Cardiac Monitoring (rev)

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Normal ECG criteria

Rate		Atrial and ventricular rates are the same. In adults, 60 to 100 cycles/min; in infants and children, within normal limits for age
Rhythm		Regular, with variance between P-P and R-R intervals less than 0.16 second
P wave		Present and 1:1 with the QRS
	Shape	Uniformly rounded without peaking or notches
	Size	Amplitude <3.0 mm, width 1.5 - 2.5 mm or duration of 0.06 - 0.11 second
	Axis	0 to +90 degrees
	Deflection	Upright in leads I, II, aVF, V_4 through V_6; inverted in aVR; may be flat, inverted, or biphasic in leads III, V_1, and V_2
PR interval		Consistent; in adults, 0.12 - 0.20 second; in infants and children, 0.11 - 0.18 second
QRS		Follows the P wave; QRS interval is 0.04 - 0.10 second
	Q wave	Duration is <0.03 second; depth is 1-2 mm in leads I, aVL, V_5, and V_6; deep QR or QS in aVR and possibly in lead III
	Amplitude	5-25 mm in limb leads, 5-30 mm in V_1 and V_6, 7-30 mm in V_2 and V_5, 9-30 mm in V_3 and V_4
	Axis	-30 to +100 degrees
QT interval		Interval <50% preceding R-R; QTc <0.42 second (men) and <0.43 second (women)
ST segment		Follows isoelectric line, slight curve at proximal portion of the T wave
		Not depressed more than 1 mm
		May be normally elevated 1-2 mm in V_1 through V_3
T wave		Asymmetric and slightly rounded, without sharp points or large notches
	Deflection	Should be in the same direction as QRS: upright in leads I, II, aVF, V_4 through V_6; inverted in aVR; varied in leads III, aVL, and V_1 through V_3

Standard electrode placement with a 5-lead set
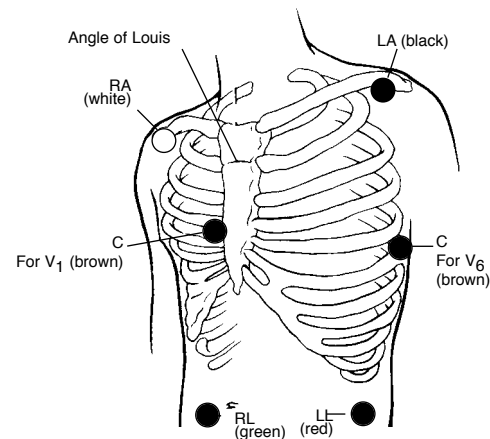
Leads recommended for arrhythmia monitoring

For monitors with 5-leadwire patient cables
1st choice
Single-lead monitoring: V_1
Dual-lead monitoring: V_1 + II

2nd choice
Substitute V_6 for V_1 when the patient cannot have an electrode at the sternal border or when QRS amplitude is not adequate for optimized computerized arrhythmia monitoring.

Leads recommended for ischemia monitoring

Inferior myocardial infarction or RCA angioplasty/stent	II, III, or aVF
Anterior myocardial infarction or LAD angioplasty/stent	V_2 or V_3
Posterior or LCX angioplasty/stent	V_2 or V_3

Wide QRS tachycardias: distinguishing supraventricular tachycardia with bundle branch block or aberrant conduction from ventricular tachycardia (VT)

Four-step approach to diagnosis
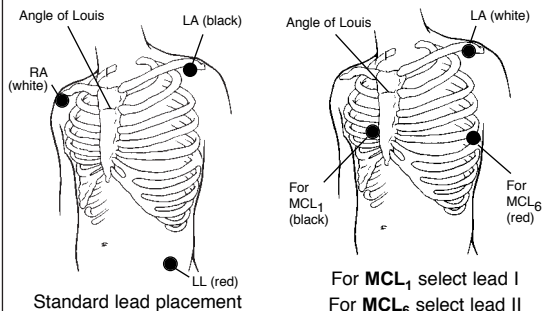
Using the bedside monitor:

1. Presence of A-V dissociation → Yes = VT
2. QRS width > 0.16 second → Yes = VT
3. Electrical axis -90° - ±180° → Yes = VT
4. QRS morphology in leads V_1 or V_6 → Yes = VT

(MCL_1 or MCL_6) suggestive of VT (see table right)

Axis determination using lead I and aVF

QRS polarity lead I	QRS polarity lead aVF	Axis
		Normal (0° to +90°)
		Right (+90° to ±180°)
		Left (0° to -90°)
		Highly abnormal (-90° to ±180°)

Electrode placement with a 3-lead set

Angle of Louis — LA (black)
RA (white)
LL (red)
Standard lead placement

Angle of Louis — LA (white)
For MCL_1 (black)
For MCL_6 (red)

For MCL_1 select lead I
For MCL_6 select lead II

Leads recommended for monitors with 3-lead patient cables:
1st choice, MCL_1; 2nd choice, MCL_6; 3rd choice, lead II

V_1 or MCL_1	V_6 or MCL_6
Ventricular tachycardia	
Monophasic R	Biphasic rS with R:S ratio <1.0 *
Taller left peak	Monophasic Q
Biphasic RS	Notched QS
Biphasic qR	Biphasic qR
Any of the following in V_1 or V_2: a) R >30 ms b) Slurred or notched S descent c) QRS onset to S nadir >60 ms	Intrinsicoid deflection ≥ 70 ms

Supraventricular tachycardia with bundle branch block or aberration

Bimodal rR' or triphasic rsR'	Triphasic qRs with R:S ratio >1.0 *
All of the following in V_1 and V_2: a) R ≤ 30 ms or no R b) Straight S descent c) QRS onset to S nadir ≤ 60 ms *And,* no Q in V_6	Intrinsicoid deflection ≤ 50 ms

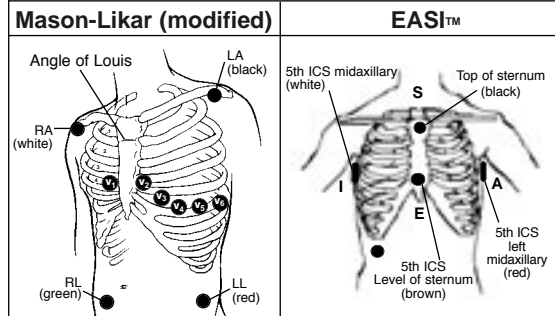### Unhelpful QRS morphologies

Slurred or notched taller right peak	Monophasic R
	Taller left or right peak
	Biphasic Rs with R:S ratio >1.0

*Applies only to tachycardias with a positive waveform in V_1.

ECG indicators of myocardial damage

Ischemia Inverted T wave ST depression	• Inverted T waves in leads with upright QRS deflections. • Deeply inverted T waves in precordial leads. • Transient ST-segment depression reflects acute ischemia. • Permanent ST-segment depression may indicate digitalis effect, LVH.
Injury Elevated ST segment	• Sign of an acute process; returns to baseline with time. • ST elevation may indicate pericarditis. • Determine location of injury similar to MI location process. • ST depression that occurs in an ECG and that also has ST elevation in other leads reflects reciprocal changes.
Infarction Q wave changes	• Evaluate Q wave size—normally small in leads V_5 and V_6; normally deep in leads III and aVR • Prolonged Q wave is ≥ 0.04 second. • Loss of R wave V_1 through V_3

12-lead placement

Mason-Likar (modified)

Angle of Louis
LA (black)
RA (white)
RL (green)
LL (red)

EASI™

5th ICS midaxillary (white) — S — Top of sternum (black)
I — A
E
5th ICS left midaxillary (red)
5th ICS Level of sternum (brown)

References

1. Drew BJ. Bedside electrocardiographic monitoring: state of the art for the 1990s. *Heart Lung.* 1991;20:610-623.
2. Drew BJ. Bedside electrocardiogram monitoring. *AACN Clin Issues.* 1993;4:25-33.
3. Drew BJ, Krucoff MW, for the ST-Segment Monitoring Practice Guideline International Working Group. Multilead ST-segment monitoring in patients with acute coronary syndromes: a consensus statement for healthcare professionals. *Am J Crit Care.* 1999;2:372-388.