Ventricular Arrhythmias

Overview:

The ventricles are the heart's least efficient pacemaker and normally generate impulses at a rate of 20 to 40 beats per minute.

The ventricles may assume responsibility for pacing the heart if:

- SA node fails to discharge
- impulse from SA node is generated, but blocked as it exits the SA node
- rate of discharge of SA node is slower than that of the ventricles
- irritable site in either ventricle produces an early beat or rapid rhythm

Ventricular beats and rhythms may originate from any part of the ventricles.

Premature Ventricular Contractions:

A PVC is an extra ventricular contraction consisting of an abnormally wide and bizarre QRS complex that originates in an ectopic pacemaker in the ventricles.

It occurs earlier than the next expected beat of the underlying rhythm and is usually followed by a compensatory pause.

Diagnostic Characteristics:

Heart Rate:
-that of the underlying rhythm

Rhythm:
-typically irregular when PVC's are present

Pacemaker Site:
-an ectopic pacemaker in the ventricles, specifically in the bundle branches, Purkinje network, or ventricular myocardium

-PVC's may originate from a single ectopic pacemaker site (Unifocal PVC's) or from multiple sites in the ventricles (Multifocal PVC's)

P waves:
-usually absent

PR Intervals:
-none with PVC because the ectopic beat originates in the ventricles

R-R Intervals:
-unequal when PVC's are present
-a full compensatory pause commonly follows a PVC because the SA node is not depolarized prematurely by the PVC

QRS Complex:

-QRS complex of the PVC typically appears prematurely before the next expected QRS complex of the underlying rhythm
-it is nearly always 0.12 second or greater in duration
-because of the abnormal direction and sequence of ventricular depolarization, QRS complex is distorted and bizarre and will appear different from the QRS complex of the underlying rhythm

Frequency and Pattern of Occurrence of PVC's:

1. Infrequent
   -less than 5 per minute

2. Frequent
   -five or more per minute

3. Isolated
   -occur singly

4. Group
   -two or more in succession
   -couplets
   -three or more is considered to be Ventricular Tachycardia

5. Repetitive
   -bigeminy
   -trigeminy
   -quadrigeminy

6. R-on-T Phenomenon
   -this is used to indicate that a PVC has occurred during the vulnerable period of ventricular repolarization (relative refractory period)
   -this may precipitate repetitive ventricular contractions and result in ventricular tachycardia or ventricular fibrillation

Cause of the Arrhythmia:

-increase in catecholamines and sympathetic tone (as in emotional stress)
-stimulants
-MI/myocardial ischemia
-CHF
-excessive administration of digitalis or sympathomimetics
-increase in vagal (parasympathetic) tone
-hypoxia
-acidosis
-hypokalemia
-hypomagnesemia

Clinical Significance:

-isolated PVC's in patients with no underlying heart disease usually have no significance and require no treatment
-in the presence of an acute MI, ischemic episode, or drug intoxication, PVC's may indicate the presence of enhanced ventricular automaticity, a reentry mechanism, or both, and my precipitate VT or VF
-PVC's may or may not produce palpable pulses

-Patients may be asymptomatic or complain of palpitations, a "racing heart", skipped beats, or chest discomfort

*these symptoms may be caused by the greater than normal contractile force of the post-ectopic beats or the feeling that the heart has stopped during the long pause after the premature complexes

-If PVC's are frequent, signs of decreased cardiac output may be present

Ventricular Tachycardia:

VT is an arrhythmia originating in an ectopic pacemaker in the ventricles with a rate between 110 and 250 beats per minute.

QRS complexes are abnormally wide and bizarre.

Diagnostic Characteristics:

Heart Rate:
-over 100 beats per minute, usually between 110 and 250
-VT exists if three or more consecutive PVC's are present
-the onset and termination of VT may or may not be abrupt

Rhythm:
-usually regular, but may be irregular

Pacemaker Site:
-ectopic pacemaker in the bundle branches, Purkinje network, or ventricular myocardium

P waves:
-may be present or absent
-if present, they have no set relation to the QRS complexes, appearing between the QRS's at a rate different from that of the VT
-P waves are difficult to detect in VT, especially if it s rapid

PR Intervals:
-none

R-R Intervals:
-may be equal or vary slightly

QRS Complexes:
-exceed 0.12 second
-usually distorted and bizarre, often with notching

Forms of VT:
1. Monomorphic
-VT with QRS complexes that are of the same or almost the same size, shape, and direction

2. Polymorphic
-VT where QRS complexes differ markedly in shape, size, and direction from beat to beat

3. Torsades de Pointes:
   -a form of polymorphic VT characterized by QRS complexes that gradually change back and forth from one size, shape, and direction to another over a series of beats
   -French for "twisting around a point"

Cause of Arrhythmia:
- -coronary artery disease (CAD) particularly in the setting of an MI
- -mitral valve prolapse
- -congenital heart disease
- -digitalis toxicity
- -PVC can precipitate VT if it falls in the relative refractory period
- -Torsades is prone to occur following administration of certain antiarrhythmics (quinidine, procainamide)

Clinical Significance:
- -may cause or aggravate angina, MI, or CHF
- -may produce hypotension or shock, SOB, CP, CHF, or decreased LOC
- -may terminate in VF or Asystole
- -reduction in cardiac output because atria do not regularly contract and empty

Ventricular Fibrillation:

VF is an arrhythmia arising in numerous ectopic pacemakers in the ventricles, characterized by very rapid abnormal fibrillation waves and no QRS complexes.

Diagnostic Characteristics:

Heart Rate:
- -no coordinated ventricular beats present
- -ventricles contract from 300-500 times a minute in an unsynchronized, uncoordinated, and haphazard manner
- -ventricles are "fibrillating" like a "bag of worms"

Rhythm:
- -grossly/totally irregular

Pacemaker Site:
- -sites are multiple ectopic pacemakers in the Purkinje network and ventricular myocardium

P waves:
- -none

PR Intervals:
- -absent

R-R Intervals:
- -none

QRS Complexes:
- -absent

Cause of Arrhythmia:
- -CAD (MI, ischemia)

-third degree AV block
-mitral valve prolapse
-cardiac trauma (blunt or penetrating)
-excessive digitalis, quinidine, procainamide
-hypoxia
-acidosis
-electrolyte imbalance (hypo and hyperkalemia)
-electrocution
-PVC can initiate VF

Clinical Significance:
-must be treated immediately with cardioversion
-fine VF can resemble Asystole (confirm arrhythmia in 2 leads)
-loose electrodes, patient movement, and muscle tremors can mimic VF **(TREAT PATIENT, NOT THE MONITOR!!)**

Idioventricular Rhythm (Ventricular Escape Rhythm):

Idioventricular rhythm is an arrhythmia originating in an escape pacemaker in the ventricles with a rate of less than 40 beats per minute.

Diagnostic Characteristics:

Heart Rate:
-less than 40 beats per minute (usually between 20-40 per minute)

Rhythm:
-usually regular, but may be irregular

Pacemaker Site:
-an escape pacemaker in bundle branches, Purkinje network, or ventricular myocardium

P waves:
-usually absent
-can appear after the QRS (no set relation with QRS) (+ or -)

PR Intervals:
-absent

R-R Intervals:
-may be equal or may vary

QRS Complexes:
-exceed 0.12 second and are bizarre
-T wave is frequently in opposite direction of QRS complex

Cause of Arrhythmia:
-electrical impulses from SA node, atria, and AV junction fail to reach the ventricles because of a sinus arrest, SA exit block, or complete AV block
-when an electrical impulse fails to arrive in the ventricles within 1.5 to 2 seconds, an an escape pacemaker in the ventricles takes over at its inherent firing rate of 30-40 beats per minute

-**This is also called agonal rhythm, appearing just before asystole.**

Clinical Significance:
-generally symptomatic rhythm
-hypotension with marked reduction in cardiac output
-decreased perfusion of brain and other vital organs
-syncope
-shock
-CHF
-must be treated promptly with a pacemaker

Accelerated Idioventricular Rhythm:

Accelerated idioventricular is an arrhythmia originating in an ectopic pacemaker in the ventricles with a rate between 40 and 100 beats per minute.

Diagnostic Characteristics:

Heart Rate:
-40-100

Rhythm:
-essentially regular, but may be irregular

Pacemaker Site:
-ectopic pacemaker in bundle branches, Purkinje network, or ventricular myocardium

P waves:
-may be present or absent
-no relation to QRS complexes

PR Intervals:
-absent

R-R Intervals:
-may be equal or vary

QRS Complexes:
-exceed 0.12 second and are bizarre
-T wave is frequently in opposite direction of QRS complex

Cause of Arrhythmia:
-Acute MI
-when firing rate of dominant pacemaker or escape pacemaker becomes less than that of the ventricular ectopic pacemaker
-digitalis toxicity
-when sinus arrest, SA block, or complete AV block develops

Clinical significance:
-usually considered to be a benign escape rhythm
-if patient becomes symptomatic, treat with pacing

Asystole:

Ventricular asystole is the absence of all electrical activity within the ventricles.

Diagnostic Characteristics:

Heart Rate:
-absent

Rhythm:
-absent

Pacemaker Site:
-pacemaker site in ventricles is absent

P waves:
-usually absent, but may be present

PR Intervals:
-absent

R-R Intervals:
-absent

QRS Complexes:
-absent

Cause of Arrhythmia:
-advanced cardiac disease
-when dominant pacemaker (SA node) and/or escape pacemaker fail to generate electrical impulses
-when electrical impulses are blocked (3^{rd} degree) and an escape pacemaker in ventricles fails to take over
-Asystole is usually the final event that occurs after:
VT
VF
PEA
idioventricular rhythm