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Basic Electrocardiography*

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HOW TO USE THIS SECTION

This chapter presents information about the interpretation of the basic 12-lead electrocardiogram (ECG). It is intended to be used as a reference and assumes a basic understanding of the PQRST complex. The authors' goal is to provide a condensed database from which useful interpretation of the ECG can be drawn or extrapolated. Included are sections discussing the following:

- Rate and Rhythm
- Conduction
- Axis
- P wave, PR interval
- QRS complex
- S–T–U complex and QT interval
- Myocardial ischemia and infarction
- Ventricular hypertrophy
- Miscellaneous disease patterns
- Arrhythmia differentials and algorithms

RATES AND BASIC RHYTHMS

Rhythm = “three or more of anything in a row.”

Sinus Rhythms (usually upright P waves in leads I, II, aVF)

- Normal sinus rhythm (60–100/min)
- Sinus bradycardia (< 60/min)

*Adapted from Evans GT Jr: *ECG Interpretation Crib Sheets*. Ring Mountain Press, 232 Granada Drive, Corte Madera, CA 94925.

- Sinus tachycardia ($> 100/\text{min}$)
- Sinus arrhythmia ($> 10\%$ variation in P–P interval)

Atrial Rhythms

- Ectopic atrial rhythm (single, nonsinus P wave shape; atrial rate $< 101/\text{min}$)
- Multiform atrial rhythm (\geq two P wave shapes; atrial rate $< 101/\text{min}$)
- Atrial tachycardia (nonsinus P waves; atrial rate $> 100/\text{min}$)
- Multifocal atrial tachycardia (MAT) (three or more different P waves; ventricular rate $> 100/\text{min}$)
- Atrial fibrillation (variable atrial morphology; atrial rate $\geq 350/\text{min}$)
- Atrial flutter (identical repetitive atrial waveforms; atrial rate $300 \pm 50/\text{min}$)

Premature Complexes

- Premature atrial complexes (PACs) (either conducted or nonconducted)
- Premature junctional complexes (PJC)s
- Premature ventricular complexes (PVCs)

Atrioventricular (AV) Dissociation

May be complete or incomplete (presence of capture or fusion complexes). There are four major causes:

1. Slowing of the primary pacemaker, eg, sinus bradycardia with junctional escape rhythm (JER)
2. Speeding of a subsidiary pacemaker, eg, ventricular or junctional tachycardia (JT)
3. Third-degree AV block
4. Combinations of the first two (ie, some sinus slowing with accelerated JER or JT)

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Paroxysmal Supraventricular Tachycardia (PSVT)

1. **Atrioventricular reentry tachycardia (AVRT):** Inverted P separate from QRS in the ST segment, or short R–P tachycardia, also known as orthodromic reciprocating tachycardia (ORT)

2. **Atrioventricular nodal reentry tachycardia (AVNRT):** P hidden in QRS or distorting the end of the QRST complex.

Atrioventricular Block (AV Block)

Differential diagnosis: Ischemia, infarction, degeneration, medications

1. **First-degree (1°):** PR prolongation ($PR \geq 0.21$ s) with all P waves followed by QRST
2. **Second-degree (2°):** Nonconducted QRST with on-time P waves
 - a. **Mobitz type I (Wenckebach):**
hjkhjk
A pause follows progressively shorter R–R intervals.
The first R–R interval following the pause is longer than the one before it.
The length of the pause is shorter than any two consecutive short R–R intervals.
 - b. **Mobitz type II:** Intermittent blocked P wave with constant PR intervals.
2:1 AV block:
May be seen with type 1 or type 2 block, or by itself.
Constant PR intervals, with every second P wave dropped.
 - c. **High-grade (advanced):**
Two or more successive P waves are blocked.
The atrial rate exceeds the ventricular rate.
3. **Third-degree (3°):** Complete AV dissociation.
 - a. Complete dissociation of the P waves and QRST complexes.
 - b. The atrial rate exceeds the ventricular rate.

Other Categories Not Listed Above

Classification	Junctional	Ventricular
Escape	40–60 bpm*	25–40 bpm
Accelerated	61–100 bpm	41–100 bpm
Tachycardia	> 100 bpm	> 100 bpm

*bpm = beats per minute

CONDUCTION

Sinoatrial Block

Commonly secondary to digitalis, hyperkalemia, class 1a antiarrhythmics.

1. **First-degree:** Not ordinarily discernible.
2. **Second-degree Mobitz type 1 (Wenckebach):**
P–P intervals before a pause shorten.
P–P interval following a pause is shorter than the P–P following it.
The duration of the pause is less than the sum of any two consecutive short cycles.
3. **Second-degree Mobitz type 2:**
The pause equals two or more cycles.
During pauses, there are either escape beats or no P or QRST complexes.
4. **Third-degree:** Atrial standstill.

Intraventricular Block and Bundle Branch Blocks

Defined as prolonged QRS duration of most common QRS complex (adult normal range 70–113 ms).

Right Bundle Branch Block (RBBB)

1. **Criteria:**
QRS ≥ 0.12 s in the limb leads
Right precordial leads:
QRS: wide RSR' (90%), notched R (10%)
ST segment: depressed
T wave: inverted
Left precordial leads and lead I:
QRS: wide, with wide slurred S wave
ST segment: normal
T wave: upright
2. **Causes:** Usually associated with organic heart disease. Sometimes seen in healthy individuals.