cardioverter-defibrillator:
  • External device to detect and treat VT or VF
  • Used for several months
  • 4 monitoring electrodes, 3 defibrillation electrodes, and a defibrillation unit
WCD Therapy for VF

• Randomized VEST trial was negative for mortality benefit from WCT use

• An important issue from the VEST trial was compliance

• Further work is needed to refine the WCD to realize the potential benefits
Defibrillators

- Defibrillation is highly effective in terminating life-threatening VA
- Transvenous ICD, a subcutaneous implantable cardioverter-defibrillator, a wearable cardioverter-defibrillator or an external defibrillator
- ICDs with epicardial sensing and pacing leads are still being implanted in some patients especially those with certain forms of congenital heart disease
- Robust data from high-quality RCTs support its use in various patient populations including survivors of cardiac arrest, patients with VT and structural heart disease, and patients with significant LV dysfunction.
The subcutaneous implantable cardioverter-defibrillator was designed to avoid the need for venous access and some of the complications of inserting transvenous lead(s) including pneumothorax, hemothorax, and cardiac tamponade.

- Consider for patients with limited venous access such as patients with ESRD.

- In a study of 27 patients with ESRD, the subcutaneous implantable cardioverter-defibrillator was not associated with an increased risk of procedural complications or inappropriate shocks.

- May be preferred in patients who are at high risk of infection, such as pts with a prior device infection, ESRD, diabetes mellitus, or who are chronically immunosuppressed.
SICD

- The subcutaneous implantable cardioverter-defibrillator is incapable of bradycardia pacing, biventricular pacing, or antitachycardia pacing.
- Pts who may need these interventions should not be offered a subcutaneous implantable cardioverter-defibrillator.
- Sometimes patients with SICDs need pacing; this can be performed as long as the pacing is not unipolar.
- Leadless pacing in this setting is under evaluation.
Ablation

• Catheter ablation is an important treatment option for patients with VA when antiarrhythmic medications are ineffective, not tolerated, or not desired by the patient

• Monomorphic VA usually have an origin or substrate that can be targeted for ablation

• Early studies in ablation of VF show promise

• Problems limiting ablation success include inability to induce an arrhythmia, or origin of the arrhythmia from an inaccessible location in the myocardium
VA Ablation in Patients with No Apparent Structural Heart Disease

- VA that are not associated with underlying structural heart disease or a genetic arrhythmia syndrome are commonly referred to as idiopathic.
- Most idiopathic VA are monomorphic and based on a focal mechanism of triggered activity or abnormal automaticity.
- Catheter ablation of idiopathic VA is usually accomplished with endocardial catheterization, though an epicardial approach through the coronary venous circulation or a subxiphoid pericardial puncture may occasionally be required.
Surgery for VAs

• Cardiac surgery as a standalone procedure for VT is rarely performed

• Has a role in some highly symptomatic patients, when antiarrhythmic medications and catheter ablation fails or are not possible

• Surgical ablation of tachycardia can also be performed at the time of other cardiac surgical interventions

• The procedure requires detailed characterization of the arrhythmia usually with preoperative imaging and mapping

• Best undertaken at centers and with collaboration between experienced surgeons and EPs.
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Ho, ..., Krummen. Heart Rhythm Case Reports
Thank you!

Questions?