Common Cardiac Arrhythmias
By: Shawn Robinson

Introduction
- Interpretation of cardiac arrhythmias plays vital role in diagnosis of cardiac disorders
- Important for health care workers in emergency care to understand principles of cardiac monitoring
- Understanding of physiology of CV system, it is possible to identify arrhythmias and explain their effects
- This should lead to early detection of signs and symptoms, accurate diagnosis, and provision of appropriate treatment

Anatomy and Physiology
- Heart is a small, muscular organ, roughly size of your fist
- Located in thoracic cavity, immediately above diaphragm and between lungs
- Beats average 70 bpm, pumps more than 6,500 L of blood throughout day
- 2 main functions:
  - Circulate oxygenated blood to tissues via high pressure arterial circulation
  - Pump deoxygenated blood to lungs through low pressure venous circulation
- Heart consists of four chambers, left and right atria and the left and right ventricle
- Atria smaller than ventricles and have thinner walls
  - Atria serve as low pressure storage chambers rather than pumps
- Ventricles propel blood through pulmonary and systemic circulations and must be strong enough to overcome resistance
- Cardiac cycle – period from end of one heartbeat to the end of the next
- Heart contracts (systole) and then relaxes (diastole)
- Average heart rate of 70 bpm, each cardiac cycle lasts 0.8 seconds, with relaxation stage (0.5 seconds) slightly longer than contraction
- Action of heart valves important in maintaining cardiac function
- If valves become incompetent, leads to increased cardiac workload and decrease in efficiency, which if left untreated can lead to heart failure
  - Mitral and aortic valves most commonly affected
- Wall of the heart another important factor
  - Consists of three distinct layers: Endocardium (inner), Myocardium (middle), and pericardium (outer).
  - Endocardium made of endothelial tissue and lines the heart and also covers the valves
    - Also forms lining of vessels entering and leaving the heart
    - Smoothness of this tissue ensures smooth flow of blood and prevents turbulent flow
  - Myocardium made of highly specialized cardiac muscle, which allows generation of action potentials
- Dependent on oxygen for its energy requirement, and performance seriously impaired by oxygen deficiency
- Thickest in the ventricles, where sufficient force must be produced to pump blood
- The more the ventricle fills with blood, the further the muscle fibres are stretched, the greater force of contraction, and greater volume of blood ejected (Starling’s Law of Heart)
- In patients with heart failure or poor ventricular function, CO is compromised with increased volume in ventricle
  - Can result in inadequate pumping and pooling of blood in pulmonary and peripheral vasculature
- Outer pericardium provides fibrous covering around heart, holds in fixed position in thorax, and provides physical protection and barrier to infection
  - Consists of tough outer fibrous layer and thin inner serous layer
  - Fibrous layer is highly resistant to distension
  - Inner serous layer consists of visceral and parietal layers
  - Visceral layer (a.k.a. epicardium) covers heart and great vessels and lines fibrous pericardium
  - Between parietal and visceral layer is potential space called pericardial cavity which contains fluid
- Heart requires good blood supply to function effectively
- Knowledge of coronary circulation is essential
- Myocardium receives blood from left and right coronary arteries, which are from first branches of aorta
- Heart receives about 250 mL of blood per minute, with myocardial cells pulling more oxygen from blood than any other organ
- Most of blood received in myocardium during diastole

**Cardiac Conduction**
- Comprises sinoatrial node (SA), atrioventricular (AV) node, bundle of His, left and right bundle branches, and Purkinje fibres
- Electrical activity of heart can be examined by electrocardiogram (ECG)
- Impulse initiated in SA node
  - These cells are autorhythmic – ability to generate action potential spontaneously
- SA node sets HR and known as the pacemaker
- From SA node, current conducted across atrial myocardium in radiating pattern, causing atria to contract (atrial systole)
  - This produces the P wave on the ECG
- After flowing through atria, electrical impulse reaches AV node, low in right atrium
- Conduction delayed slightly to allow time for atria to fully contract
  - This conduction time is noted as the P-R interval
- Impulse then enters ventricular septum and bundle of His, which divides into right and left bundle branches
• Bundle branches terminate in finely branched Purkinje fibres embedded in ventricular myocardium
• Rapid conduction of impulse across ventricles results in ventricular systole
  o Depolarization indicated by QRS complex on ECG
• ST segment is transient period where no electrical current can be passed
  o Measured from end of S wave to beginning of T wave
• T wave is a representation of ventricles relaxing
• Cells of the AV node pace the heart at 40-60 bpm
• SA node has ability to generate fastest rate, and usually remains in control
• In SA node disease, a latent pacemaker will generate an escape rhythm

![ECG Diagram]

**Sinus Rhythm**
• P wave (spread of electrical depolarization through atria) lasts less than 0.11 s
• P-R interval (beginning of P wave to beginning of QRS complex) normally takes between 0.12s to 0.21s
• Q wave is the first negative deflection in complex
• R wave is first positive deflection
• S wave is negative deflection that follows
• Sinus rhythm defined as being a rate between 60-100 beats per minute
• Heart beat is regular and complexes identical

![ECG Strip]

**Assessing a Rhythm Strip**
• Displays and printouts from cardiac monitors only suitable for rhythm recognition and NOT diagnosis of MI
Disorders of Impulse Formation

Sinus Bradycardia

- Regular and originates in SA node, but the SA node discharges impulses at rate of less than 60 bpm
- Can be found in athletes and possibly during sleep
- Slow heart rate might be helpful in certain patients – such as those with MI
- Slow heart rates tolerable in people with healthy hearts
- Severe heart disease, the heart may not be able to increase SV to compensate for slow rate
  - Treatment required if patient becomes symptomatic
  - Symptoms include light headedness, fainting, chest pain, hypotension, dyspnea

Sinus Tachycardia

- Heart rate is between 100-180 bpm due to excessive discharge from SA node as result of vagus nerve inhibition, or sympathetic stimulation, or both
- All other ECG characteristics are the same as in Sinus Rhythm
- Usual response to stressors
- Because heart is beating faster, amount of time between contractions reduced, thus, ventricles don't have sufficient time to fill, and CO falls
- Often a sign of underlying problem that requires investigation

Sinus Arrhythmia

- Accepted phenomenon in young people caused by variations in parasympathetic activity on SA node during respiration
- Impulses originate in SA node, but the rate at which impulses appear varies
Atrial Fibrillation
- Can be permanent or paroxysmal
- Rapid chaotic depolarization of impulses, occurring throughout the atrial myocardium, replacing normal rhythmic activity in SA node
- Every minute 400-600 impulses reach the AV node form different atrial foci rather than the SA node, but only 120-180 of these will reach the ventricles to produce QRS
- Transmission of atrial impulses through AV node is erratic, making ventricular rhythm irregular
- Fast pace at which atria depolarize leads to failure of atria to contract effectively, causing them to quiver
- Patients often present with palpitations or symptoms of underlying cause
- If AF persists for more than 48 hours, stasis of blood in fibrillating atrium can lead to blood clot formation and systemic embolism
- Aim of treatment is to control ventricular rate, thereby optimizing cardiac function, reducing risk of embolism

Atrial Flutter
- Much less common than AF
- Almost always associated with underlying significant cardiac abnormalities
- Occurs when a single abnormal focus in atria discharges regularly at a rate of 250-350 per minute
- AV node unable to transmit all impulses, and usually a degree of AV block, as node acts as a gatekeeper
- Rapid atrial rate gives a characteristic ‘saw tooth’ appearance in the ECG

Ventricular Tachycardia
- Occurs when three or more ventricular extrasystoles occur in sequence
• Duration of V Tach varies from a few beats to many hours
• Often preceded by ectopic beats and evolves from a ventricular focus in right or left ventricle that depolarizes with a rate of 140-220 per minute
• Typically, beats that originate in ventricles produce wide QRS complexes
• P waves often buried in previous QRS
• P-R interval also unidentifiable
• Occurs in patients with organic heart disease
• Can quickly lead to heart failure and shock with pulmonary edema

Ventricular Fibrillation
• Rhythm of cardiac arrest
• occurs when parts of the ventricular myocardium depolarize in a chaotic manner, independently of each other
• Co-ordinated ventricular activity and muscular contraction ceases
• Irregular, chaotic and abnormal deflections of varying height and width are evident on ECG
• Coarse or fine, depending on appearance
• Baseline is irregular without any identifiable QRS
• Heart ceases to pump and after approximately ten seconds the BP drops and unconsciousness occurs
• If untreated, death will follow after three to five minutes
• Most common cause of sudden cardiac death

Disorders of Impulse Control
• Characterized by a delay or failure in impulse conduction from atria to ventricles
• Occurs on three levels

First-Degree AV Block
Atrial conduction is prolonged
- Impulse is delayed passing through the AV node to ventricles, resulting in prolonged P-R interval
- QRS complex follows every P wave and rhythm is regular
- Prolonged conduction time frequently found in athletes and older people

Second-Degree Heart Block
- Two types of second degree heart block
  - Mobitz Type 1
    - occurs when progressive increase in conduction time over several beats
    - Phenomenon repeats itself with a gradual prolonging of PR interval over 3-6 beats until an impulse is totally blocked, and P wave occurs without corresponding QRS
    - QRS irregular and often slow
    - Usually localized to AV node

  - Mobitz Type 2
    - Characterized by an occasional fdropped QRS complex without a preceding lengthening of P-R interval
    - Dropped beat can occur irregularly or regular
Third Degree AV Block

- Complete heart block
- Characterized by a complete or permanent cessation of AV conduction so that all impulses from above the AV junction are blocked
- Most cases, pacemaker function taken over by a focus below the block, heartbeat can then be sustained by impulses from area around AV node, or ventricles
- Nodal rhythm gives a rate of around 40-60 beats, while ventricular rhythm gives 30-40 bpm
- If this escape rhythm does not develop, ventricular standstill will occur and fatal if not treated
- Atrial rate might be normal and regular, and ventricular rate might also be regular, but impulse transmission between the atria and ventricles is absent
- P wave does not preceded a QRS complex on ECG

Conclusion

- With a better understanding of physiology of heart and electrical conduction system, the cardiac arrhythmias can be better understood
- Effective patient care and intervention depends on accurate assessment, observation, and recognition

Summary

- Cardiac arrhythmias are quite complex and difficult to understand, but breaking down the anatomy, physiology, and electrical conduction of the heart, allows us to understand them better
- A good understanding of the cardiac arrhythmias and the ability to recognize these rhythms on a monitor can increase the efficiency to which we treat such problems
- As dental professionals, it is important that we understand the rhythms and their characteristics in order to identify these quickly and be able to inform the attending team upon arrival

Reference