Chapter 11: Arrhythmias and Cardiac Emergencies

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Arrhythmia interpretation and care of patients experiencing acute cardiac events is a foundational competency required of registered nurses working in critical care. The aim of this chapter is to provide a resource for critical care nurses internationally that will assist with recognition of key characteristics of sinus, atrial, junctional, ventricular arrhythmias and atrio-ventricular (AV) blocks. In addition, evidence-based care will be discussed in relation to symptomatic arrhythmias and cardiac emergencies such as myocardial infarction and cardiac arrest. The chapter will conclude with practice questions and a case study. Helpful websites and further resources will also be provided. The intention of the chapter is to provide an

overview of the key components of basic arrhythmias and a summary of treatment. The chapter is designed to accommodate learners that have a good understanding of cardiac anatomy and physiology in addition to an introductory level of understanding of cardiac arrhythmias.

Arrhythmia Interpretation: Where do I start?

The first part of accurately interpreting arrhythmias is to use a *Systematic Approach* (see Figure1). However, before you begin to analyze the rhythm strip, ALWAYS check the patient first and ensure the patient is stable.

Table 1. ***Systematic Approach to Interpreting Arrhythmias***

Steps	***Explanation***
1. Regularity	*Assess whether the rhythm is regular or irregular*
2. Rate	*Calculate ventricular and atrial rate*
3. Assess p waves	*Are the p waves: rounded, symmetrical, one for every QRS, all look the same?*
4. Calculate pr interval (pri)	*Normal=.12-.20 seconds*
5. Calculate QRS interval	*Normal= .06-.10 seconds*
6. Assess ST segment	*The ST segment should be on the baseline or 'isoelectric' line. If it is elevated or depressed it could mean cardiac injury or ischemia and requires urgent further assessment. In addition, the physician should be notified immediately since this could indicate that the patient could be experiencing an MI.*
7. Interpret the arrhythmia	*Name the arrhythmia based on the characteristics above (i.e. atrial fibrillation)*
8. Nursing Intervention/Treatment Required	*Determine what intervention is required. Is the patient stable of unstable? Should the physician be notified?*

Normal Sinus Rhythm

In order to analyze cardiac rhythms, it is essential to have an understanding of the 'benchmark' rhythm or hemodynamically perfect rhythm; which is referred to as Normal Sinus Rhythm and sometimes abbreviated to NSR. In order to be considered Normal Sinus Rhythm, the rhythm must have the following characteristics:

Table 2: ***Characteristics of Normal Sinus Rhythm***

Rhythm	Regular
Rate	60-100/minute
p waves	Present, upright, symmetrical, one before every QRS
pri	.12-.20 seconds
QRS	.06-.10 seconds

If the rhythm has all of the above characteristics but the ST segment is elevated, it would be referred to as sinus rhythm with an elevated ST segment versus 'normal' sinus rhythm.

>>insert Figure 1. Normal Sinus Rhythm>>

Sinus Rhythms

In the next section, arrhythmias originating in the sino-atrial (SA)node will be explored. The characteristics, causes, nursing implications and treatment required for sinus bradycardia, sinus tachycardia, sinus arrhythmia and wandering atrial pacemaker will be presented.

Slow Rhythms: Sinus Bradycardia

A patient is considered to be bradycardic when their heart rate drops below 60 beats per minute. Generally, a person often becomes symptomatic when their heart rate drops below 50 beats/minute, however slower heart rates can be observed in fit & athletic individuals, who will often remain asymptomatic. As a general rule, when a patient's heart rate is less than 60/minute critical care nurses should be prepared to immediately assess for signs of decreased cardiac output (i.e. decreased level of consciousness, hypotension, chest pain).

Table 3. ***Characteristics of Sinus Bradycardia***

Rhythm	Regular
Rate	< 60/minute
p waves	Present, upright, symmetrical, one before every QRS
pri	.12-.20 seconds
QRS	.06-.10 seconds
Cause	Parasympathetic stimulation (i.e. medications, vomiting, suctioning, bearing down) Also hypoxemia
Treatment	Only treated if patient is symptomatic. If symptomatic, Atropine administered IV bolus is the treatment of choice If the patient becomes unstable (i.e. exhibits symptoms of chest pain, heart failure, syncope or a reduced level of consciousness) an intravenous chronotrope infusion (such as Epinephrine or Dopamine) or external transcutaneous pacing should be considered

Figure 2. Sinus Bradycardia

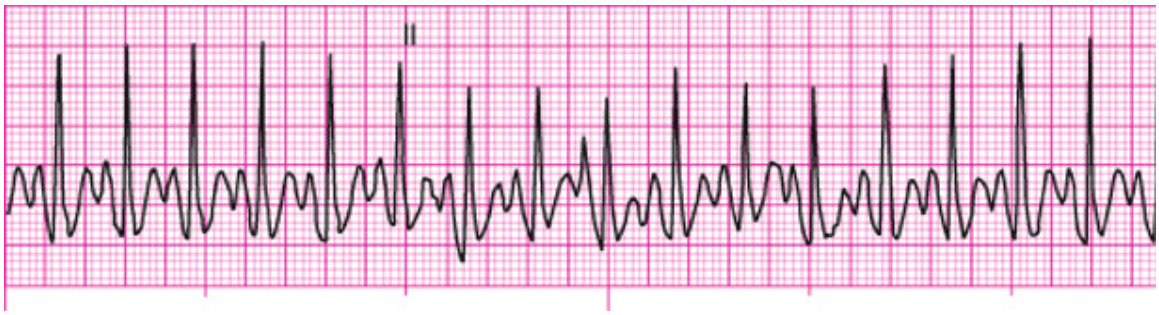
Fast Rhythms: Sinus Tachycardia

A patient is considered tachycardic when their heart rate rises above 100/minute, although typically individuals do not experience symptoms until the heart rate climbs above 150/minute. It is best practice for a critical care nurse to assess for signs and symptoms of decreased cardiac output (i.e. hypotension, decreased level of consciousness) when the heart rate is greater than 100/minute since this could result in patients developing cardiac ischemia, angina or even a myocardial infarction.

Table 4: Characteristics of *Sinus Tachycardia*

Rhythm	Regular
Rate	>100/minute
p waves	Present, upright, symmetrical, one before every QRS
pri	.12-.20 seconds
QRS	.06-.10 seconds
Cause	Sympathetic stimulation (i.e. medications, pain, fever, anxiety, shock) Also hypoxemia ** typically gradual in onset versus paroxysmal
Treatment	Treatment is aimed at treating the underlying cause (i.e. intravenous fluids for hypovolaemia or analgesics for acute pain)

Figure 3. Sinus Tachycardia



Irregular Rhythms: Sinus Arrhythmia and Wandering Atrial Pacemaker (WAP)

The next two arrhythmias, sinus arrhythmia and wandering atrial pacemaker are typically benign and do not require treatment.

Table 5: Characteristics *Sinus Arrhythmia*

Rhythm	Irregular
Rate	60-100/minute
p waves	Present, upright, symmetrical, one before every QRS
pri	.12-.20 seconds
QRS	.06-.10 seconds
Cause	Can be a normal aberration Seen in children and also in mechanically ventilated patients
Treatment	No treatment required Observe for further arrhythmia development

>> insert Figure 4. Sinus Arrhythmia>>

Table 6: Characteristics *of Wandering Atrial Pacemaker*

Rhythm	Regular or slightly irregular
Rate	60-100/minute
p waves	P waves vary in shape and size
pri	.12-.20 seconds
QRS	.06-.10 seconds
Cause	Can be a normal aberration Ischemia
Treatment	No treatment required

>> insert Figure 5. Wandering Atrial Pacemaker>>

Atrial Rhythms

In the next section, rhythms originating in the atria will be explored. These arrhythmias include: premature atrial contractions, atrial flutter, atrial fibrillation and supraventricular tachycardia. Key characteristics of these rhythms will be identified along with nursing implications and helpful tips to assist critical care nurses in accurately interpreting atrial arrhythmias.

Table 7: Premature Atrial Contractions (PACs)

Rhythm	Early beat (PAC) causes rhythm to be irregular
Rate	Underlying rhythm usually 60-100/minute
p waves	P waves have different configuration than underlying rhythm
pri	.12-.20 seconds in underlying rhythm
QRS	.06-.10 seconds in underlying rhythm
Cause	Can be a normal aberration Ischemia Or a signal of atrial irritability- can lead to more serious atrial rhythms
Treatment	No treatment required for isolated PACs Assess for increasing PACs since this indicates increasing atrial irritability and underlying cause (i.e. hypovolemia, hypervolemia or electrolyte imbalance) needs to be treated

>> insert Figure 6. Premature atrial contractions>>

Table 8: Characteristics *of Atrial Flutter*

Rhythm	Regular or irregular
Rate	60-100/minute (ventricular rate) 250-400 (atrial rate)
p waves	No p waves present Flutter waves (F waves) or 'sawtooth' waves
pri	No pri since no p wave
QRS	.06-.10 seconds
Cause	Electrolyte imbalance Hypertension Ischaemic heart disease Congenital heart disease Rheumatic valve disease Following cardiac surgery
Treatment	Anticoagulation should be considered due to the risk of atrial thrombus formation. Medications for rhythm and rate are recommended. Cardioversion or ablation may also be considered.

Figure 7. Atrial Flutter

Table 9: Characteristics *of Atrial Fibrillation*

Rhythm	Irregular
Rate	60-100/minute (ventricular rate) >400/minute (atrial rate)
p waves	No p waves Fibrillatory waves (f waves)
pri	No pri since no p waves
QRS	.06-.10 seconds
Cause	Electrolyte imbalance Hypertension Ischaemic heart disease Congenital heart disease Rheumatic valve disease Following cardiac surgery
Treatment	Anticoagulation should be considered due to the risk of atrial thrombus formation. Medications for rhythm and rate are recommended. Cardioversion or ablation may also be considered.

Figure 8. Atrial Fibrillation

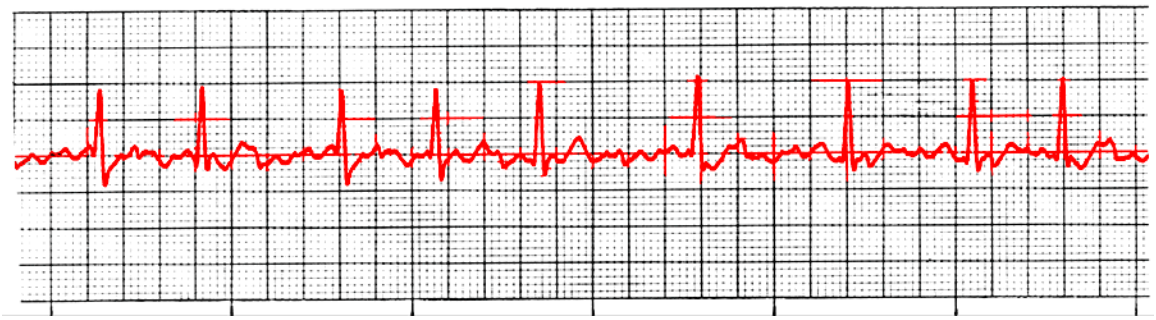
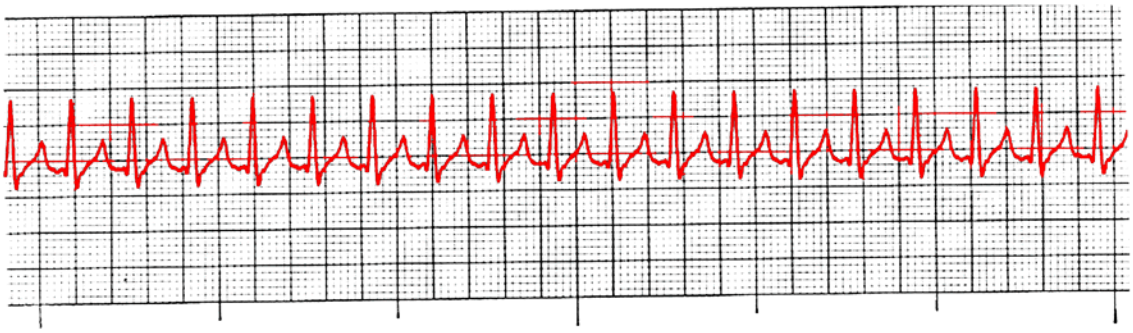


Table 10: Characteristics *of Supraventricular Tachycardia (SVT)*

Rhythm	Regular
Rate	150-250/minute
p waves	P waves may not be seen at higher rates
pri	.12-.20 seconds (if seen)
QRS	.06-.10 seconds
Cause	Congenital heart disease Emotional stress Physical stress or exertion Illegal drugs (i.e. Cocaine or ecstasy) Alcohol Caffeine
Treatment	Urgent expert referral Oxygen administration if required Intravenous access Vagal maneuvers (i.e. carotid sinus massage or Valsalva maneuver) Intravenous Adenosine Other rate controlling agents may be considered if the patient is not haemodynamically compromised

Figure 9. Supraventricular Tachycardia



Junctional Rhythms

Junctional rhythms originate in the AV node or junctional area and are typically transient and non-lethal. The rhythms that will be presented in this section include: premature junctional contractions, junctional rhythm, accelerated junctional rhythm and paroxysmal junctional tachycardia. All junctional rhythms have the common feature of inverted p waves although in some cases the p waves are not seen since the depolarization of the atria is occurring close to the time that the ventricles are being depolarized. Junctional rhythms are simply differentiated by rate since they possess the same characteristics.

Table 11: Premature Junctional Contraction (PJC)

Rhythm	Early beat (PJC) causes the rhythm to be irregular
Rate	60-100/minute (underlying rhythm)
p waves	P waves inverted or not seen in PJC
pri	Not applicable
QRS	.06-.10 seconds (in underlying rhythm)
Cause	Medication toxicity (i.e. digoxin) Ischemia
Treatment	No treatment required Continue to observe for increasing number of PJCs since this indicates increasing AV node irritability

>> insert Figure 10. Premature Junctional Contractions>>

Table 12: Characteristics of Junctional Rhythm

Rhythm	Regular
Rate	<60/minute
p waves	P waves inverted or absent
pri	.12-.20 seconds
QRS	.06-.10 seconds
Cause	Medication toxicity (i.e. digoxin) Ischemia
Treatment	Treat cause

Figure 11. Junctional Rhythm

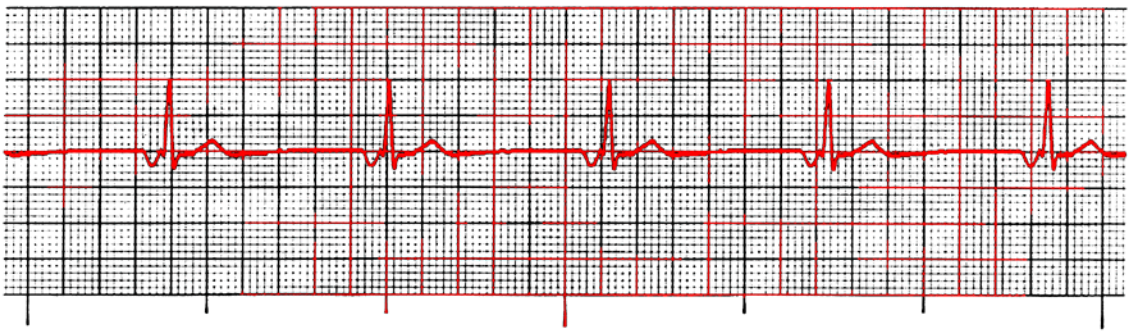


Table 13: Characteristics *of Accelerated Junctional Rhythm*

Rhythm	Regular
Rate	60-100/minute
p waves	P waves inverted or absent
pri	Not applicable
QRS	.06-.10 seconds
Cause	Medication toxicity (i.e. digoxin) ischemia
Treatment	Treat cause

>> insert Figure 12. Accelerated Junctional Rhythm>>

Table 14: Characteristics *of Paroxysmal Junctional Tachycardia (PJT)*

Rhythm	Regular
Rate	150-250/minute
p waves	P waves inverted or absent (if seen)
pri	Not applicable
QRS	.06-.10 seconds
Cause	Ischemia
Treatment	See SVT

>> insert Figure 13. Paroxysmal Junctional Tachycardia>>

Ventricular Rhythms

Ventricular rhythms are characterized by wide and bizarre QRS complexes. The rhythms that will be explored in this section include those caused by irritability which include: premature ventricular contractions (PVCs), ventricular tachycardia and ventricular fibrillation. In addition, ventricular rhythms that arise due to failure of higher level pacemakers (i.e. idioventricular, accelerated ventricular and aganol rhythms). It is important to distinguish between these two types of ventricular rhythms since the treatment and implications are very different.

Table 15: Characteristics *of Premature Ventricular Contractions (PVCs)*

Rhythm	Early beat (PVC) causes the rhythm to be irregular
Rate	60-100/minute (underlying rhythm)
p waves	None (in PVC)
pri	None (in PVC)
QRS	> .12 seconds (wide and bizzare)
Cause	Ventricular irritability (i.e.hypoxemia, acid-base imbalance, medications, electrolyte imbalance)
Treatment	No treatment required for isolated PVCs Watch for an increase in PVCs (> 10/minute) since this indicates an increase in ventricular irritability Note morphology and incidence of PVC's & escalate if required (i.e. PVC's could be multifocal, unifocal, couplets, bigeminal or trigeminal.

>> insert Figure 14. Premature Ventricular Contractions>>

Table 16: Characteristics *of Ventricular Tachycardia (VT)*

Rhythm	Regular
Rate	150-250/min
p waves	none
pri	none
QRS	> .12 seconds (wide and bizzare)
Cause	Ventricular irritability (i.e.hypoxemia, acid-base imbalance, medications, electrolyte imbalance)
Treatment	Confirm signs of life (i.e. presence of pulse & normal respiratory effort)

	Obtain emergency assistance (i.e. cardiac arrest or rapid response team if available) <u>If no signs of life (pulseless VT):</u> Commence basic life support in accordance to national resuscitation guidelines (chest compressions and ventilation breaths) Defibrillate as per national resuscitation guidelines Secure intravenous access & administer Epinephrine & Amiodarone as per guidelines <u>If signs of life are noted (VT with a pulse):</u> Administer oxygen as required Obtain intravenous access Administer intravenous Amiodarone Correct abnormal electrolytes

Figure 15. Ventricular Tachycardia

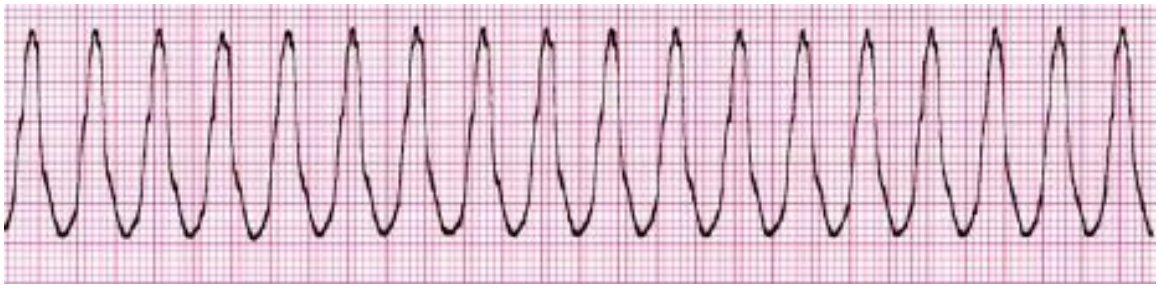


Table 17: Characteristics *of Ventricular Fibrillation (VF)*

Rhythm	Irregular and chaotic
Rate	Cannot calculate
p waves	none
pri	none
QRS	none
Cause	Ventricular irritability (i.e.hypoxemia, acid-base imbalance, medications, electrolyte imbalance)
Treatment	Confirm signs of life (i.e. presence of pulse & normal respiratory effort) Obtain emergency assistance (i.e. cardiac arrest or rapid response team if available) Commence basic life support in accordance to national resuscitation guidelines (chest compressions and ventilation breaths)

	Defibrillate as per national resuscitation guidelines Secure intravenous access & administer Epinephrine & Amiodarone as per guidelines

Figure 16. Ventricular Fibrillation

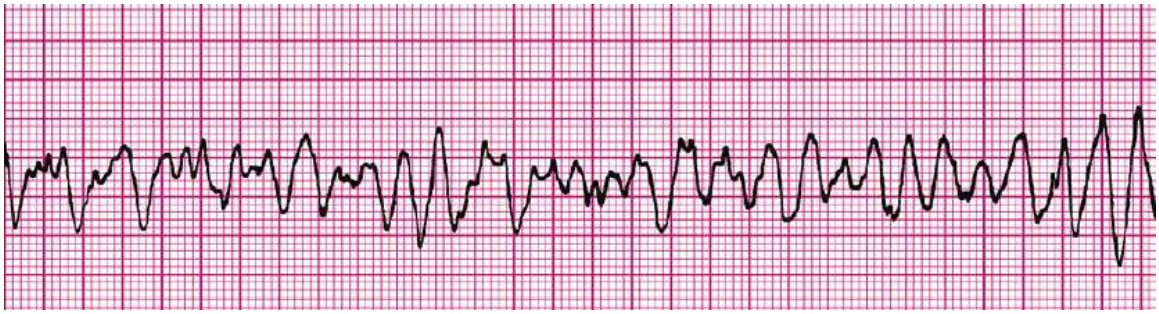


Table 18: Characteristics *of Idioventricular Rhythm*

Rhythm	Regular
Rate	<40/minute
p waves	No p waves
pri	No pri
QRS	> .12 seconds (wide and bizarre)
Cause	Ischemia, reperfusion post thrombolytics
Treatment	Typically benign, transient However if the patient exhibits signs of haemodynamic compromise, treat with interventions listed for bradycardia: atropine, chronotropic agents (intravenous infusion of Epinephrine), transcutaneous pacing.

Figure 17. Idioventricular Rhythm

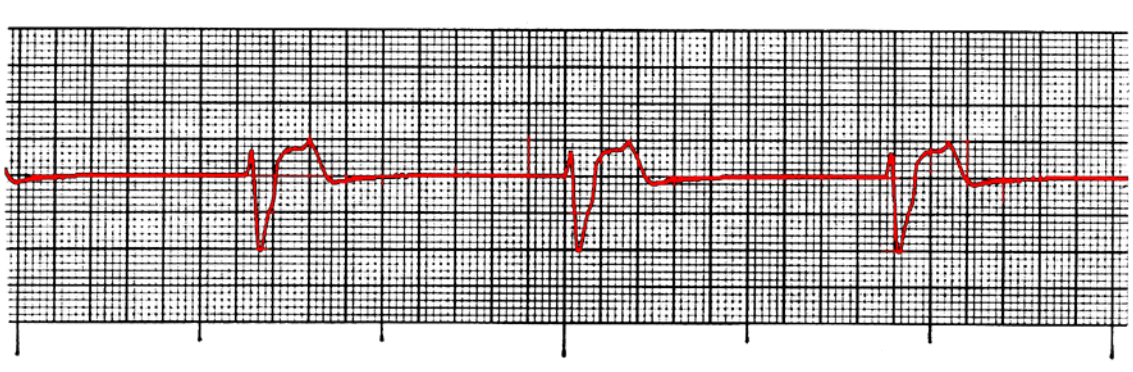


Table 19: Characteristics *of Accelerated Idioventricular Rhythm (AIVR)*

Rhythm	Regular
Rate	40-100/minute
p waves	No p waves
pri	No pri
QRS	> .12 seconds (wide and bizarre)
Cause	Add here
Treatment	Typically transient, no treatment required

>> insert Figure 18. Accelerated Idioventricular Rhythm>>

Table 20: Characteristics *of Aganol Rhythm*

Rhythm	very irregular
Rate	< 40/minute
p waves	No p waves
pri	No pri
QRS	> .12 seconds seconds
Cause	End stage cardiac disease
Treatment	This rhythm technically indicates a refractory end of life situation

>> insert Figure 19. Aganol Rhythm>>

AV Blocks

Atrioventricular (AV) blocks are characterized by electrical conduction dysfunction through the myocardium. This is manifested as obstructed, delayed or variable electrical conduction through the AV node. Types of AV block include: 1st degree heart block, 2nd degree heart block (Mobitz type 1 or Wenkebach), 2nd degree heart block (Mobitz type 2) and 3rd degree heart block (complete heart block). AV blocks can be associated with significant risk deterioration or haemodynamic compromise, so prompt identification and treatment is vital for the critical care nurse.

Characteristics of each AV block will be explored, including nursing considerations and treatment options.

Table 21: First Degree AV Block

Rhythm	Regular
Rate	60-100/minute
p waves	P waves normal
pri	>.20 seconds
QRS	.06-.10 seconds
Cause	AV nodal disease Enhanced vagal tone (i.e. athletes) Myocarditis Following Myocardial Infarction Electrolyte disturbances Medications (i.e. Calcium channel blockers, Beta blockers)
Treatment	No treatment required Observe for further block

Figure 20. First Degree Heart Block

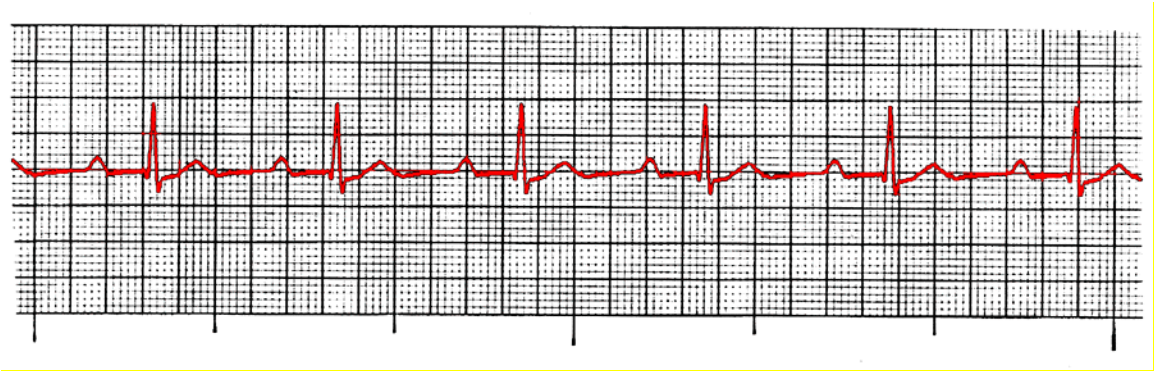


Table 22: Characteristics *of Second Degree Type I*

Rhythm	Regular or slightly irregular
Rate	60-100/minute
p waves	P waves normal
pri	Progressively gets longer until a beat is dropped
QRS	.06-.10 seconds
Cause	Ischemia
Treatment	Usually benign, with no treatment required If patient becomes haemodynamically compromised consider interventions for bradycardia Observe for worsening AV block

Figure 21. Second Degree Type I

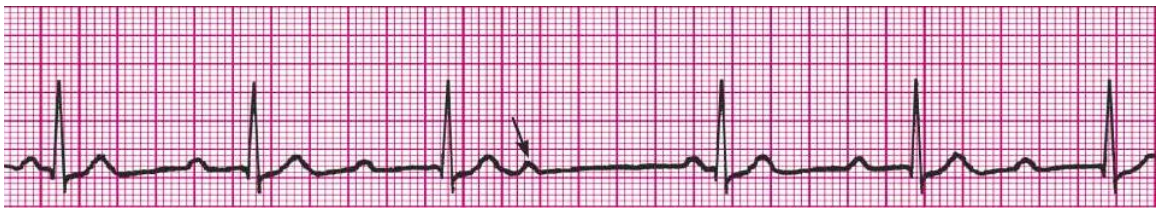


Table 23: Characteristics *of Second Degree AV Block Type II*

Rhythm	Regular or irregular
Rate	varies
p waves	More p waves than QRS complexes
pri	constant
QRS	.06-.10 seconds or may be widened
Cause	Ischemia, MI
Treatment	If patient becomes haemodynamically compromised consider interventions for bradycardia Observe for worsening AV block May require temporary or permanent pacing

Figure 22. Second Degree AV Block Type II

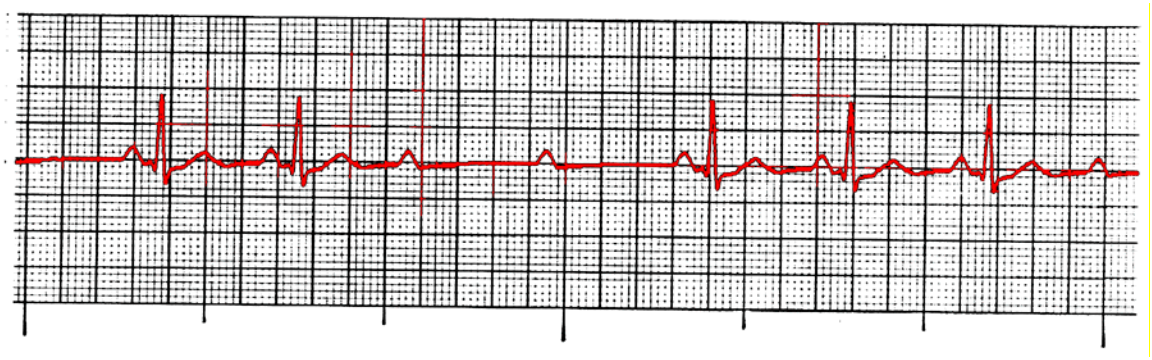


Table 24: Characteristics *of Third Degree Heart Block*

Rhythm	Ventricular rhythm regular (R-R) and atrial rhythm regular (p-p)
Rate	Ventricular rate typically <40/min and atrial rate 60-100/minute
p waves	No relationship between p waves and QRS complex

pri	Not applicable
QRS	Usually >.12 seconds but may be normal
Cause	Ischaemic heart disease Following Myocardial Infarction Lyme disease Congenital
Treatment	If patient becomes haemodynamically compromised consider interventions for bradycardia May require temporary or permanent pacing

Figure 23. Third Degree Heart Block

Summary

In this chapter, a systematic approach was presented for interpreting arrhythmias. This approach should be routinely used to ensure accurate interpretation of arrhythmias when caring for your critically ill patient. In the event that the patient is hemodynamically unstable or unresponsive, the first priority would be to assess the patient first and provide emergency treatment. For further development in your skill in interpreting basic arrhythmias, we recommend continued development by further rhythm practice and attendance at arrhythmia refresher courses when

possible. In addition, we have provided resources at the end of this chapter that we hope you find helpful as you develop further competency in this subject area.

Practice Questions- Test Yourself!

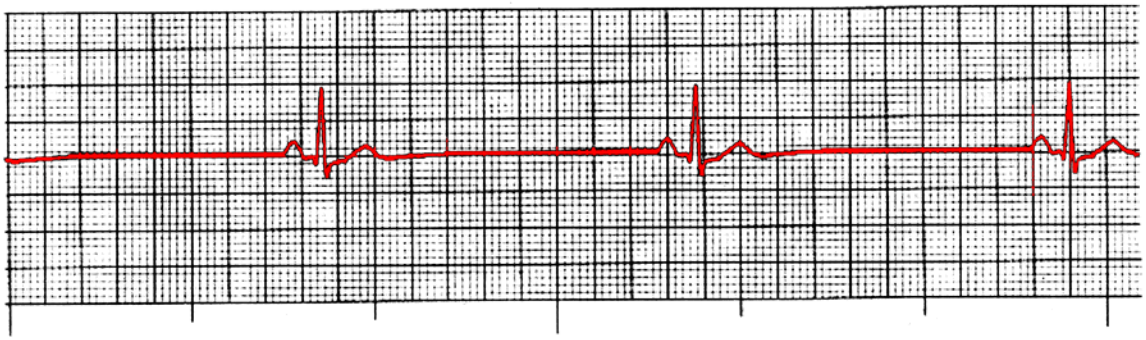
Below you will find a case study and several practice questions to test your knowledge after reviewing this chapter.

Case Study

Mr Mohammed Ahmed is a 59 year male, who has presented to his local hospital with severe central, crushing chest pain. He has a past medical history of diabetes, hypertension and a high body mass index. On admission to hospital, Mr Ahmed's ECG, clinical presentation & blood results confirm a diagnosis of an inferior ST elevation myocardial infarction (STEMI), then then proceeds to the cardiac catheterization lab for primary percutaneous coronary intervention (PPCI). During the procedure, the cardiac catheterization lab team notes a cardiac rhythm change:

This rhythm change is treated immediately and the patient returns to normal sinus rhythm (NSR) at a rate of 90 beats per minute. Following the procedure, Mr Ahmed

is transferred to the cardiac care unit. He recovers well following his STEMI & PPCI, however the following day a further rhythm change is noted by the nursing team:



Mr Ahmed becomes symptomatic with this new cardiac rhythm, with profound hypotension (BP of 68/45mmHg) and a reduced level of consciousness. The physician attends and requests emergency interventions.

Multiple Choice Questions:

1. Concerning the first rhythm (Ventricular Fibrillation). What key treatment interventions are required immediately?
    a. Epinephrine & cardiopulmonary resuscitation (CPR).
    b. Cardiopulmonary resuscitation (CPR), defibrillation.
    c. Confirmation of cardiac arrest, cardiopulmonary resuscitation (CPR) and defibrillation.
    d. Transcutaneous pacing.

Answer: c. Confirmation of cardiac arrest, cardiopulmonary resuscitation (CPR) and defibrillation. Artifact or patient movement can mimic ventricular fibrillation (VF), to it is vital that the healthcare professional confirms cardiac arrest prior to calling for assistance, commencing CPR or initiation of defibrillation. Cardiopulmonary resuscitation (CPR) should be initiated immediately to ensure that key organs remain perfused. Once a defibrillator is available, the patient should receive a shock, followed by further CPR.

2. Ventricular fibrillation (VF) should be described by which statement?
    a. A regular, fast rhythm, which is characterized by a wide QRS & no clear P wave activity.
    b. An irregular, chaotic fast rhythm, which features no clear P wave or QRS complexes.
    c. An irregular, fast rhythm, which has fibrillatory P waves and normal QRS complexes.
    d. A regular, normal speed rhythm, which is characterized by clear P wave activity and normal QRS complexed.

Answer: b. Ventricular fibrillation (VF) can be described as a complex, irregular and chaotic rhythm, which features no clear P waves and QRS complexes that have a random width and amplitude. VF is a cardiac arrest rhythm and warrants immediate CPR and defibrillation.

3. Concerning management of the 2nd cardiac rhythm & Mr Ahmeds deterioration, what interventions are required?
    a. Commence cardiopulmonary resuscitation (CPR) & defibrillate.
    b. Administer an intravenous fluid bolus.
    c. Administer intravenous Atropine. If no improvement, consider transcutaneous pacing via a pacing enabled defibrillator.
    d. Commence an intravenous infusion of Epinephrine.

Answer: c. Mr Ahmed's rhythm deteriorated into Sinus Bradycardia (SB). Treatment for symptomatic bradycardia includes administration of intravenous Atropine. If Atropine fails to achieve a satisfactory result, transcutaneous pacing can be implemented via a pacing enabled defibrillator.

Other Helpful Resources

Ecglibrary.com (for practice)

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