ELECTROCARDIOGRAM

Cardiac monitoring and the use of a systematic approach in interpreting electrocardiogram rhythms

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Abstract
Attaching a patient to a cardiac monitor and obtaining a clear electrocardiogram (ECG) trace may now be considered basic nursing skills. In line with the UK professional standards and code of conduct, healthcare practitioners are required to practise effectively and preserve patients’ safety. Therefore, healthcare practitioners undertaking cardiac monitoring are required to have a basic understanding of normal sinus rhythms and some of the common types of cardiac arrhythmia. This will enable prompt recognition of early warning signs of potential and actual clinical conditions, and the timely initiation of treatment. This article reviews the clinical skill of attaching a patient to a three and five-lead cardiac monitor, discussing appropriate skin preparation and lead selection. It also outlines the identification of several of the common types of cardiac arrhythmia on an ECG rhythm strip using a systematic approach.

Keywords
arrhythmias, atrial fibrillation, bradycardia, cardiac monitor, cardiology, electrocardiogram interpretation, electrocardiogram monitoring, five-lead cardiac monitor, sinus rhythm, tachycardia, three-lead cardiac monitor

Aims and intended learning outcomes
The aim of this article is to enable nurses to understand how to attach a patient successfully to a three or five-lead cardiac monitor, how to obtain a clear electrocardiogram (ECG) trace and to identify some of the common types of cardiac arrhythmia using a systematic approach. After reading this article and completing the time out activities you should be able to:

» Describe how the clinical skills of three and five-lead cardiac monitoring should be applied to patient care.
» Understand the appropriate preparation required before undertaking cardiac monitoring.
» Recognise the components of the ECG complex and characteristics of normal sinus rhythm.

» Outline how to use graph paper to measure timings as part of analysing an ECG rhythm strip.
» Identify some of the common types of cardiac arrhythmia on a rhythm strip using a systematic approach.

Relevance to the Code
Nurses are encouraged to apply the four themes of The Code: Professional Standards of Practice and Behaviour for Nurses and Midwives to their professional practice (Nursing and Midwifery Council (NMC) 2015). The themes are: Prioritise people, Practise effectively, Preserve safety, and Promote professionalism and trust. This article relates to The Code in the following ways:

» The Code requires nurses to listen to people and respond to their preferences and concerns. Nurses should be aware
that cardiac monitoring may make some patients feel anxious, and therefore they should provide reassurance, listen to their concerns and explain the procedure with compassion and care.

- It enables nurses to practise effectively by improving their understanding and confidence in attaching a patient to a three or five-lead cardiac monitor, obtaining a clear ECG trace, and identifying some of the common types of cardiac arrhythmia.

- The Code theme of prioritising people states that nurses must ensure that people’s physical, social and psychological needs are assessed and responded to, and make sure that any treatment is delivered without undue delay. Interpreting an ECG trace can enable nurses to identify arrhythmias and initiate immediate treatment or preventative action where necessary.

- It emphasises the importance of nurses being able to identify some of the common types of cardiac arrhythmia, to enable prompt recognition of early warning signs of potential and actual clinical conditions. This is relevant to The Code theme of preserving safety, which states that nurses must accurately assess signs of normal or worsening physical health.

Introduction
Cardiac monitoring is a familiar aspect of healthcare that is frequently undertaken in a range of settings, including assessment, high dependency and intensive care units, as well as healthcare transportation. Almost all healthcare practitioners can be expected to encounter cardiac monitoring during their practice; therefore, they should have a basic understanding of the interpretation of an ECG trace, ensuring they practise within their competence and seek assistance where required.

While cardiac monitoring is painless, it is important for healthcare practitioners to remember that attaching a patient to a cardiac monitor, even through a wireless device (telemetry), can provoke anxiety for the patient and their family, loved ones or significant others. Therefore, it is necessary for healthcare practitioners to explain the procedure to the patient and provide reassurance in an empathic way. Attaching the ECG leads requires the healthcare practitioner to consider skin preparation for the patient to reduce electrical impedance, and to ensure correct lead placement to obtain an ECG trace that is diagnostically valuable.

The clinical skill of recognising cardiac arrhythmias on an ECG trace requires healthcare practitioners to have an underpinning knowledge and practice of this. A range of resources are available that are suited to various levels of ability and learning styles, including study days, practical ECG interpretation texts (Hampton 2013, Resuscitation Council (UK) (RCUK) 2016) and detailed, treatment-focused texts (Tsiperfal et al 2011, Bennett 2013). Many resources are also available on the internet; however, readers are advised to ascertain the reliability of the resource to ensure accuracy.

Prompt and accurate recognition of cardiac arrhythmias is vital, because some arrhythmias will require immediate management, while others can be an early warning sign that enables preventative action to be taken. For example, if ventricular ectopics occur, this indicates that the patient’s blood electrolytes should be checked.

Preparing the patient and their skin, and the cardiac monitor
The Society for Cardiological Science and Technology (SCST) (2017) provide guidelines for preparing the patient’s skin to obtain a clear ECG trace in a 12-lead recording, which can be applied in cardiac monitoring. Care must be taken with patients who have sensitive or broken skin. Various methods are available to reduce the grease on the patient’s skin and minimise skin-to-electrode impedance. If the skin requires to be cleaned, it is usually sufficient for it to be washed with mild soap. RCUK (2016) guidelines suggest the use of an alcohol swab, but this may be an irritant to the skin. If it is necessary to remove dead skin cells by exfoliation,
light abrasion can be undertaken using a paper towel, gauze swab or proprietary abrasive tape designed for this purpose (SCST 2017).

It may also be necessary to remove the patient’s chest hair to ensure adequate contact with the skin. To undertake chest hair removal, the healthcare practitioner should obtain verbal consent from the patient and use an unused disposable razor to reduce the risk of cross-infection (Houghton and Gray 2014, SCST 2017). They should also take care to dispose of sharps in an appropriate sharps bin (SCST 2017). Shaving or using clippers is an infection risk, so hair should only be removed in the area where the electrodes are to be placed.

It is important for the healthcare practitioner to understand how the cardiac monitor works and to read the manufacturer’s instructions and complete training as appropriate. They should switch the monitor on and unravel the leads, and attach the single-use click-on electrodes to the leads. This avoids the discomfort of attaching the electrodes to the patient’s skin and having to press the leads on to them. During this time, the healthcare practitioner should be aware that cardiac monitoring restricts the patient’s movement, unless telemetry is being used. In telemetry, the patient is mobile; however, it is important that they inform the healthcare practitioner where they are, so they can respond to any alarms or concerns. The healthcare practitioner should also ensure that the patient has all their required belongings within easy reach if telemetry is being used.

It is important to reassure and communicate with the patient, being aware of their possible anxiety. The purpose of cardiac monitoring is to reassure the patient and to enable staff to provide appropriate treatment, therefore it should not cause unnecessary stress or distress. The healthcare practitioner should remind the patient that the monitor is a sensitive device and an alarm may be activated, but this does not necessarily indicate a major concern.

**Attaching the patient to a cardiac monitor**

Cardiac monitors tend to have three or five attachable leads. The leads must be placed in the correct position to obtain a reliable ECG trace. The healthcare practitioner should follow the manufacturer’s instructions for the cardiac monitor on where to place the leads. The leads are often either labelled on the block where the wires emerge, to reflect their placement position, possibly with an additional diagram on the monitor or its instructions. The leads may also be colour-coded to aid their placement. The colour coding for a three-lead cardiac monitor is usually red, yellow and green.

In a three-lead cardiac monitor, the red lead is placed just underneath the patient’s right clavicle, not over the bone. The yellow lead is placed just under the patient’s left clavicle. Both leads are placed near the adjacent shoulder and on the rib cage. The green lead is placed much lower down, on the bottom of the rib cage on the patient’s left side. In a five-lead cardiac monitor, a black lead is placed on the patient’s right side in the thorax and hip area (Jevon and Ewens 2012) (Figure 1). A white lead is generally placed in the V1 position of the 12-lead ECG. The V1 position is the fourth intercostal space at the right sternal edge (Adam et al 2017). Stroobandt et al (2016) noted that this lead can be placed in any of the standard V1 to V6 locations. The V1 position is most commonly used to provide a visual display of a limb lead and chest lead simultaneously. V1 can thus be moved, for example moving it to the V5 position to ‘view’ the lateral left ventricle and atrium (Adam et al 2017).

The healthcare practitioner should ensure they set the upper and lower alarm limits on the monitor. There is no clear rule of where to set these limits, and the healthcare practitioner should set them according to the patient’s clinical condition (Adam et al 2017). However, as a guide, they could observe where the patient’s usual heart rate is and set the upper limit approximately 15-20 beats per minute (bpm) above this, and set the lower limit in the same range below the normal heart rate of 60-70bpm. It is important to remember
that frequent false alarms undermine the rationale for alarm-setting and may cause undue patient anxiety (Adam et al 2017). The healthcare practitioner should be aware that some patients may usually have a slower heart rate, for instance athletic patients who exercise regularly, or patients who are taking medicines such as beta blockers (RCUK 2015a).

Selecting the monitoring lead
In three and five-lead cardiac monitors, there will be a choice of leads that can be used. Generally, lead II is advised because this demonstrates clear and strong amplitude (height) in areas such as the QRS complex (RCUK 2016), and arrhythmias, if they occur, should appear more familiar. In health, the electrical impulse travels through the heart from the top right (patient’s right) of the heart, where depolarization originates in the sinoatrial (SA) node, through the atrioventricular (AV) node in the centre of the heart and, predominately, to the left to the larger muscular mass of the left ventricle. The electrical activity spreads through the myocardium, but the general direction follows this route. This is known as the ‘cardiac axis’ (Hampton 2013). The different leads will show the electrical activity from different angles relative to the cardiac axis.

As the electrical activity travels towards a lead, it will create an upright deflection from baseline. As it travels away from a lead, it will create a downward or negative deflection. Lead II presents the most ‘textbook familiar’ and upright QRS complex, because the cardiac axis travels towards this lead and it has a strong amplitude. If the healthcare practitioner switches through the leads and another lead provides the most upright QRS complex, they should set the monitor to this lead or setting. The direction of the cardiac axis can change between patients and is not always a sign of pathology.

Using graph paper to measure timings
Timings are an essential aspect of ECG rhythm strip analysis; for example, if they are too long, this may indicate conduction issues in specific areas of the heart. These timings include the heart rate, as well as the length of time electrical activity takes to travel through specific parts of the heart, which can be worked out from the ECG trace superimposed on graph paper. The graph paper consists of large squares each subdivided by five small squares. The rhythm passes by on the monitor, and is printed on graph paper, at a set international speed of 25mm per second (Hampton 2013). Therefore, ECG timings work to this set speed. Box 1 shows the

**BOX 1. Electrocardiogram timings using graph paper**

- The speed of the rhythm strip is 25mm per second
- Each small square (1mm) = 0.04 seconds (40 milliseconds)
- One large square = 0.2 seconds (200 milliseconds)
- Five large squares = 1 second (1,000 milliseconds)
timings for the squares printed on the graph paper at this set speed.

TIME OUT 1
Under the supervision of an experienced colleague, practise attaching a patient to a cardiac monitor and obtaining a clear ECG trace. Once you have achieved this, identify which aspects of this you found most challenging.

Recognising normal sinus rhythm and associated timings
Figure 2 shows the normal electrical conduction pathway through the myocardium and the associated ECG trace generated. Myocardial cells have a unique autorhythmic property. This is the ability to depolarize, without need of an external nerve stimulus, facilitating an electrical stimulus to rhythmically spread through the myocardium, allowing the heart to contract. Depolarization is a complex physiological process based on the membrane permeability of the myocardial cells and the movement of ions, notably sodium (Na+) into the interior of the cell, followed by a rapid influx of calcium (Ca2+), creating a reversal of the action potential, and an electrical impulse (Marieb and Hoehn 2015). It is beyond the scope of this article to discuss this in further detail; however, readers are advised to read a human anatomy and physiology text for further information, such as that by Marieb and Hoehn (2015) or Peate and Nair (2017).

Figure 3 shows the ECG complex of normal sinus rhythm for one heartbeat. The flat horizontal baseline is the isoelectric line, which is the lack of sensed electrical activity between and within each heartbeat. The components of normal sinus rhythm are:
» The P wave – small rounded and upright – precedes contraction of both atria together. There should be one P wave per QRS complex. Corresponds to atrial depolarization.
» The PR interval – the time period from the onset of the P wave to the beginning of the QRS complex and includes electrical conduction through the AV node.
The T wave – rounded, slightly larger than the P wave. Corresponds to ventricular repolarization (electrical resetting).

The U wave – sometimes seen; however, the source is unclear.

Figure 4 shows normal sinus rhythm for a series of eight heart beats.

**TIME OUT 2**

Identify the components of normal sinus rhythm. If a nursing student asked you to draw this and link it to electrical conduction through the myocardium, could you do this? Take some time to attempt this exercise.

Three of the most critical timings in rhythm strip analysis are: heart rate, PR interval, and the width and shape of the QRS complex (Hampton 2013). It may be easier to consider the timings in terms of squares because ECG interpretation is largely a visual skill. Table 1 shows the normal timings for these three aspects and considers possible diagnosis for abnormal timings or findings. Box 2 shows the various methods for calculating the heart rate in bpm on a rhythm strip. This can be challenging when the rhythm is irregular, as occurs in a common arrhythmia such as atrial fibrillation. In this case, it is valuable to print out a long rhythm strip for analysis to incorporate the irregularity. The six-second method may be useful in this instance, as described in Box 2. In addition, when providing the heart rate for an irregular rhythm, it can be useful to provide the range of heart rate that was shown on the rhythm strip; such as heart rate 105 bpm, heart rate range 94-115 bpm. This provides broad but useful information on how irregular the heart rate is beyond one static figure.

**TIME OUT 3**

Consider the main timings of the normal rhythm strip shown in Figure 4. What would be considered

![Figure 4. Normal sinus rhythm for a series of eight heart beats](image)

**TABLE 1. Normal timings for heart rate, PR interval and QRS complex length, and possible abnormalities**

<table>
<thead>
<tr>
<th>Timing</th>
<th>Abnormality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart rate (patient-dependent): 60-100 beats per minute (bpm) (Herzog 2012)</td>
<td>Tachycardia &gt;100 bpm</td>
</tr>
<tr>
<td></td>
<td>Bradycardia &lt;60 bpm</td>
</tr>
<tr>
<td></td>
<td>Examine patient trends and relate these to the individual patient</td>
</tr>
<tr>
<td></td>
<td>The parameters of bradycardia may vary slightly between resources</td>
</tr>
<tr>
<td>PR interval (measured from the start of the P wave to the start of the QRS complex): 3-5 small squares or 0.12-0.2 seconds or 120-200 milliseconds (Hampton 2013)</td>
<td>Consistently prolonged PR interval indicates first-degree heart block. This is usually harmless but should be reported to appropriate medical or senior nursing colleagues</td>
</tr>
<tr>
<td>QRS complex length: three small squares or less or ≤0.12 seconds or 120 milliseconds (Hampton 2013)</td>
<td>Prolonged and bizarre-shaped QRS complex may indicate conduction issues in the ventricles. This should be reported to appropriate medical or senior nursing colleagues</td>
</tr>
</tbody>
</table>
bradycardia and tachycardia? In squares – how wide should the PR interval be and the QRS complex at its widest point?

TIME OUT 4

Attempt to work out the heart rate from the rhythm strip shown in Figure 4. If you are unsure how to do this, ask an experienced colleague to work it out with you. If you are sure your answer is correct, but are new to ECG analysis, check it with a colleague.

Analysing a rhythm strip

There is no set order to analysing a rhythm strip, and several tools and frameworks are available to assist healthcare practitioners in undertaking this analysis. Jevon (2010) emphasised that although considerable experience and expertise is required to accurately interpret an ECG trace, it is possible to interpret most traces and provide a reliable diagnosis by using a systematic approach. Most systematic tools and frameworks feature broad questions that support the healthcare practitioner to determine what type of arrhythmia is present (Moore and Woodrow 2009, RCUK 2016, Woodrow 2016). These rely on the healthcare practitioner’s experience and enhanced knowledge to understand the significance of the findings. This is developed through practice. The aim of these tools or frameworks is to assist the healthcare practitioner to interpret the ECG rhythm promptly and reliably, even if this is sinus rhythm. Box 3 shows the RCUK (2016) six-stage tool to analyse an ECG rhythm strip. Whatever the cardiac monitor or printed rhythm strip shows, it is necessary to assess the patient for haemodynamic consequences. Box 4 outlines the signs suggestive of haemodynamic compromise, which can enable a rapid assessment to be undertaken.

BOX 2. Methods for calculating the heart rate in beats per minute (bpm) on a rhythm strip

Print a rhythm strip to work on

The 300 method
Count the number of large squares and small squares between two R waves
Divide the number into 300 to obtain the heart rate
For example:
1. Length is 3 large squares = \( \frac{300}{3} \) = heart rate of 100bpm
2. Length is 4 large and 2 small squares = 4.4 (each small square = 0.2) = \( \frac{300}{4.4} \) = 68bpm

The 1,500 method
Count the number of small squares between two R waves
Divide the number into 1,500 to obtain the heart rate

The six-second method
- Print out at least 30 squares worth of paper
- Count the number of R waves that appear in the length of 30 large squares (= six seconds).
- Multiply by 10 to obtain the heart rate
Alternatively, use 50 large squares (ten seconds) and multiply by 6 to obtain the heart rate, known as the ten-second method

Irregular heart rate
When a heart rate is irregular, as in atrial fibrillation, a longer time period is required for analysis to pick up the irregularity and provide a more precise heart rate. Therefore, the six or ten-second method is recommended to calculate the heart rate

(Houghton and Gray 2014, Stroobandt et al 2016)

BOX 3. Resuscitation Council (UK) six-stage tool to analyse an electrocardiogram rhythm strip

- Is there any electrical activity?
- What is the ventricular (QRS) rate?
- Is the QRS rhythm regular of irregular?
- Is the QRS complex width normal – narrow or broad?
- Is atrial activity present?
- Is atrial activity related to ventricular activity?
  If so, how?
(Adapted from Resuscitation Council (UK) 2016)

BOX 4. Signs suggestive of haemodynamic compromise

- Patient appears confused and/or has reduced level of consciousness
- Hypotension
- Thready pulse and/or tachycardia or bradycardia
- Delayed capillary refill time (more than two seconds)
- Cold, clammy skin – vasoconstriction diverting blood to vital organs such as the heart and brain
- Oliguria or anuria. If the patient is catheterised, this would be: urine output in mL/hour < half the patient’s body weight in kg, for example an 80kg patient passing less than 40mL/hour of urine
- Metabolic acidosis and hypoxaemia
(Grant 2014, Cecconi et al 2016, Adam et al 2017)
Cardiac monitors generally have the ability to print out the rhythm on a graph paper strip and this makes it easier to study. The healthcare practitioner should always print out a long strip because this enables patterns to be clearly identified, particularly in conditions where there may be a lack of association between the P wave and the QRS complex, such as second or third-degree (complete) heart block, or irregularity between the R waves such as in atrial fibrillation. Printing out a rhythm strip also enables the healthcare practitioner to have time to work on a static ECG rhythm and to mark off and measure any important elements. Whichever tool or framework is used to undertake a systematic analysis of the rhythm, most tend to cover similar areas. These will be discussed in further detail.

**Heart rate**

The heart rate is significant in rhythm strip analysis. The normal resting heart rate for adults is 60-100bpm (Herzog 2012). Tachyarrhythmias are heart rates exceeding 100bpm and bradyarrhythmias are slow heart rates of less than 60bpm (Romanò and Bertona 2015). Box 2 shows common methods that can be used to calculate the heart rate in bpm from a rhythm strip that has no printed figure for this.

If the heart rate is abnormally fast (tachycardia) or abnormally slow (bradycardia) this can affect the cardiac output and ultimately the blood pressure. The haemodynamic consequences will vary between patients, and it is important for the healthcare practitioner to remember to anticipate future effects and not only focus on the immediate situation, particularly if the patient is haemodynamically stable within acceptable parameters. Decreased and elevated heart rates may occur in sinus rhythm and other arrhythmias.

**Narrow or broad QRS complex**

As a general rule, atrial arrhythmias will have a narrow QRS complex – three small squares or less at its widest point (≤0.12 seconds or 120 milliseconds), while ventricular arrhythmias will have a wide and bizarre-shaped QRS complex – wider than three small squares at its widest point (>0.12 seconds or 120 milliseconds). This is because in an atrial arrhythmia, the electrical impulse travels into the ventricles via the normal and fastest conduction route, through the AV node, giving a normal QRS complex. In a ventricular arrhythmia, the impulse generally originates from within the ventricles and has to travel around an abnormal pathway to allow the ventricles to depolarize. Hence, this takes longer, and the QRS complex is wide and bizarre in appearance.

**Determining if the rhythm is regular or irregular**

There are a range of types of cardiac arrhythmia, but by far the most common is atrial fibrillation and this is characteristically irregular – the R to R intervals between the QRS complexes vary. Atrial fibrillation is defined by a continuous and chaotic electrical activity in the atria, instead of a steady and rhythmic depolarization. This means that electrical activity moves in an intermittent fashion through the AV node, resulting in the classic regular irregularity between the R waves seen on the rhythm strip. The method for determining if the rhythm is regular or irregular is outlined in the ECG examples that follow. Atrial fibrillation is usually fast when untreated and identifying the irregularity can be challenging. Box 2 describes how best to calculate the heart rate in bpm in a cardiac arrhythmia.

**P wave (atrial activity) association to QRS (ventricular activity)**

There should be one P wave for each QRS complex. Where there is more than one, it is suggestive of a block at the AV level. This can occur in second and third-degree (complete) heart block, where impulses either pass through intermittently or, as in third-degree heart block, fail to pass through at all. This requires immediate review. In third-degree heart block, the ventricles release their own, usually slower, impulse to enable ventricular contraction, but treatment is required.
Analysing and identifying common arrhythmias

This article will demonstrate how various common arrhythmias can be analysed and identified on a rhythm strip, using the RCUK (2016) framework outlined in Box 3.

Sinus bradycardia

In the rhythm strip shown in Figure 5, there is clearly electrical activity. The ventricular (QRS) rate is approximately 33bpm. The QRS rhythm is regular. This can be ascertained by placing a piece of paper on the rhythm strip and marking two R waves on the paper which are next to each. When moving the paper along to the next R waves, the marks will still correspond if the rhythm is regular. The QRS width is narrow and normal in shape. There is atrial activity – P waves can be seen. The atrial activity is related to ventricular activity, with one P wave per QRS complex and a normal PR interval throughout. This is sinus bradycardia. There are several potential causes of sinus bradycardia, and these should be ascertained. For example, an athletic patient may have a slow heart rate (RCUK 2015a). Other causes can include hyperkalaemia (high potassium levels), vasovagal stimulation and certain medicines, such as beta blockers (RCUK 2015a).

Sinus tachycardia

In the rhythm strip shown in Figure 6, there is clearly electrical activity. The ventricular rate is approximately 125bpm. The QRS rhythm is regular. The QRS width is narrow and normal in shape. There is atrial activity – P waves can be seen. The atrial activity is related to ventricular activity, with one P wave per QRS complex and a normal PR interval throughout. This is sinus tachycardia. There are many causes of sinus tachycardia and these should be ascertained. Sinus tachycardia is a normal response of the heart to exercise and stress, including anxiety, fever and pain (Herzog 2012). In hypovolaemia, where the blood volume has dropped, the heart attempts to compensate for a decreasing stroke volume (the volume of blood ejected in each heartbeat), by raising the heart rate and hence the volume of blood expelled in each minute.
Atrial fibrillation
In the rhythm strip shown in Figure 7, there is clearly electrical activity. The ventricular rate is approximately 90bpm, with the range approximately 68-136bpm. The QRS rhythm is irregular. This can be ascertained by placing a piece of paper on the rhythm strip and marking two R waves on the paper which are next to each one. When moving the paper along to the next R waves, the marks will not correspond if the rhythm is irregular. The QRS width is narrow and normal in shape. Atrial activity is present, but it is not normal. There is no clear P wave but a coarse, fibrillating baseline between the QRS complexes. The atrial activity is related to ventricular activity, but in an intermittent fashion with electrical activity passing through the AV node irregularly. This is atrial fibrillation. This is a common arrhythmia, and is the most frequent sustained arrhythmia in older people (Ungar and Marchionni 2017). As discussed previously, the atria no longer contract in a steady, organised and regular beat-like fashion. Instead, there is continuous and chaotic electrical activity. It should be noted that there is a risk of clot formation in the atria, as a result of the turbulent blood flow. The treatment for atrial fibrillation will depend on a range of factors, and includes pharmacological rate or rhythm control.

Ventricular ectopics
In the rhythm strip shown in Figure 8, there is clearly electrical activity. The ventricular rate is approximately 107bpm where it is not interrupted by an abnormal shaped QRS complex. The QRS rhythm appears irregular because of the interruption by abnormal shaped QRS complexes. In some places, the QRS width is narrow and normal in shape, whereas in other places, it is wide and bizarre in shape. There is atrial activity - P waves can be seen. However, this does not precede the abnormal shaped QRS complexes. The atrial activity is related to ventricular activity, with one P wave per normal QRS complex and a normal PR interval throughout. However, there is no P wave associated with the
abnormal shaped QRS complexes. This is normal sinus rhythm with ventricular ectopics, also known as ventricular extrasystoles.

Ventricular ectopics represent individual foci of depolarization from within the ventricular wall. Since the impulse does not travel down the normal pathway, it takes time to travel through the myocardium. Therefore, it appears bizarre in shape. The ventricular ectopic is not triggered, and therefore preceded by, atrial activity, hence there is no P wave before it. It should be noted there is a short compensatory pause following the oddly-shaped ectopic beat, before the familiar P wave and sinus rhythm occurs again. It is best practice to measure the electrolytes when these abnormal impulses occur, notably blood potassium, and to consider the cause (Olson 2014). Ventricular ectopics do not usually require treatment.

**Third-degree (complete) heart block**

In the rhythm strip shown in Figure 9, there is clearly electrical activity. The ventricular rate is approximately 50bpm. The QRS rhythm is regular. The QRS width appears narrow and normal in shape; this is not always the case in this arrhythmia. There is atrial activity – P waves can be seen. The atrial activity is not related to ventricular activity, and the atrial rate is approximately 83bpm. This is best seen in several ways. For example, the healthcare practitioner could calculate the atrial (P wave) rate and the ventricular (QRS) rate. This will usually differ, as shown in the differing rates mentioned previously, because of a dissociation between the P waves and the QRS complex. To clearly identify this, the healthcare practitioner could mark off two P waves next to each other on a piece of paper. Moving the paper along will show that the P waves appear regularly but have no association with the QRS complexes. This is third-degree (complete) heart block.

Physiologically, in third-degree (complete) heart block, electrical impulses from the SA node are occurring but can no longer travel through the AV node to the ventricles (Grant 2014). The cause of this AV block may be idiopathic, chronic degenerative changes and infarction, among others. Therefore, the rhythm strip will show regular normal shaped P waves, which do not enter the ventricular conduction system, and hence facilitate depolarization of the ventricles. The heart remains functioning by the ventricles releasing ventricular beats, which are usually, but not always, slow. These are ectopic beats. The important factor in identifying this rhythm is the dissociation between the atrial and ventricular activity. The patient is likely to be bradycardic (Grant 2014) and they will feel unwell. If long-term, treatment is required through a permanent pacemaker to resynchronise atrial and ventricular activity.

**TIME OUT 5**

What are the ECG characteristics of atrial fibrillation and third-degree (complete) heart block? Can you explain to a colleague what is occurring physiologically to produce an ECG trace?
Answer to Time out 4: approximately 75bpm

TIME OUT 6
This article has discussed some of the common types of arrhythmia. Access a resource such as Tsiperfal et al (2011), Bennett (2013), Hampton (2013) or RCUK (2016) and consider four other arrhythmias that are not discussed in this article, for example first and/or second-degree heart block, ventricular tachycardia (VT) and atrial flutter. What are their characteristics on an ECG trace?

Conclusion
Cardiac monitoring and interpreting ECG rhythm strips can assist healthcare practitioners in diagnosing and treating patients. If explained carefully and empathically to patients and their families, who may be anxious, cardiac monitoring can provide reassurance and enables treatment to be instigated promptly. In addition, early warning signs of potential and actual clinical conditions can be identified, and further investigations and preventative action may be taken. Healthcare practitioners who are involved in monitoring patients’ ECG traces should have the ability to understand and interpret the trace. Rhythm strip analysis requires an underpinning knowledge base and practice, and a variety of resources are available to enhance this clinical skill.

TIME OUT 7
Nurses are encouraged to relate the four themes of The Code (NMC 2015) to their professional practice. Consider how an understanding of cardiac monitoring and interpretation of an ECG trace relates to The Code.

TIME OUT 8
Now that that you have completed the article, you might like to write a reflective account as part of your revalidation.

References


### Cardiac monitoring

**TEST YOUR KNOWLEDGE BY COMPLETING SELF-ASSESSMENT QUESTIONNAIRE 919**

1. **As part of the preparation for cardiac monitoring, the healthcare practitioner should:**
   - a) Wash the patient’s skin with mild soap, if necessary
   - b) Remove the patient’s chest hair in areas where electrodes need to be placed
   - c) Remove dead skin cells via exfoliation
   - d) All of the above

2. **What is the usual colour coding for a three-lead cardiac monitor?**
   - a) Red, yellow and green
   - b) Red, white and blue
   - c) Pink, grey and brown
   - d) Green, blue and purple

3. **In a three or five-lead cardiac monitor, healthcare practitioners are generally advised to use:**
   - a) Lead I
   - b) Lead II
   - c) Lead III
   - d) Lead IV

4. **Which of the following is not a component of normal sinus rhythm?**
   - a) The PR interval
   - b) The P wave
   - c) The SPQ interval
   - d) The T wave

5. **On a rhythm strip printed on graph paper, how would a healthcare practitioner calculate the patient’s heart rate using the six-second method?**
   - a) Count the number of large squares between two R waves and divide the number into 300
   - b) Count the number of small squares between two R waves and divide the number into 1,500
   - c) Count the number of R waves that appear in the length of 30 large squares and multiply by 10
   - d) Count the number of R waves that appear in the length of 50 large squares and multiply by 6

6. **The most common type of cardiac arrhythmia is:**
   - a) Atrial fibrillation
   - b) Sinus tachycardia
   - c) Ventricular ectopics
   - d) Third-degree (complete) heart block

7. **Which of the following is not a sign suggestive of haemodynamic compromise?**
   - a) Threaded pulse
   - b) Cold, clammy skin
   - c) Delayed capillary refill time
   - d) Nocturia

8. **In third-degree (complete) heart block:**
   - a) There is no electrical activity
   - b) The QRS width is wide and bizarre in shape
   - c) There is atrial activity – P waves can be seen
   - d) The QRS rhythm is irregular

9. **Which of the following is a possible cause of sinus bradycardia?**
   - a) Hyperkalaemia
   - b) Beta blockers
   - c) Vasovagal stimulation
   - d) All of the above

10. **Which statement is true?**
    - a) Sinus bradycardia is less likely in athletic patients
    - b) There should be three P waves for each QRS complex
    - c) The set international speed of a rhythm strip is 25 mm per second
    - d) Atrial arrhythmias will generally have a wide and bizarre shaped QRS complex

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**How to complete this assessment**

This self-assessment questionnaire will help you to test your knowledge. It comprises ten multiple choice questions that are broadly linked to the article starting on page 51. There is one correct answer to each question.

- You can test your subject knowledge by attempting the questions before reading the article, and then go back over them to see if you would answer any differently.
- You might like to read the article before trying the questions. The correct answers will be published in *Nursing Standard* on 22 November.

Subscribers making use of their RCNi Portfolio can complete this and other questionnaires online and save the result automatically.

Alternatively, you can cut out this page and add it to your professional portfolio. Don’t forget to record the amount of time taken to complete it.

You may want to write a reflective account based on what you have learned. Visit rcni.com/reflective-account

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**This self-assessment questionnaire was compiled by Alex Bainbridge**

The answers to this questionnaire will be published on 22 November

Answers to SAQ 917 on Eating disorders in children and young people, which appeared in the 25 October issue, are: