A novel systematic approach to ECG interpretation

Darlene Hutton, RN, BScN, MSN(c)

Abstract

Regardless of the patient's symptoms, the 12-lead electrocardiogram (ECG) needs to be assessed in a comprehensive and systematic manner in order to avoid missing critical information. The RIRI© approach to ECG interpretation offers a fast, reliable and systematic method to ensure that all aspects of interpretation are covered. The acronym is easy to remember and can be used by all health care practitioners ranging from novice to expert. RIRI reminds us to check the rate, intervals, rhythm and ischemia/infarction. Becoming familiar with the RIRI approach and consistently using this method will reduce the amount of time spent on the interpretation of the ECG and increase the time spent with the patient.*

**RIRI has been developed by Darlene Hutton, 2004*

For years, health care providers have been interpreting 12-lead electrocardiograms (ECG) but, at times, have missed critical information because of the quantity or the complexity of items to assess. A fast yet reliable method that provides a consistent approach to ECG assessment and interpretation is required to reduce the incidence of missed information. In this article, I will introduce the RIRI approach and how to integrate it into the assessment of the ECG. The RIRI approach is a simple tool that can be used by novice to expert practitioners and can be adapted to suit the specific skill level.

As simple as it may sound, the RIRI approach to ECG interpretation is comprehensive. The acronym "RIRI" reminds us to assess the following: rate, intervals, rhythm, ischemia/infarction. I would strongly suggest that when using this approach, it be used in this order. It is important to first assess the heart rate and then determine if the intervals are within normal limits prior to assessing the ST segment and T wave. This ensures that critical information, such as the presence of a left bundle branch block or an AV block, is not missed. A detailed examination of each component will now be presented (Table One).

Table One:
The RIRI systematic approach to ECG assessment

R =	Rate (six-second strip)
I =	Intervals PR (AV node problem), QRS (is wide, ACS is masked), QT (risk of Torsades de Pointes)
R =	Rhythm (is the patient hemodynamically unstable?)
I =	Ischemia/infarction (is there any ST segment elevation, depression, and/or T wave inversion in the presence of chest pain or equivalent? = ACS

Darlene Hutton, RN, BScN, MSN(c), Co-Founder of QRS Educational Services. Seneca College Critical Care Program Instructor and Coronary Care Instructor. Clinical Research Coordinator for Cardiology Research Associates and Rouge Valley Metabolic Research Associates.

Address correspondence to Darlene Hutton, 4040 Finch Avenue East, Suite 404, Scarborough, ON M1S4V5
E-mail address: dhutton@bellnet.ca,
Phone: (905) 706-3301

There are numerous methods to calculate the heart rate. The fastest method to determine the rate is to count the number of QRS complexes in a six-second period and multiply the total by 10. Using the "six-second rule" is reliable and fast, however, not as accurate as other methods. It is the opinion of the author that accuracy in assessing heart rate isn't as critical as assessing the impact of the rate on the patient. Thus, the six-second rule is considered to be a safe and effective means of determining heart rate.

Figure One shows how to determine where six seconds are on the 12-lead ECG. If using a standard 12-lead ECG machine, the first step is to locate the start of the V3 column and the end of the V3 column. A vertical line at the start and end of V3, not related to the cardiac cycle, indicates this. Once the start and end of the V3 column are visualized, estimate the middle of that column. The middle of the V3 column is the end of six seconds. The next step is to count the number of complexes from the beginning of the continuous rhythm strip found at the very bottom of the ECG, to the middle of the V3 column. This is six seconds. Multiply the total number of complexes by 10 to get the heart rate.

The next step in the RIRI approach to interpreting the ECG is to check the **intervals.** These intervals include the PR, QRS and QT interval. For the more experienced practitioner, addi-

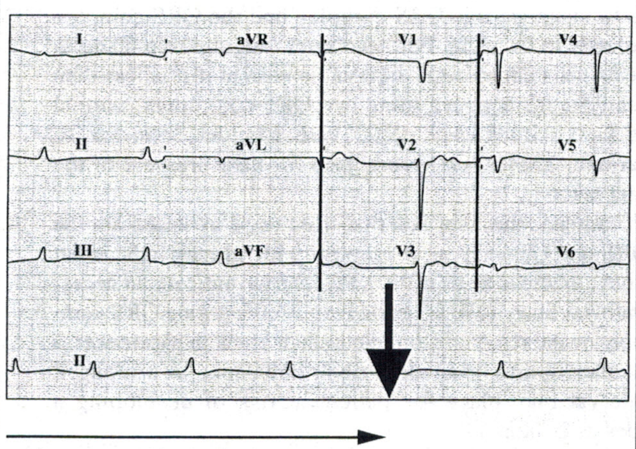


Figure One: Six seconds on an ECG are measured from the beginning of the ECG to the middle of the third column. The QRS complexes are then added and multiplied by 10. The heart rate in this case is approximately 40 beats per minute.

tional assessment of the ECG may be added during this stage, such as checking the axis and checking for potential hemiblocks. The main reason for assessing intervals is to determine if there are any abnormalities present. It is not necessary to assess every single lead of the 12-lead ECG. When measuring the PR and QRS intervals, the lead II rhythm strip is a good lead to assess. However, if lead II does not provide clear PR or QRS waves, often V1 or V2 may.

The normal PR interval ranges between 0.12 to 0.20 seconds, with some experts claiming a PR interval of 0.22 seconds is also within normal limits (Urden, Stacy, & Lough, 2002; Wagner, 1994). A PR interval that is prolonged or varies is likely due to an AV block. A PR interval that is shorter than 0.12 seconds may be due to an accessory pathway such as Wolff Parkinson White.

The width of the QRS complex may be difficult to measure and the upper limit may vary from 0.10 up to 0.14 seconds (Hampton, 2003; Urden et al., 2002; Wagner, 1994). If wide, the cause may be due to a bundle branch block, a pacemaker rhythm, a ventricular escape rhythm or an electrolyte imbalance. Normally, when the QRS complex is wider than normal, the ST segment and T wave will go in the direction opposite the QRS complex (Urden et al., 2002; Hampton, 2003). It is critical at this stage of the RIRI approach to assess if a wide QRS complex exists, as it will cause ST segment and T wave changes. These alterations in the ST segment and T wave, due to the wide QRS complex, will mask or hide acute changes associated with a myocardial infarction (Boudreau Conover, 2004).

The QT interval is as important to measure as the PR and QRS intervals. An abnormally long QT interval places the patient at risk for Torsades de Pointes. Torsades de Pointes is a polymorphic ventricular tachycardia associated with a long QT interval. Many things can predispose a patient to a lengthening QT interval and it is for this reason that it is now recommended that the QT interval be routinely assessed. The first step in assessing whether the QT interval is within normal limits or prolonged is to identify the QT interval. It is measured from the start of the QRS complex to the end of the T wave. Choose a lead on the ECG that offers good visualization of the start of the QRS complex and the end of the T wave. The next step is to visualize this QRS complex and the QRS complex immediately to the right. For heart rates ranging from 60 up to 100 beats per minute, a QT interval is normal if it is less than half the distance between these two QRS complexes (normal QT=½ R-R) (Urden et al., 2002; Luo, Michler, Johnston, & Macfarlane, 2004). See Figure Two for measurement of the QT interval.

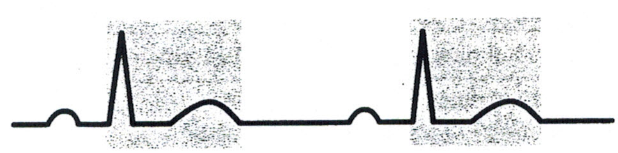
In summary, the intervals that need to be assessed are the PR, QRS and QT interval. A long PR interval may indicate an AV block, whereas a short PR interval may indicate an accessory pathway such as Wolff Parkinson White. A long QRS complex may be the result of a bundle branch block, a pacemaker, a ventricular rhythm or an electrolyte imbalance. A prolonged QT interval may place the patient at risk of developing a Torsades de Pointes.

The next step in the assessment of the ECG is to check the **rhythm.** Rhythms can originate from within the atria, junctional or ventricular area and may occur as a result of a problem with the electrical conduction of the heart, a mechanical problem with the heart, or some imbalance with homeostasis. Rhythms are interpreted based on a variety of criteria: what part of the heart the rhythm is coming from, whether there are premature or escapes beats present, to name a few. Essentially, it is at this step of the RIRI process that the assessment of the heart rate and measurement of the PR, QRS and QT interval that have just taken place are analyzed and determined to be normal or abnormal, life-threatening or not. According to the 2005 Advanced Cardiac Life Support (ACLS) treatment guidelines, rhythms, for the most part, fall into three categories: those that are stable and do not require emergency treatment, those that are too slow and those that are too fast (Kern, Halperin, & Field, 2001). A stable rhythm is one where the patient is stable as indicated by an adequate blood pressure and level of consciousness, and an absence of chest pain or pulmonary edema. Once a patient is considered unstable due to a slow or fast heart rate, the ACLS guidelines recommend using electricity.

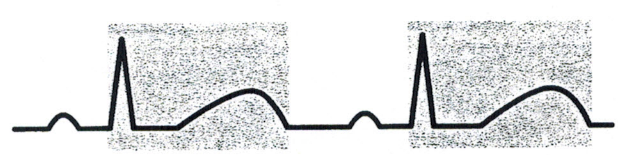
In the case of an unstable bradycardia, a pacemaker should be used. In the case of an unstable tachycardia, either cardioversion or defibrillation depending on whether a patient has a cardiac output or not. With pulseless ventricular tachycardia and ventricular fibrillation, immediate treatment is defibrillation. With a tachycardic rhythm where the unstable patient still has a cardiac output such as atrial flutter/fibrillation, atrial tachycardia, PAT and ventricular tachycardia with a pulse, emergency cardioversion is required (Kern et al., 2001).

In review, what has been covered in the RIRI approach to ECG interpretation so far? The **rate** has been assessed using the "six-second rule". The assessment of the **PR, QRS,** and **QT intervals** has been done to establish that the intervals are within normal limits. The **rhythm** and its effect on the patient have been assessed. The next important step when faced with a patient experiencing chest pain or equivalent is checking each lead on the ECG for **ischemia/infarction.**

Assessing the ST segment and T wave on the ECG is done to determine if the patient is experiencing an acute coronary syndrome (ACS), a term that includes unstable angina, non-ST elevation myocardial infarction (NSTEMI) or STEMI. In order to diagnose ACS, there must be two criteria met. The first criterion is the presence of symptoms, either chest pain or equiva-



Normal QT interval



Prolonged or abnormal QT interval

Figure Two: A normal QT interval is less than half the distance between the two QRS complexes. The top diagram shows a normal QT interval. The bottom diagram shows a prolonged QT interval.

lent. The second criterion is the presence of changes in the ST segment or T waves on the ECG (Hochman, Tamis, & Thompson, 1999; Armstrong, Bogaty, Buller, Dorian, & O'Neill, 2004). For this, the assessor must check the ST segment and T waves in each lead on the ECG. This is where the ECG is now examined in light of the walls of the heart each lead reflects. Leads II, III, and aVF look at the inferior wall of the left ventricle. Leads V1, V2, V3, V4 look at the anterior wall of the left ventricle. Leads I, aVL, V5, V6 look at the lateral wall of the left ventricle (Urden et al., 2002; Wagner, 1994). See Table Two.

When checking for ST changes, it is important to remember that in every lead of the ECG, the ST segment should be isoelectric or at baseline. Where is baseline? Baseline is just before the QRS complex, the PR segment. If a line was drawn starting on the PR segment and drawn right through the QRS complex to the ST segment, the ST segment should be at that baseline. If the ST segment is on baseline this is considered normal. The other element of the cardiac cycle to assess in determining if the patient is experiencing an ACS is the T wave. Other than aVR, the T wave should be upright in all leads. It is common to have flat or slightly inverted T waves in V1 but, in all other leads, the T wave should be smooth and upright (Wagner, 1994; Hampton, 2003). To diagnose ACS from the ECG criteria, two or more contiguous leads need to have ST segment deviation. Therefore, at least two inferior, lateral or anterior leads need to have some alteration in the ST segment or T wave in order to meet the criteria of ACS.

Table Two: Lead selection on the ECG corresponding to the heart, the coronary artery, and potential complications of ST segment elevation myocardial infarctions

Locating myocardial injury/ischemia/infarct			
Area	Leads	Artery involved	Complications
Inferior	II, III, aVF 15 Lead ECG: RV4=Right Ventricle V8, V9= Posterior	Right Coronary Artery	Right Ventricular MI • do 15 Lead prior to NTG/Morphine • fld bolus if hypotensive and chest is clear AV Blocks • pacemaker Bradycardia
Anterior	V1, V2, V3, V4	Left Anterior Descending Artery	Pulmonary edema Edema • assess lungs • if hypotensive, dopamine RBBB & Hemiblock • watch for axis change
Lateral	I, aVL, V5, V6	Circumflex	

If a patient is presenting with symptoms thought to be cardiac in nature and there are changes in the ST segment or T waves, this is considered to be an ACS. ACS needs to be promptly treated, as the coronary artery causing the symptoms and ECG changes is completely blocked (ST elevation) or almost completely blocked (ST depression and/or T wave inversion) (Urden et al., 2002; Hochman et al., 1999; Armstrong et al., 2004). Without aggressive therapy, the patient is at high risk of sudden cardiac death and other major, life-threatening complications related to myocardial infarction.

Our role as critical care nurses is to assess the ECG, determine if there are any potential life-threatening rhythm disturbances or changes associated with ACS, inform the physician promptly of these concerns and anticipate the appropriate nursing and medication interventions. The RIRI approach to ECG interpretation provides the practitioner with a tool that quickly and efficiently ensures that all aspects of the ECG are assessed in a thorough and timely fashion; therefore, increasing the time spent with the patient.

References

Armstrong, P., Bogaty, P., Buller, C., Dorian, P., & O'Neill, B. (2004). The 2004 ACC/AHA Guidelines: A perspective and adaptation for Canada by the Canadian Cardiovascular Society Working Group. **Can J Cardiol, 20,** 1075-1079.

Boudreau Conover, M. (2004). **Mosby's pocket guide series electrocardiography.** St. Louis: Mosby.

Drew, B.J. (2002). Celebrating the 100th birthday of the electrocardiogram: Lessons learned from research in cardiac monitoring. **American Journal of Critical Care, 11,** 378-386.

Hampton, J. (2003). **The ECG in practice.** Toronto: Churchill Livingstone.

Hochman, J., Tamis, J., & Thompson, T. for the Global use of strategies to open occluded coronary arteries in acute coronary syndromes IIb Investigators. (1999). Sex, clinical presentation, and outcome in patients with acute coronary syndromes. **New England Journal of Medicine, 341,** 226-232.

Jenkins, D., & Gerred, S. (2002, October 12). **A lady with Romano-Ward Syndrome.** Retrieved July 2, 2005, from http://www.ecglibrary.com

Kern, K., Halperin, H., & Field, J. (2001). New guidelines for cardiopulmonary resuscitation and emergency cardiac care. Changes in the management of cardiac arrest. **Journal of the American Medical Association, 285,** 1267-1269.

Luo, S., Michler, K., Johnston, P., & Macfarlane, P. (2004). A comparison of commonly used QT correction formulae: The effect of heart rate on the QTc of normal ECGs. **Journal of Electrocardiology, 37,** 81-90.

Ruskin, J. (n.d.). **Drug-induced proarrhythmia and the use of QTc prolonging agents: Clues for clinicians.** Retrieved July 5, 2005, from http://naspe.box21.com/GR/RUS/start.html

The University of Arizona Center for Education and Research on Therapeutics. (2005, June 30). **Drugs that prolong the Qt interval and/or induce Torsades de Pointes ventricular arrhythmia.** Retrieved July 2, 2005, from http://www.qtdrugs.org

Urden, L., Stacy, K., & Lough, M. (2002). **Critical care nursing diagnosis and management.** Toronto: Mosby.

Wagner, G. (1994). **Marriott's practical electrocardiography.** Baltimore: Williams & Wilkins.