Arrhythmia Interpretation Workshop

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Objectives

- Describe the important steps in analyzing rhythm strips.
- Describe the diagnostic criteria for each of the rhythms discussed below.
- Differentiate distinctions between atrial, AV blocks, and ventricular arrhythmias.
- Analyze unknown rhythm strips and accurately diagnose normal sinus rhythm, sinus bradycardia, sinus tachycardia, sinus arrhythmia, premature atrial contractions, paroxysmal atrial tachycardia, atrial flutter, atrial fibrillation, first degree AV block, second degree AV blocks, third degree AV block, premature ventricular contractions, ventricular tachycardia (Torsades de pointes), ventricular fibrillation and asystole.
- Propose appropriate first line treatment options for each arrhythmia.

Disclosure Statement

- No association or financial arrangement with any vendor or pharmaceutical company.

First Things First

- Coming from a Primary Care Perspective
- Evaluate an ECG the same way each time
- Develop a system to accomplish this process
- Force yourself to practice

Plan for Workshop

- Develop an organization plan for Arrythmias
- Work through each set (in your handouts)
- Discuss and focus on key concepts
- Move on to next set
- Ask questions along the way

Introduction

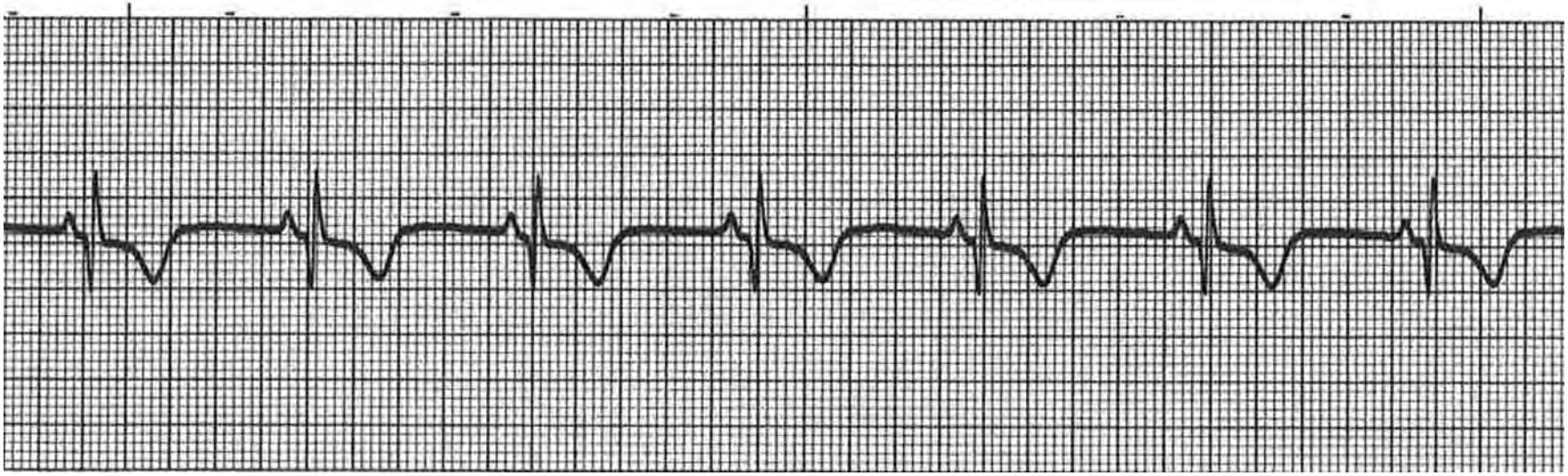
- Assume all rhythm strips are from Limb Lead II
- Know initial management/Tx where appropriate
- Leads used in monitoring patients
  - II
  - V1
  - MCL1

12-Lead ECG Method

- ~~Gestalt or general impression~~
- ~~Determine the Heart Rate~~
- ~~Determine the Rhythm~~
- ~~Measure the Longest Interval in the Limb Leads~~
- ~~Determine the Axis~~
- ~~Assess the R-Wave Progression~~

Method for Rhythm Strip Analysis

- For each rhythm strip, note the following:
  - Determine regularity (rhythm)
  - Calculate rate
  - Location and morphology of P-waves
  - Measure PR interval (fixed or variable)
  - Measure QRS interval



For each rhythm strip, note the following:

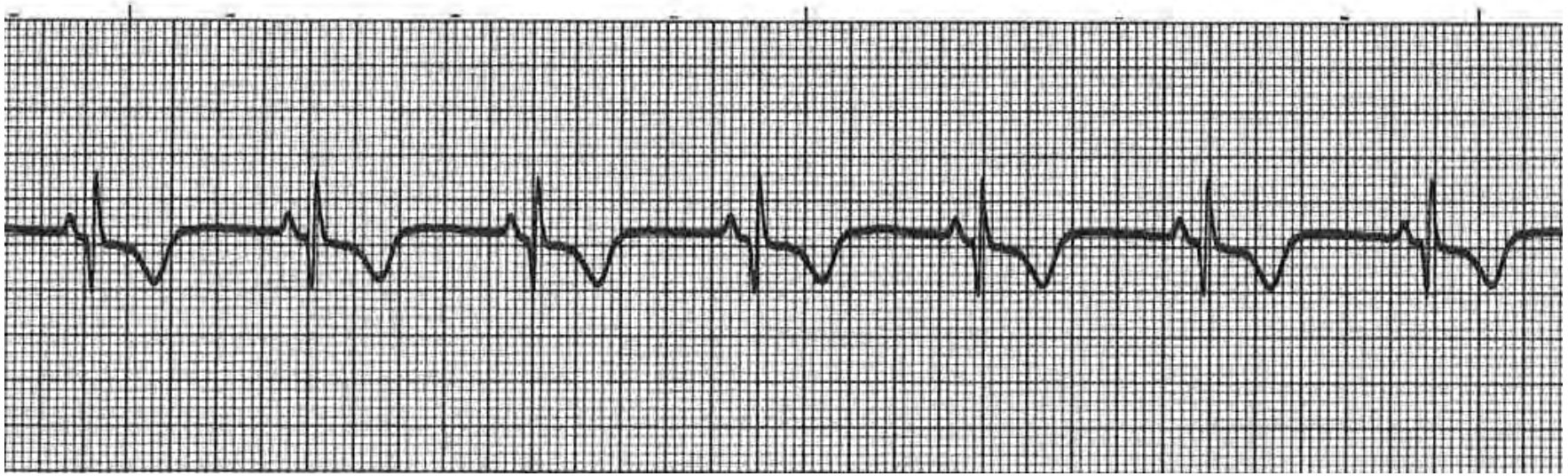
Determine regularity (rhythm)
Calculate rate
Location and morphology of P-waves
Measure PR interval (fixed or variable)
Measure QRS interval

Arrhythmia Handout and Practice

- Lecture will cover the basics
- Review appropriate material in handout
- Work through homework for each section
- For homework:
  - Determine rhythm, calculate HR, Note presence of P-waves, measure PR and QRS intervals, determine rhythm interpretation

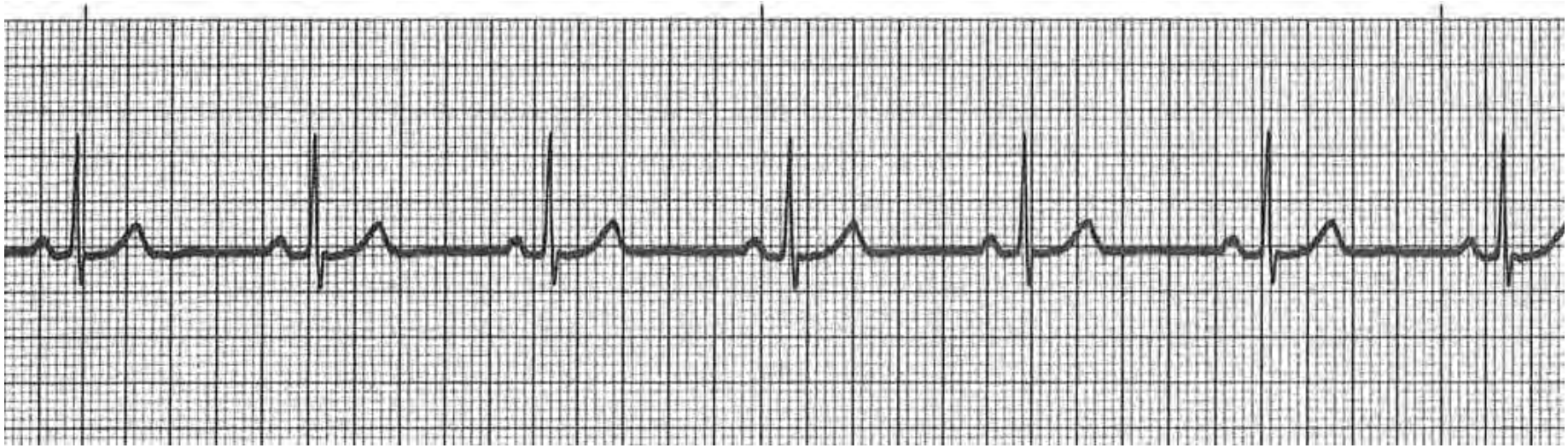
SINUS ARRHYTHMIAS

Normal Sinus Rhythm (NSR)



Rate: 60 - 100 bpm
Rhy: Regular
P-wave: Present, 1:1 with QRS, look the same
PR: 120 – 200 ms
QRS: <120 ms

Sinus Bradycardia

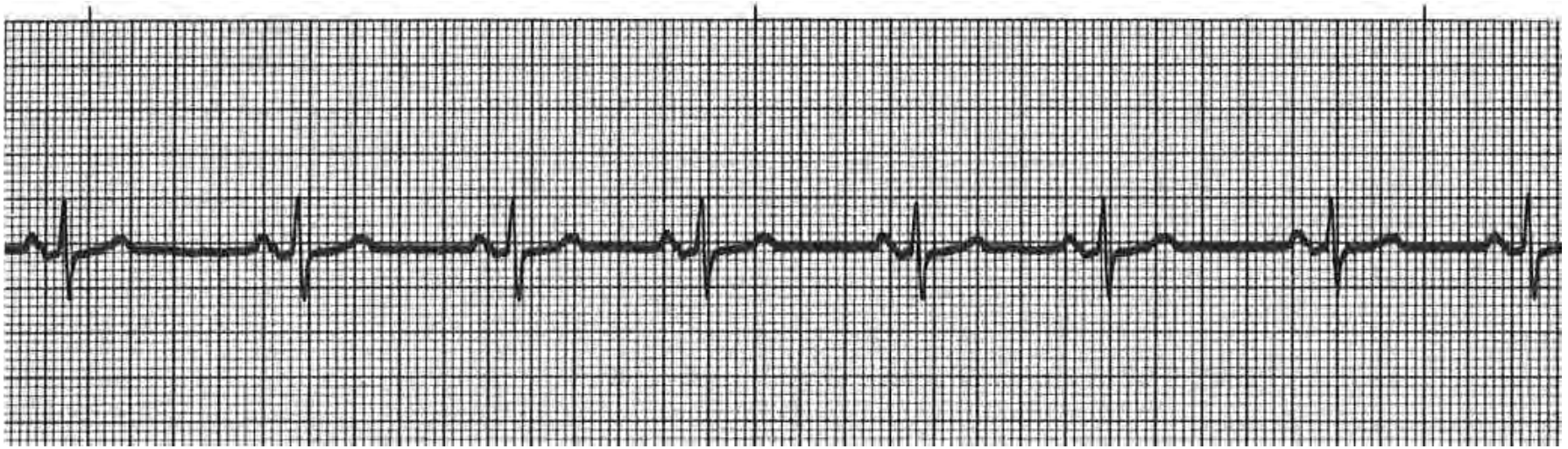


Rate: 40 - 60 bpm
Rhy: Regular
P-wave: Present, 1:1 with QRS, look the same
PR: 120 – 200 ms
QRS: <120 ms

Sinus Tachycardia

Rate: 100 - 160 bpm
Rhy: Regular
P-wave: Present, 1:1 with QRS, look the same
PR: 120 – 200 ms
QRS: <120 ms

Sinus Arrhythmia



Rate: 60 - 100 bpm
Rhy: Irregular
P-wave: Present, 1:1 with QRS, look the same
PR: 120 – 200 ms
QRS: <120 ms

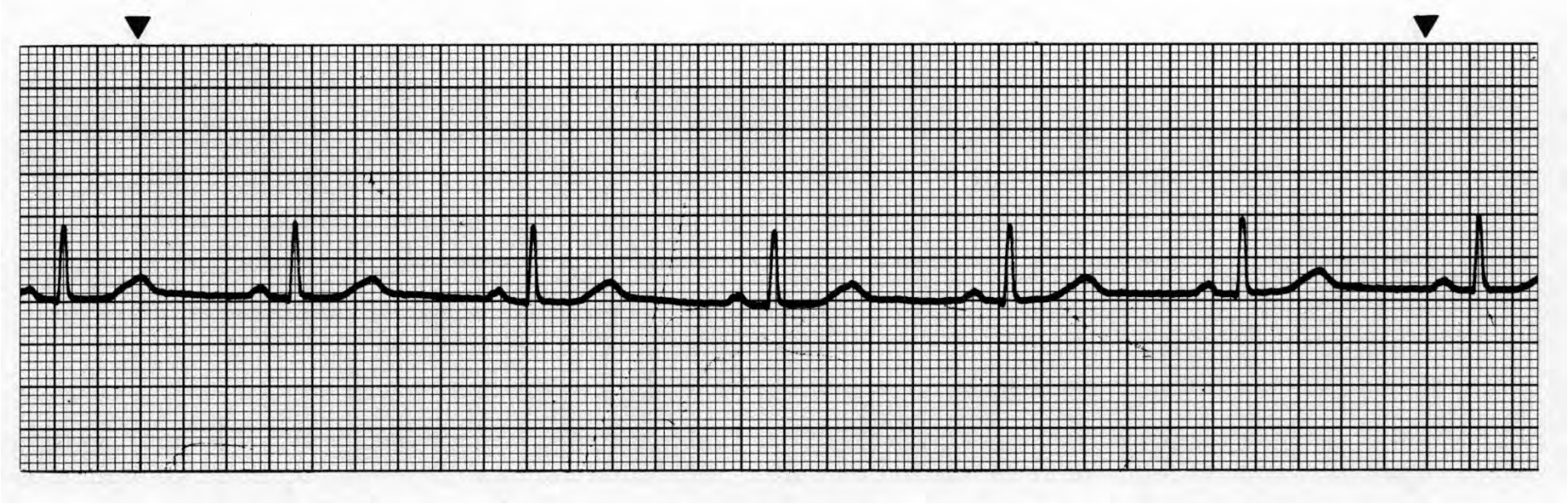
Homework Assignment

- Complete the following rhythm strips:
- Work in pairs, 10 minutes

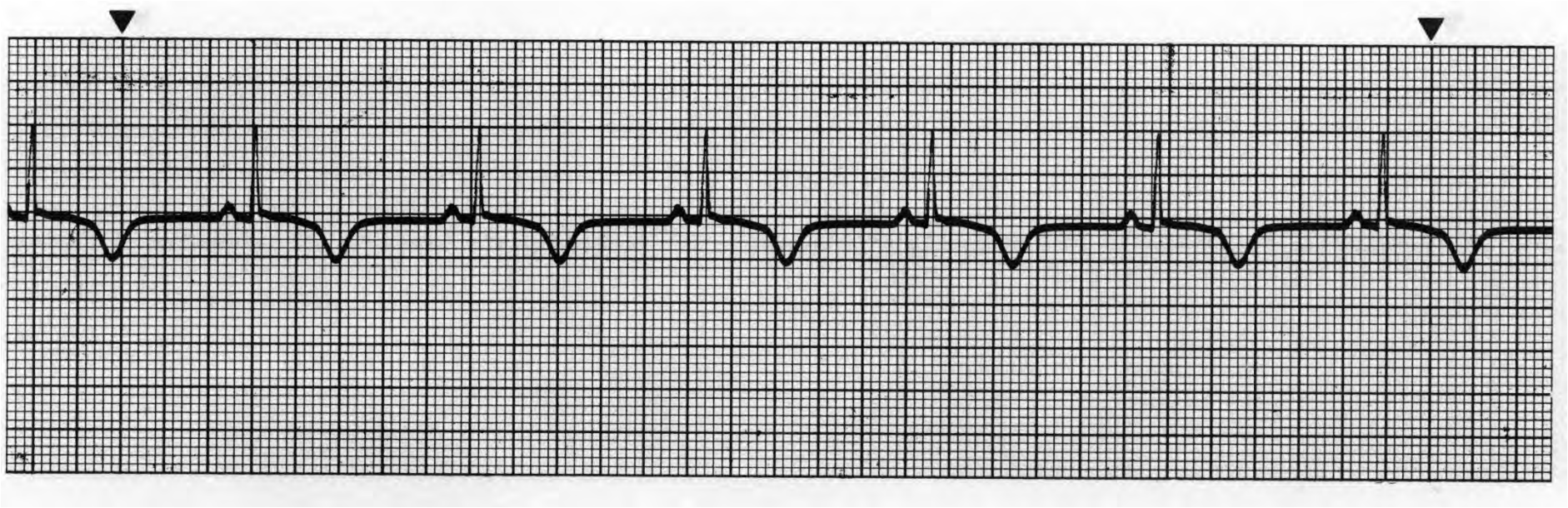
- 1, 2, 3, and 4

Practice 1

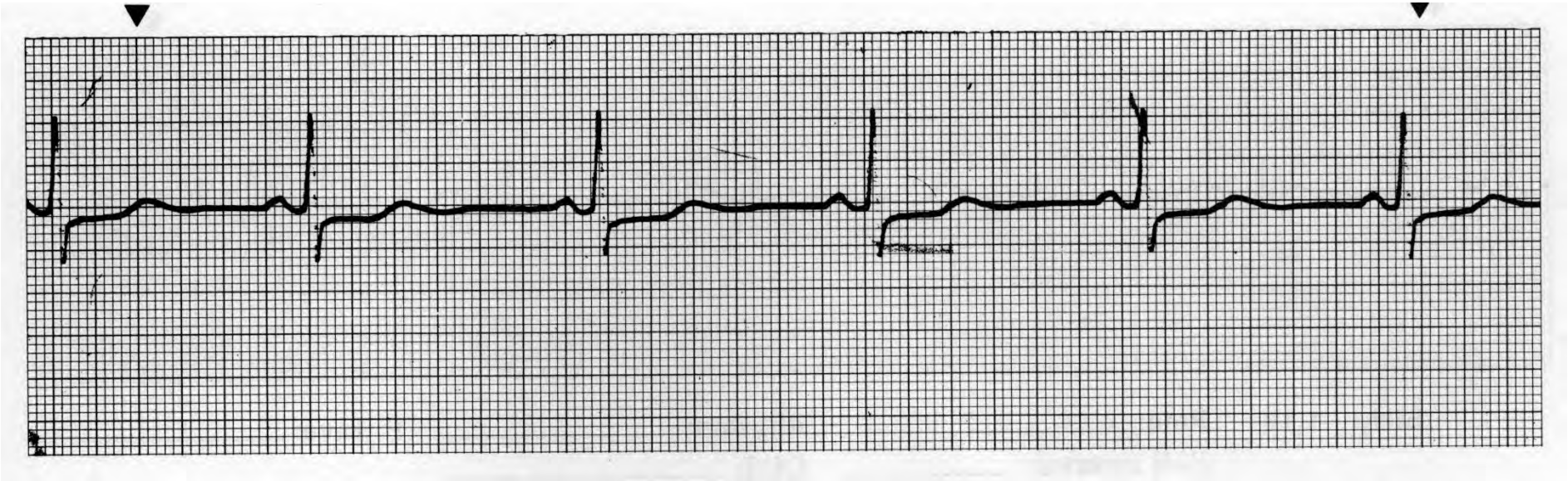
Practice 2



Practice 3

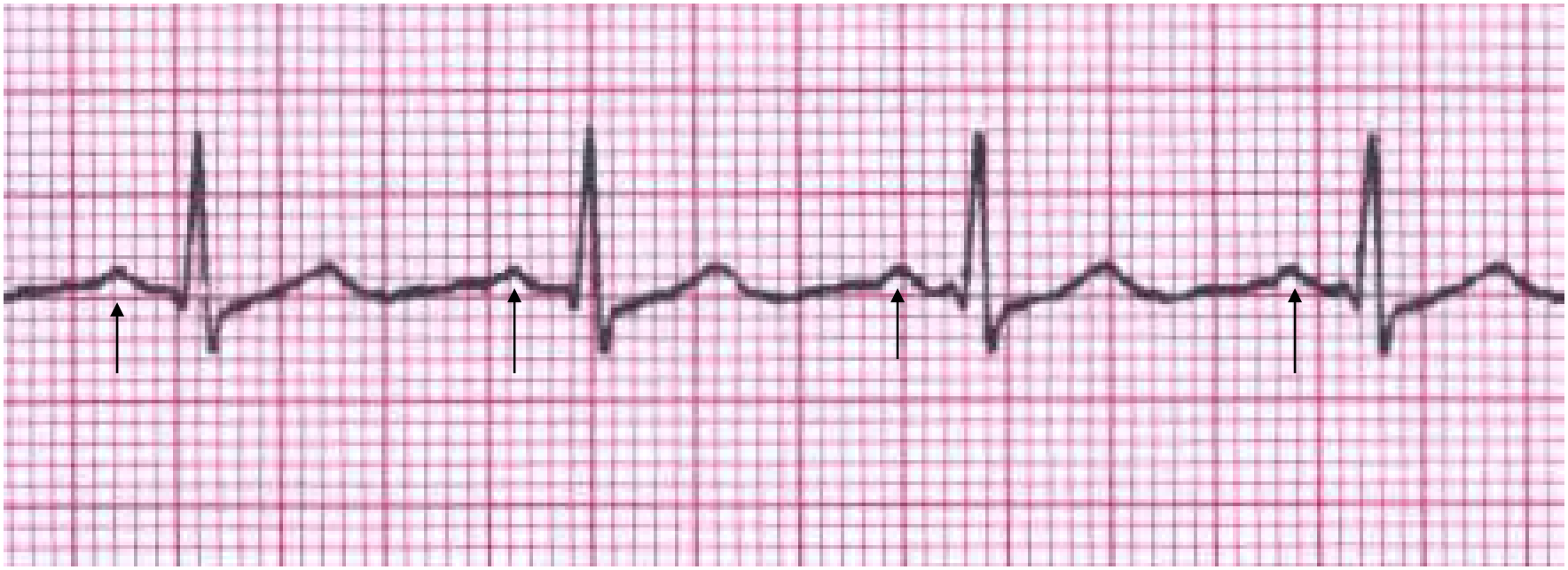


Practice 4



ATRIAL ARRHYTHMIAS

Location and Morphology of “P” Waves

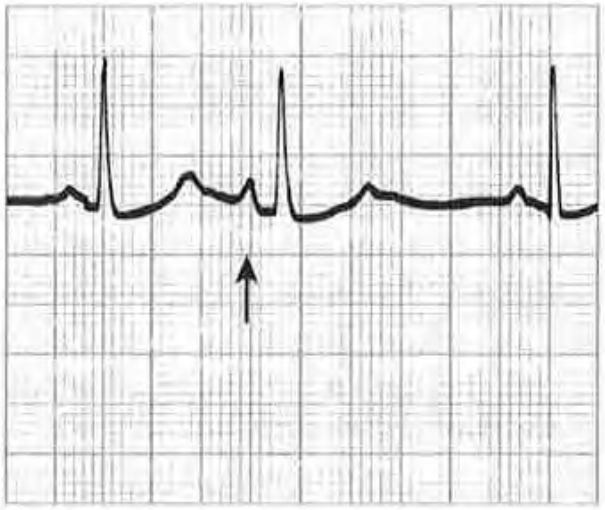


A single P-wave should proceed each QRS complex.

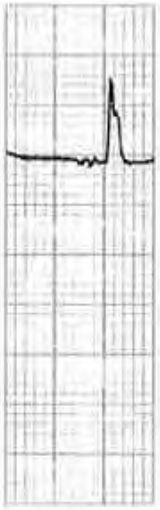
Should bear a family resemblance to all other P-waves.

Measure the PR interval.

Various P waves



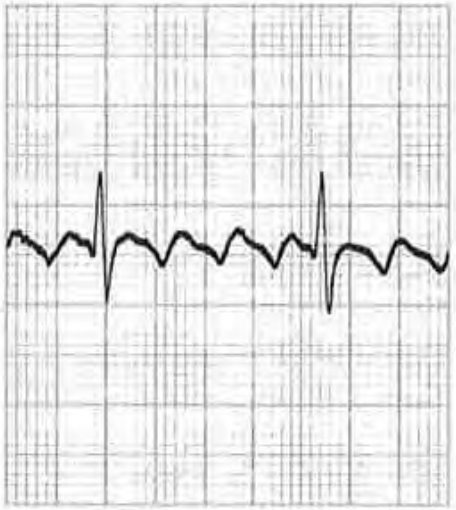
Pointed



Squiggle

Inverted

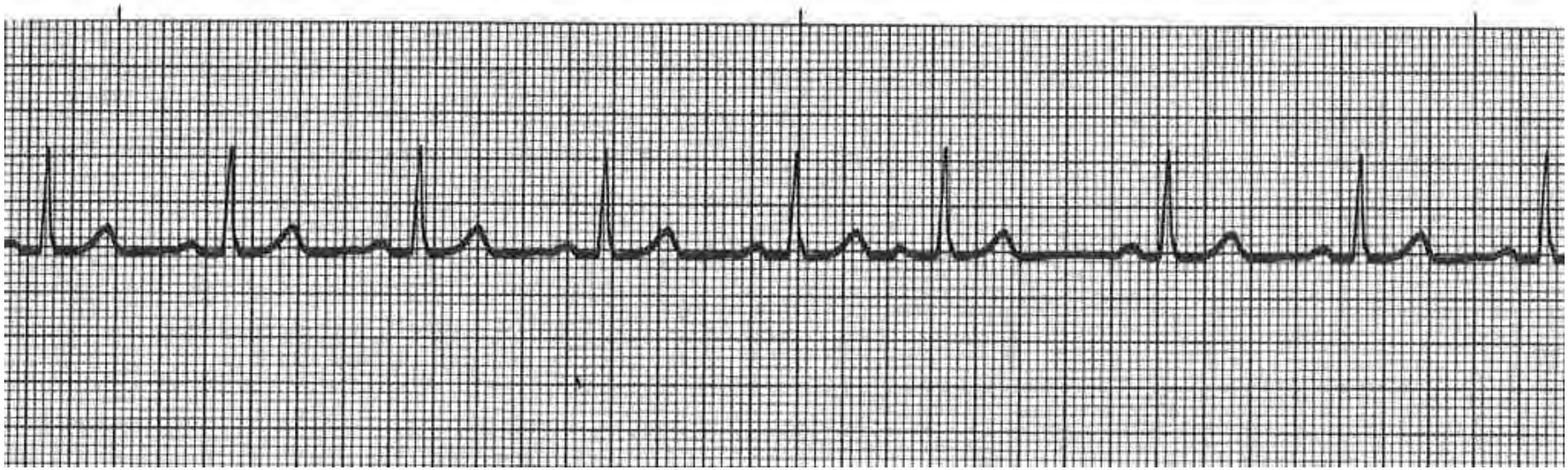
TP wave



Sawtooth

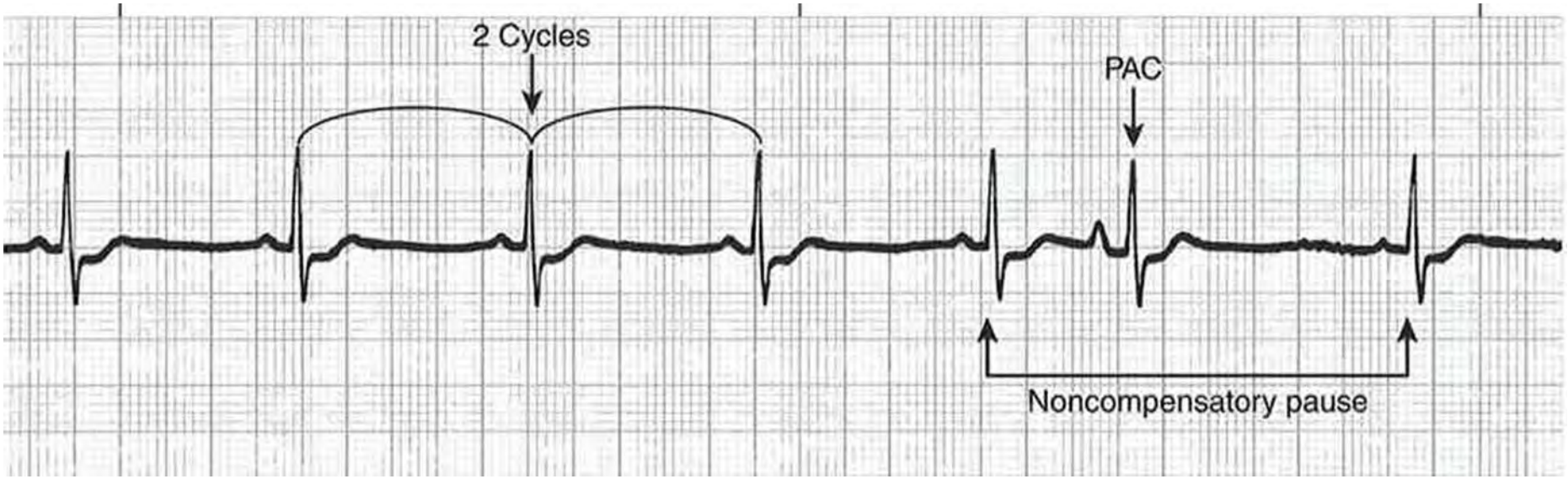
Wavy

Premature Atrial Contraction (PAC)

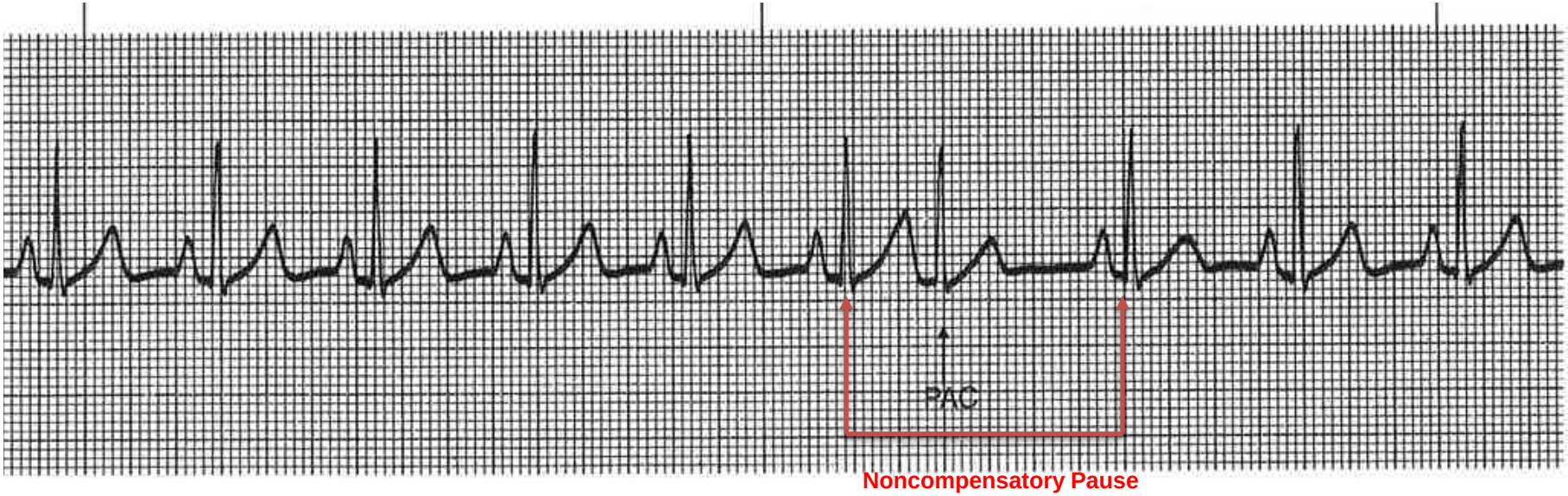


Rate: 60 – 100 bpm
Rhy: Underlying usually regular, Irregular with PAC
P-wave: Present, 1:1 with QRS, look the same except
P wave associated with PAC, early, lost in T wave
PR: Usually normal, maybe shorter,
QRS: <120 ms

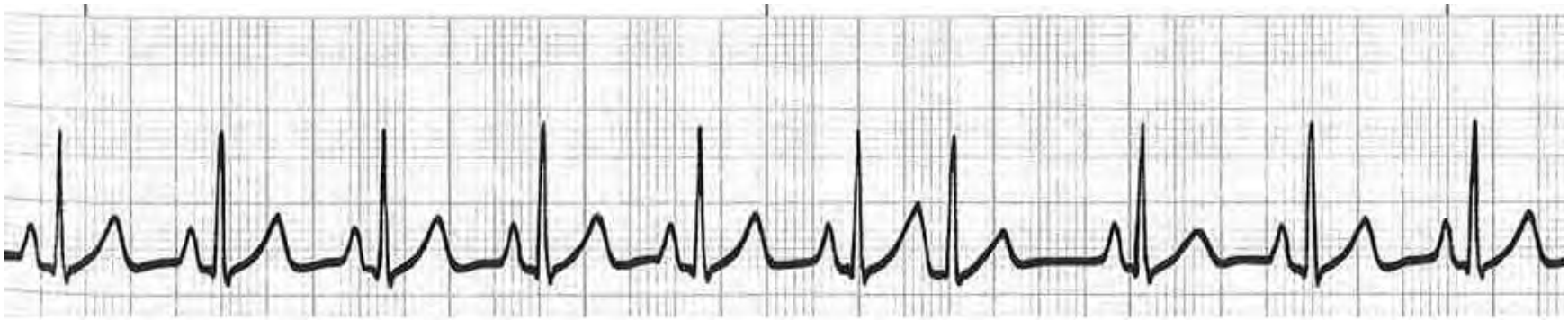
Noncompensatory Pause with PAC

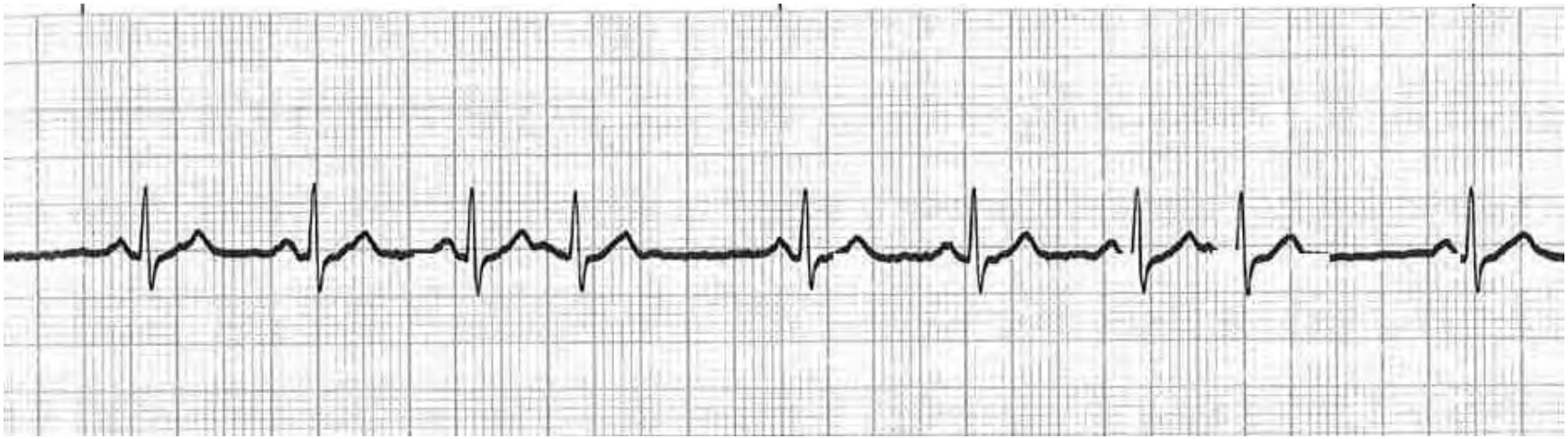


Noncompensatory Pause with PAC



PACs





PACs

- Causes
  - Increased sympathetic tone, stimulants (drugs, caffeine, tobacco), hypoxia, electrolyte imbalance, ischemia, injury, HF…..
- Treatment aimed at the underlying condition

- Occasionally occur later than earlier, referred to as an “escape beat”

Atrial Arrhythmias

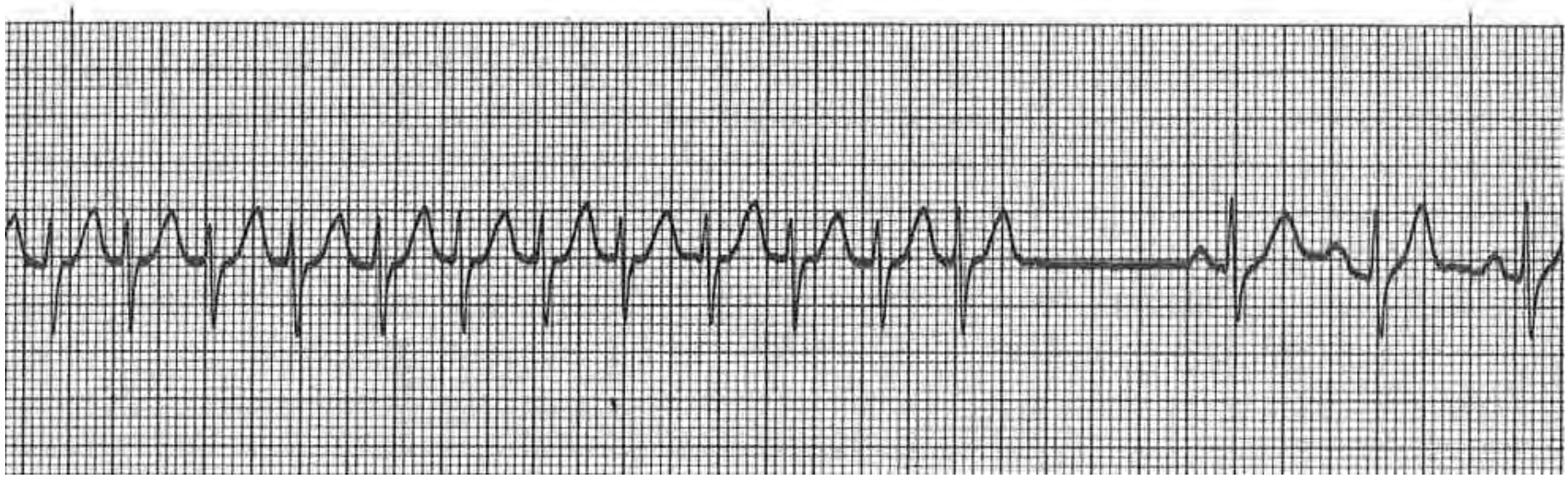
- Very common in clinical practice
- Usually easy to differentiate and diagnose
- Will cover A Fib, A Flutter, and PSVT

Paroxysmal Supraventricular Tachycardia (PSVT)

Rate: 140 - 250 bpm*
Rhy: Very Regular
P-wave: Lost in the T-wave, not typically observed on rhythm strip
PR: Not measurable
QRS: Normal (narrow, <0.12 sec)

Paroxysmal Supraventricular Tachycardia (PSVT)

- Lots of names (AVNRT, AVRT, AT, PAT…)
- Typically, a “reentry” process
- Often presents abruptly for a number of reasons.
- Symptoms can include: light-headedness, syncope, racing heart. Can worsen angina and heart failure.
- Signs: Rapid HR, low BP?
- Can manage most in office.



PAT Treatment Options

- Depends on patient's tolerance of the rhythm
- Unstable – Cardioversion (synchronized)
- Stable
  - Vagal maneuvers
  - Adenosine
  - Calcium channel blocker or Beta blockers

ATRIAL FIBRILLATION

Epidemiology

- Most common arrhythmia
- Prevalence about 3% in adults >20 years old
- More common in men (1.1%) than women (0.8%)
- More common with increasing age
- Lifetime risk of AF at age 40: 26% for men, 23% for women

Atrial Fibrillation

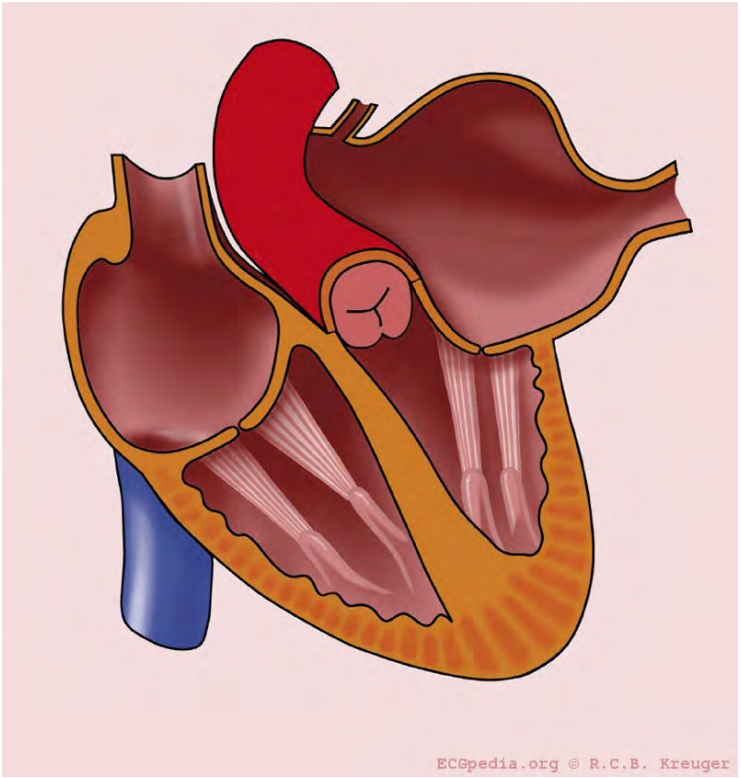
Rate: Variable, usually fast > 100 bpm
Rhy: Irregularly irregular (chaotic)
P-wave: Not consistently present or reproducible
PR: Not measurable
QRS: Normal (narrow, <0.12 sec), but can be wide

Pathophysiology of AF

- The pathogenesis of AF is now thought to involve an interaction between initiating triggers, often in the form of rapidly firing ectopic foci located inside one or more pulmonary veins, and an abnormal atrial tissue substrate capable of maintaining the arrhythmia. Although structural heart disease underlies many cases of AF, the pathogenesis of AF in apparently normal hearts is less well understood. Although there is considerable overlap, pulmonary vein triggers may play a dominant role in younger patients with relatively normal hearts and short paroxysms of AF, whereas an abnormal atrial tissue substrate may play a more important role in patients with structural heart disease and persistent or permanent AF.

Risk Factors for Developing AF

- Cardiac abnormalities
  - Subclinical atherosclerosis
  - Increased left atrial size
  - Mitral regurgitation



Risk Factors for Developing AF

- Subclinical Hyperthyroidism
- Alcohol consumption
- Obesity
- Sleep apnea

Causes of AF

- Cardiac
  - Valvular
  - Conduction abnormalities
  - MI
  - CAD
  - HTN
  - Many others
- Metabolic ($\downarrow$ K, Mg, O_2)
- Drugs (many)
- Idiopathic
- Several others

Presentation - History

- May be asymptomatic
- Typical symptoms
    - Palpitations
    - Shortness of breath (with HF)
    - Lightheadedness/dizziness
    - Focal neurological deficit (with embolic stroke)
- Assess for Triggers and Causes
- Assess for end-organ disease

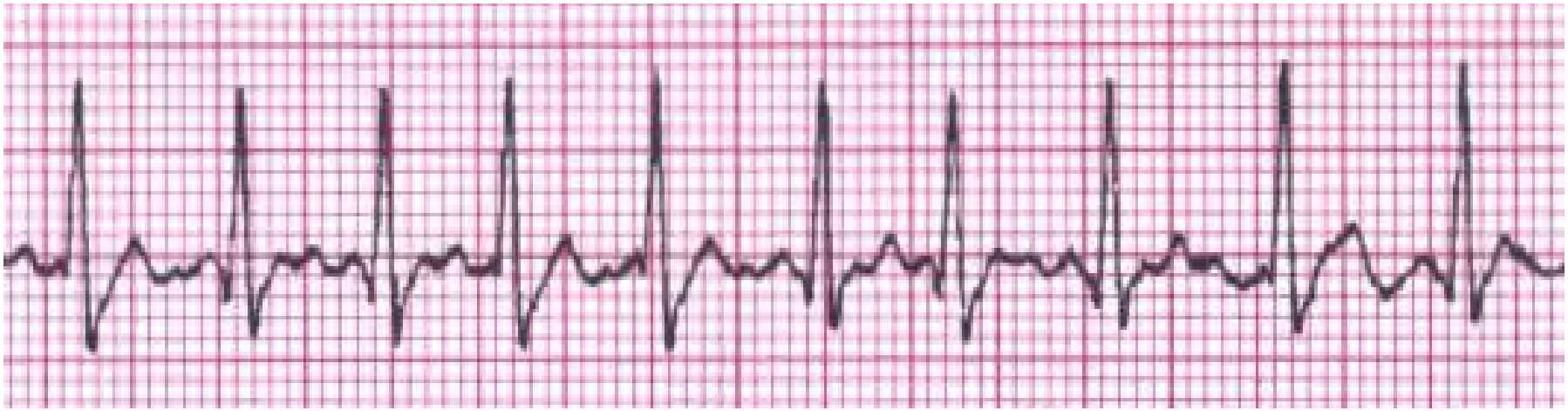
Evaluation – Physical Exam

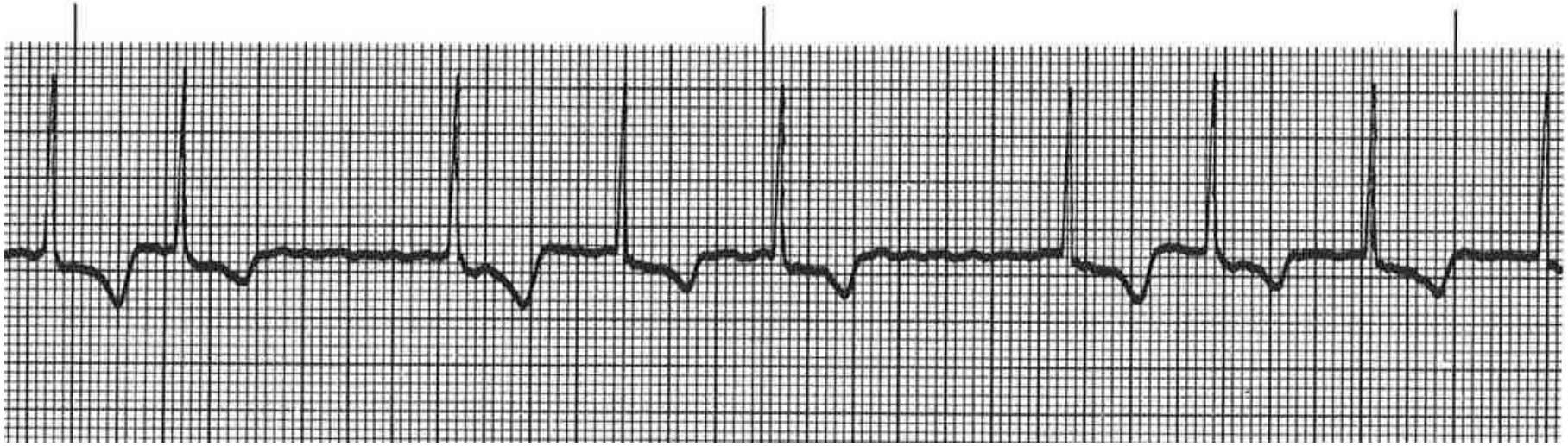
- Neck
    - Elevated JVP (if associated with HF)
- Cardiac
    - Irregularly irregular rhythm
- Lungs
    - Bibasilar crackles (with concomitant HF)
- Extremities
    - Edema (with concomitant HF)

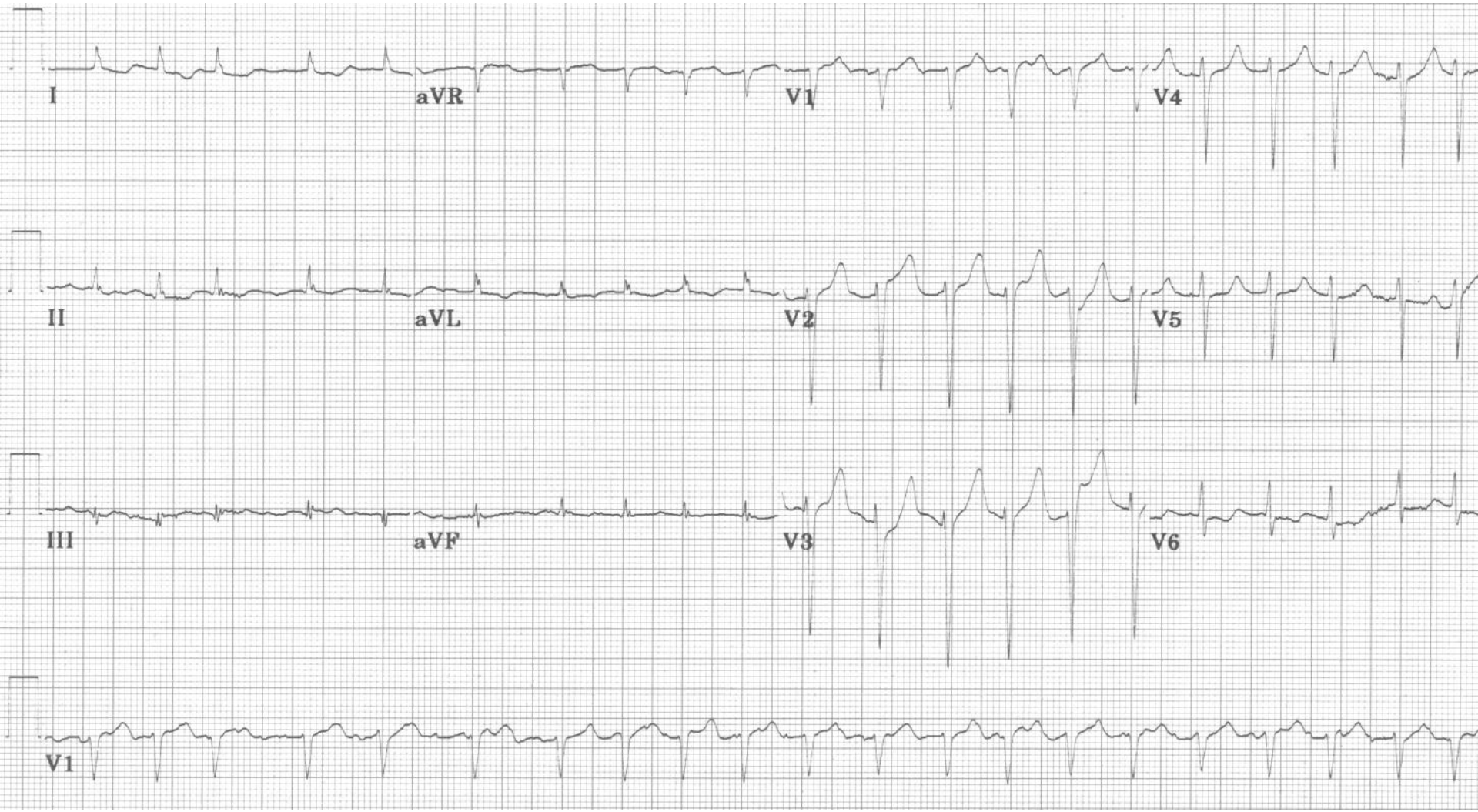
Diagnostic EKG Criteria

- Rhythm – Irregularly irregular (grossly irregular)
- Rate – Atrial rate approx. 400 bpm.

  Ventricular rate varies Fast to slow
- P-waves – missing (P wave activity, but No consistently reproducible P waves) Key to diagnosis
- PR interval – not measurable
- QRS – normal, < 120 ms.






I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1

Management Considerations

- Rate Control
- Rhythm Control
- Anticoagulation
- Does it matter??

Rate Control

- Rate controlling agents act primarily by increasing AV nodal refractoriness
- Beta-blockers (caution in pts with impaired LV function)
- Calcium blockers (Diltiazem)
- Amiodarone
- Digoxin in acute setting

Rhythm Control & Anticoagulation

- Pharmacologic
  - Amiodarone
- Cardioversion
  - If emergent or unstable
- Anticoagulation issues
  - If more than 48 hours old

Risk-Management Decisions

CHADS2 – VASc Score		
C	Congestive Heart Failure	1
H	Hypertension (>140/90 mmHg)	1
A	Age ≥ 75	2
D	Diabetes Mellitus	1
S_2	Prior TIA or stroke	2
V	Vascular disease (MI, aortic plaque etc)	1
A	Age 65-74	1
Sc	Sex category (Female = 1 pt)	1

CHA_2DS_2-VASc Score

$CHADS_2$ score	Patients (n=1733)	Adjusted stroke rate (%/year)
0	120	1.9
1	463	2.8
2	523	4.0
3	337	5.9
4	220	8.5
5	65	12.5
6	5	18.2
CHA_2DS_2-VASc score	Patients (n=73538)	Adjusted stroke rate (%/year)
0	6369	0.7
1	8203	1.5
2	12771	2.9
3	17371	4.3
4	13887	6.5
5	8942	10.0
6	4244	12.5
7	1420	14.0
8	285	14.1
9	46	15.9

CHA_2DS_2-VASc Score	Recommended Therapy
0	No Therapy
1	No therapy, or ASA 81-325 mg daily or anticoagulation therapy (eg, warfarin [international normalized ratio (INR) goal 2-3], dabigatran, rivaroxaban, apixaban, edoxaban)
≥2	Anticoagulation therapy (eg, warfarin [INR goal 2-3], dabigatran, rivaroxaban, apixaban, edoxaban)

Atrial Fibrillation

Rate: Variable, usually fast > 100 bpm
Rhy: Irregularly irregular (chaotic)
P-wave: Not consistently present or reproducible
PR: Not measurable
QRS: Normal (narrow, <0.12 sec), but can be wide

Atrial Flutter

Rate: Atrial rate 250 – 400
Ventricular rate Varies
Rhythm: Regular or Irregular
P-waves: Saw tooth deflection (F waves)
PR: Not measurable
QRS: Typically normal

Atrial Flutter

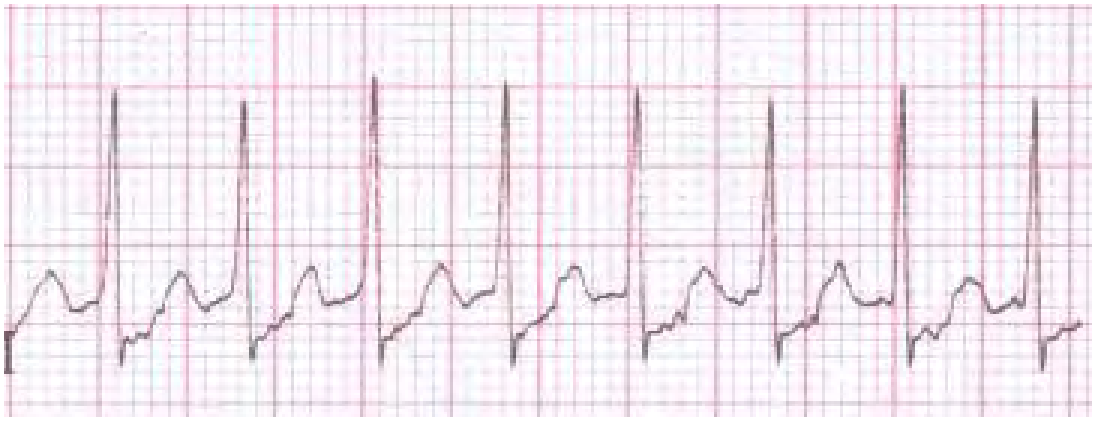
- Management concerns:
  - Less common overall
  - Conversion more difficult
  - Consider anticoagulation if A Flutter > 48 hours
- Options
  - Electricity works well (90% conversion)
  - Same agents as used in A Fib.

Atrial Flutter Treatment

- Controlling Heart Rate
  - Calcium channel blocker or Beta blocker
- Anticoagulation
- Converting to NSR
- Radiofrequency catheter ablation

How to Differentiate

- Is the Rhythm Regular?
  - If yes, think PSVT or Atrial Flutter
  - If no, Atrial Fibrillation or Atrial Flutter
- Are P-waves (F-waves) present?
  - If F-waves present, Atrial Flutter
  - If no, PSVT or Atrial Fibrillation

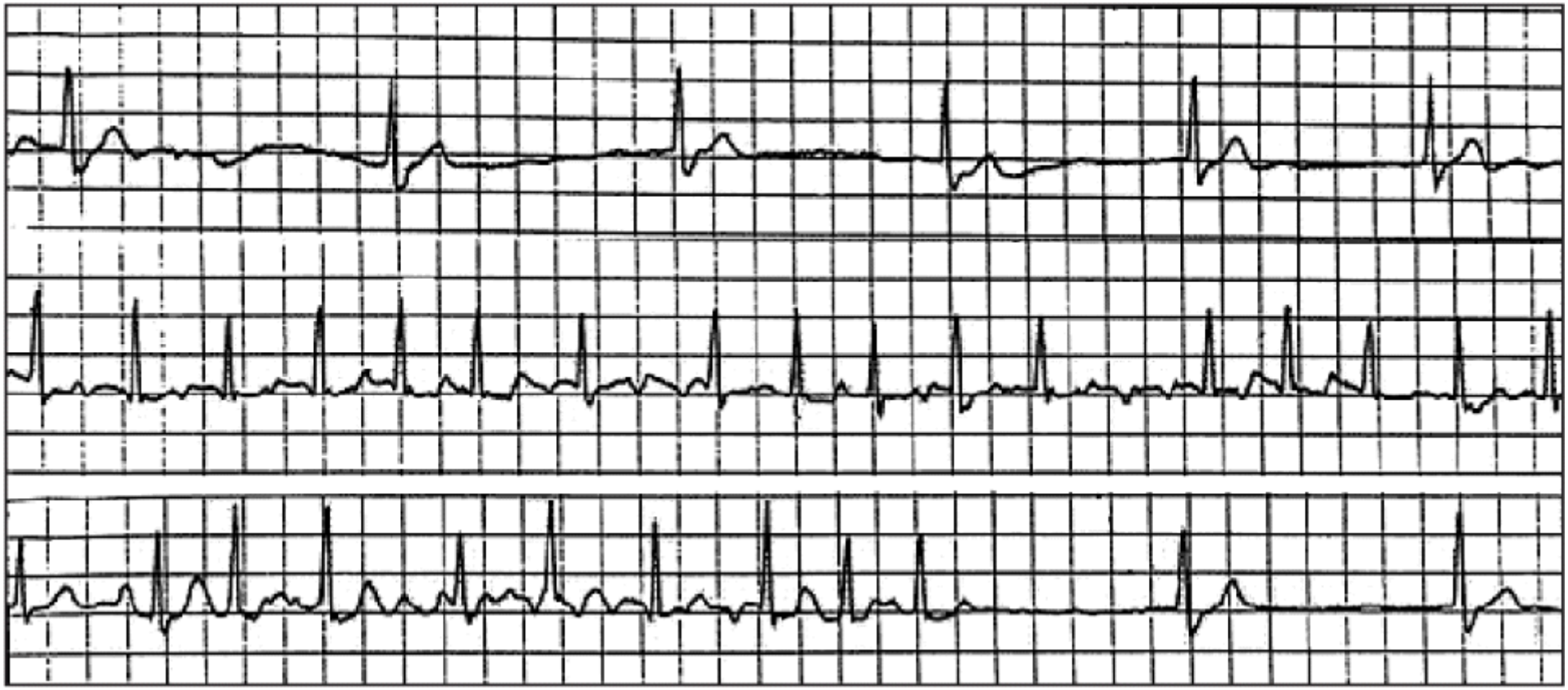


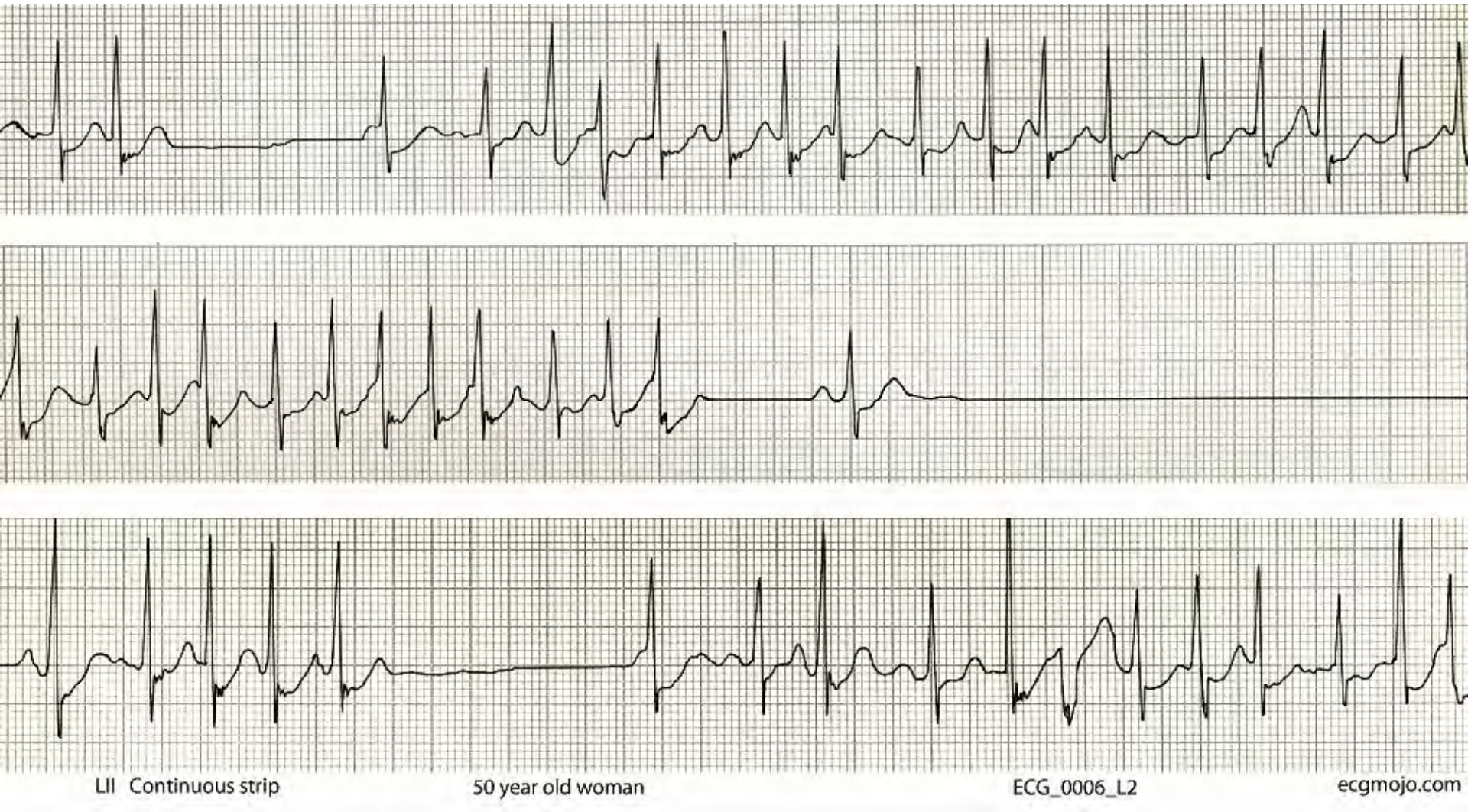
Sick Sinus Syndrome (Sinus Node Dysfunction)

- Disorder of SA node
- Causes: Intrinsic and External
- Disease of the elderly: average age is 68
- Accounts for more than 50% of pacemakers

Sick Sinus Syndrome

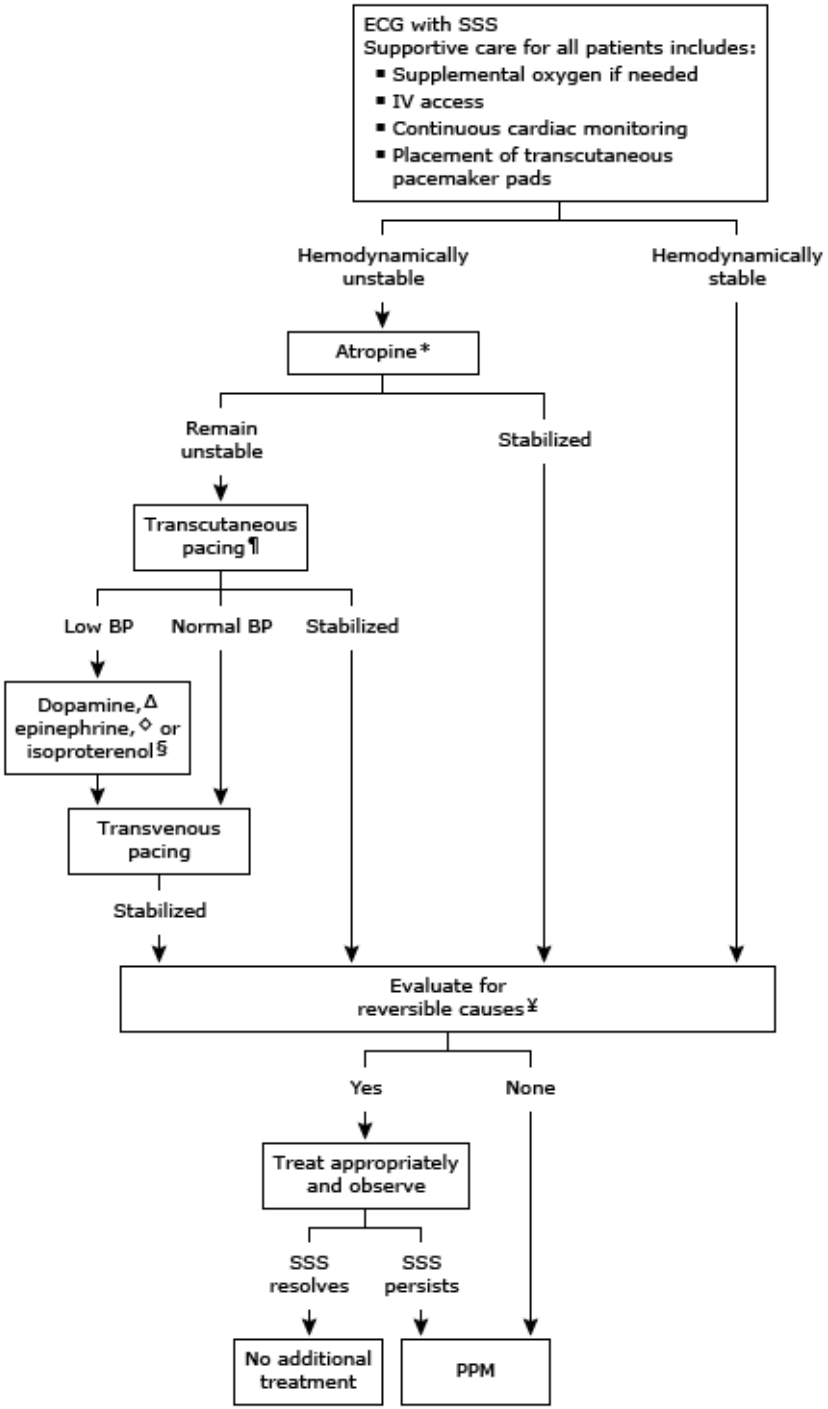
- SA dysfunction results in arrhythmias
  - Severe sinus bradycardia
  - Sinus arrest, sinus block
  - Tachy-brady syndrome
  - Atrial fibrillation with slow ventricular response
- Presentation
  - Early on, asymptomatic
  - Hypo-perfusion symptoms (syncope, oliguria, TIAs)
  - Thromboembolism secondary to AF or af
  - Palpitations, worsening angina or HF




LII Continuous strip
50 year old woman
ECG_0006_L2
ecgmojo.com

Sick Sinus Syndrome

- Evaluation
  - Exclude reversible causes
  - Need clear documentation of bradycardia that correlates with patient's symptoms
  - Use event recorders (Holter monitor…)
- Treatment
  - Permanent pacemaker
    - Dual-chamber pacemaker preferred

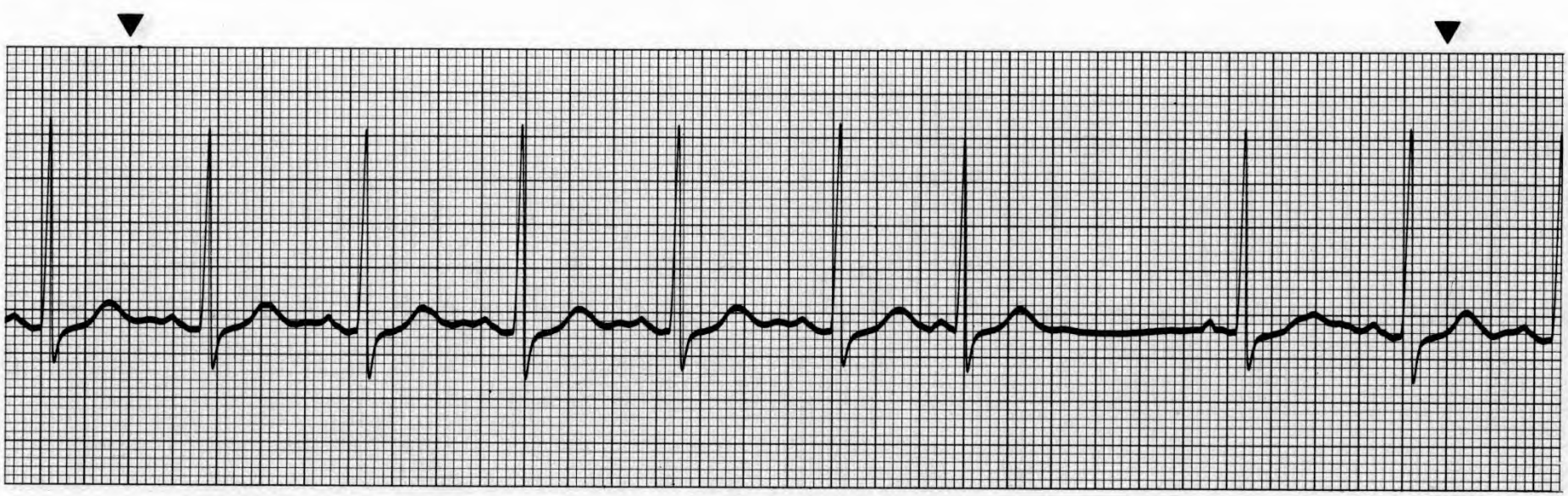

ECG with SSS
Supportive care for all patients includes:
Supplemental oxygen if needed
IV access
Continuous cardiac monitoring
Placement of transcutaneous pacemaker pads
Hemodynamically unstable
Hemodynamically stable
Atropine*
Remain unstable
Stabilized
Transcutaneous pacing¶
Low BP
Normal BP
Stabilized
Dopamine,Δ epinephrine,◇ or isoproterenol§
Transvenous pacing
Stabilized
Evaluate for reversible causes¥
Yes
None
Treat appropriately and observe
SSS resolves
SSS persists
No additional treatment
PPM

Homework Assignment

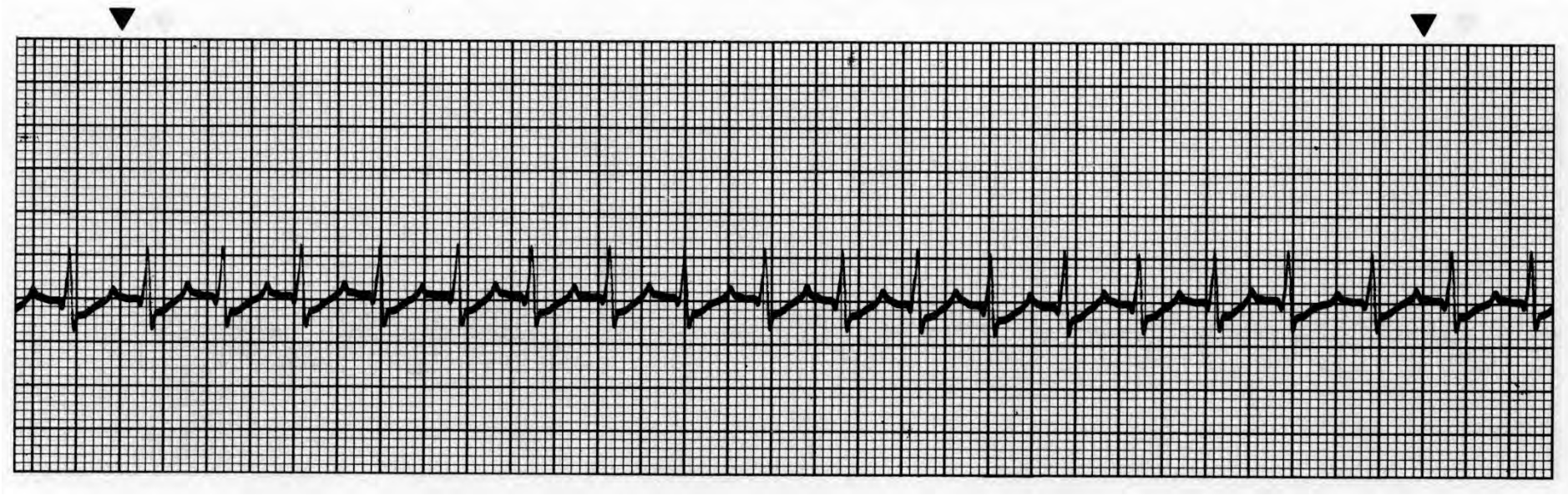
- Complete the following rhythm strips:
- Work in pairs, 10 minutes

- 5 - 8

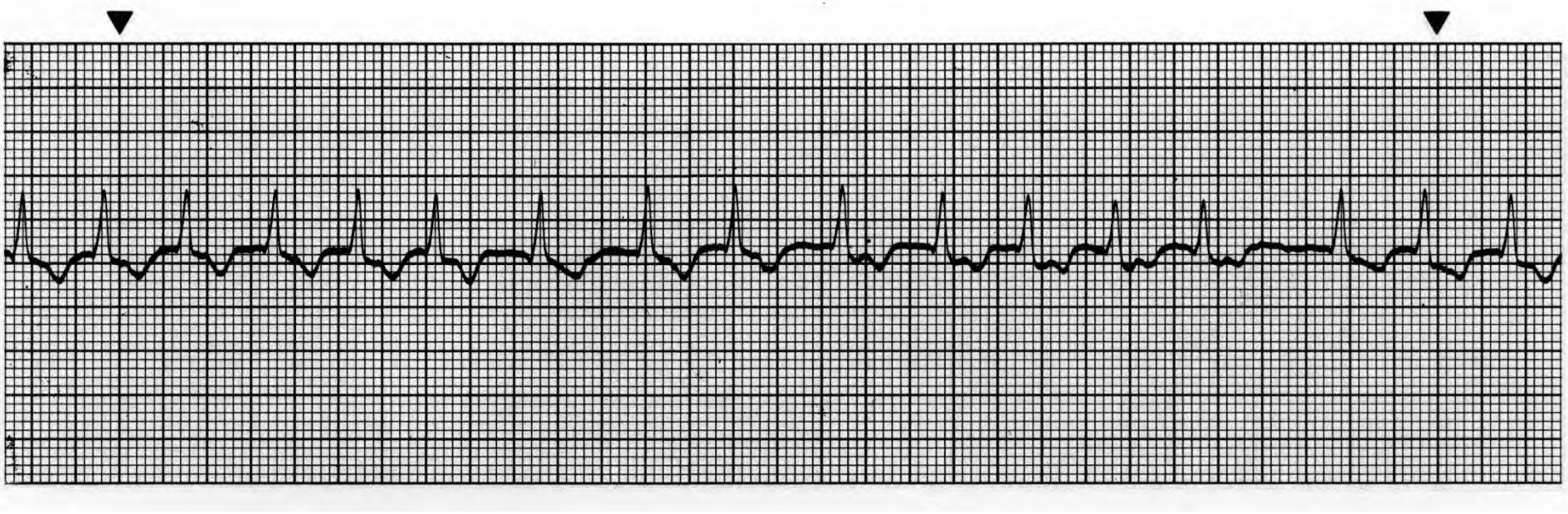
Practice 5



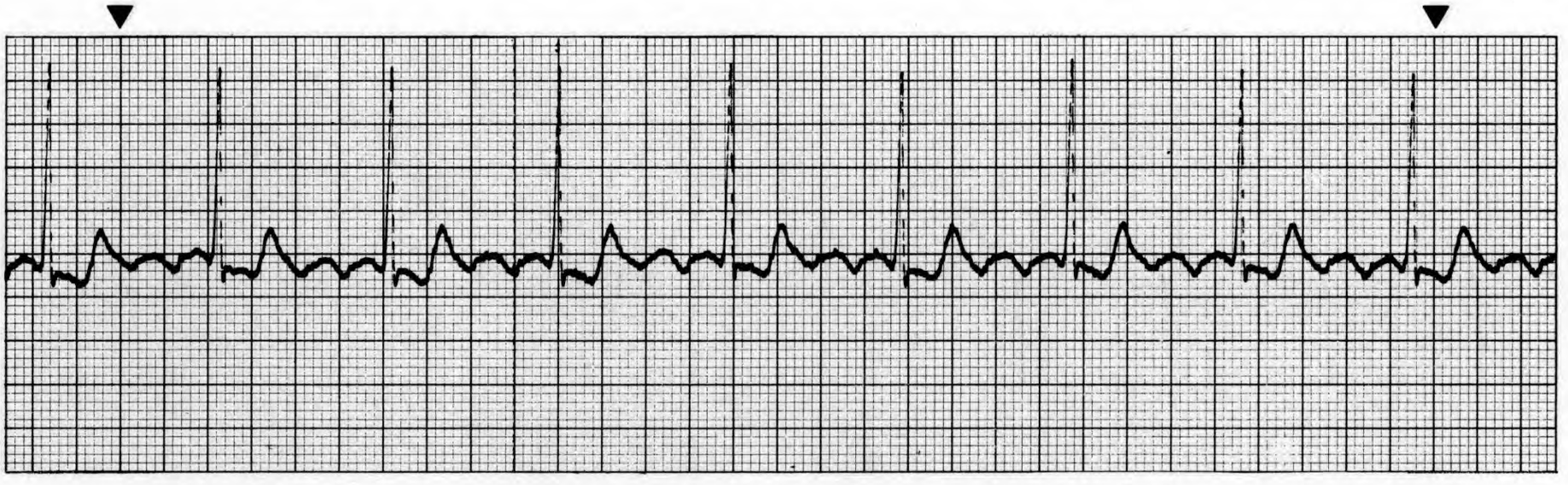
Practice 6



Practice 7



Practice 8



ATRIOVENTRICULAR BLOCKS

AV Heart Blocks

- Helpful hints to assist with diagnosing
  - Look for the P wave. Is there one P wave before each QRS or more than one?
  - Measure the regularity of the atrial rhythm (P-P) and ventricular rhythm (R-R).
  - Measure the PR interval. Is it fixed, consistent or does it vary? This is KEY!!
  - Is the QRS narrow (normal) or wide?

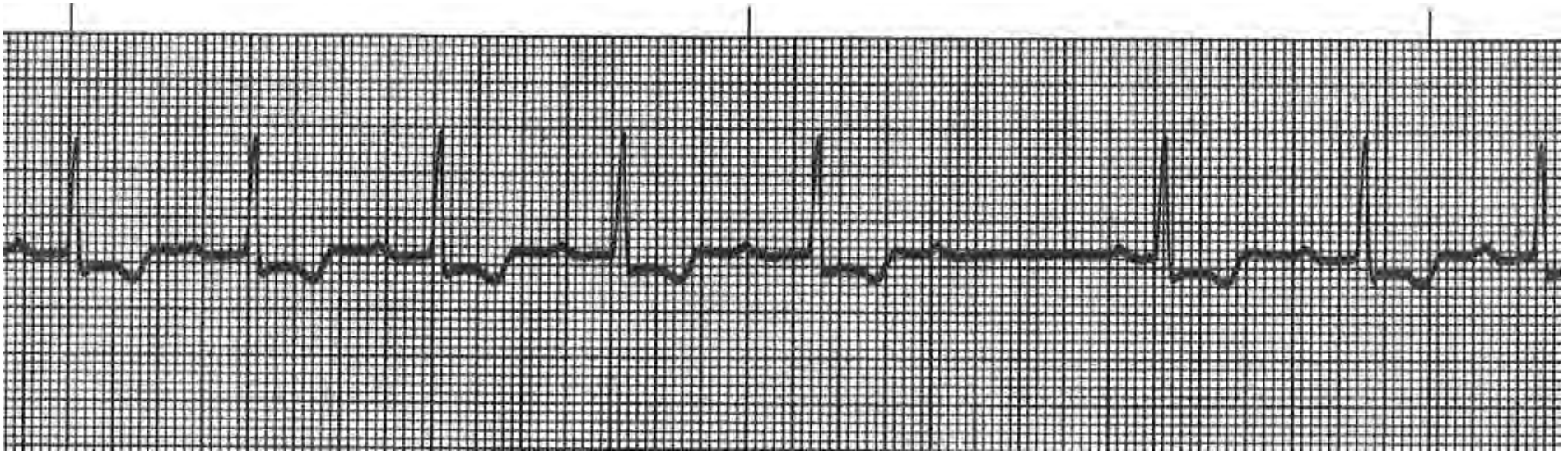
First-Degree AV Block

Rate: 60 -100 bpm
Rhy: Regular
P-wave: Sinus, one P wave to each QRS complex
PR: > 200 ms, fixed and prolonged
QRS: <120 ms

First-Degree AV Block

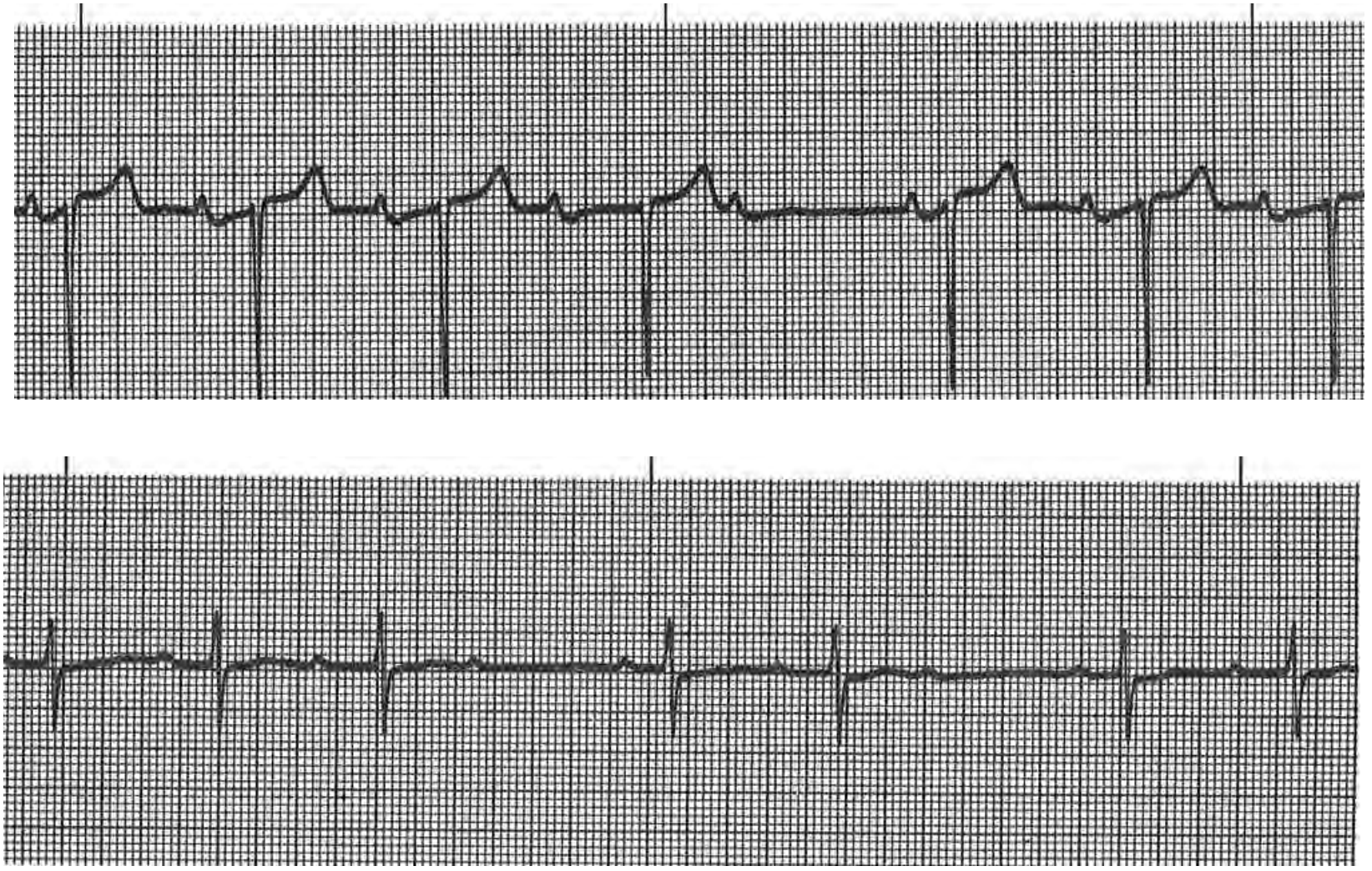
- Causes
  - Ischemia, injury of AV node, drug effects (beta blockers, CCBs, digitalis, amiodarone), hyperK, increased parasympathetic tone, …….
- Asymptomatic
- No treatment necessary
- Can progress, monitor until stabilized
- Review drugs that might induce

Second-Degree AV Block, Type I



Rate: Atrial – sinus rate. Vent depends on conduction
Rhy: Regular atrial rhythm, irregular ventricular rhy
P-wave: Sinus
PR: Progressively lengthens until P wave dropped
QRS: <120 ms

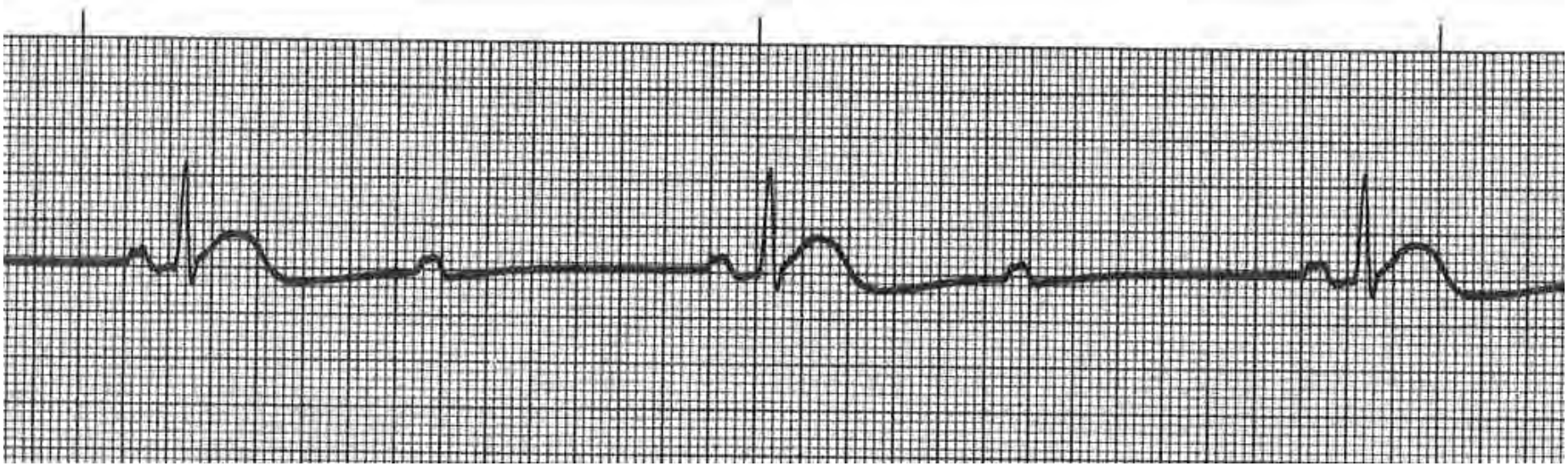
2nd AV Block Type I



2nd AV Block Type I

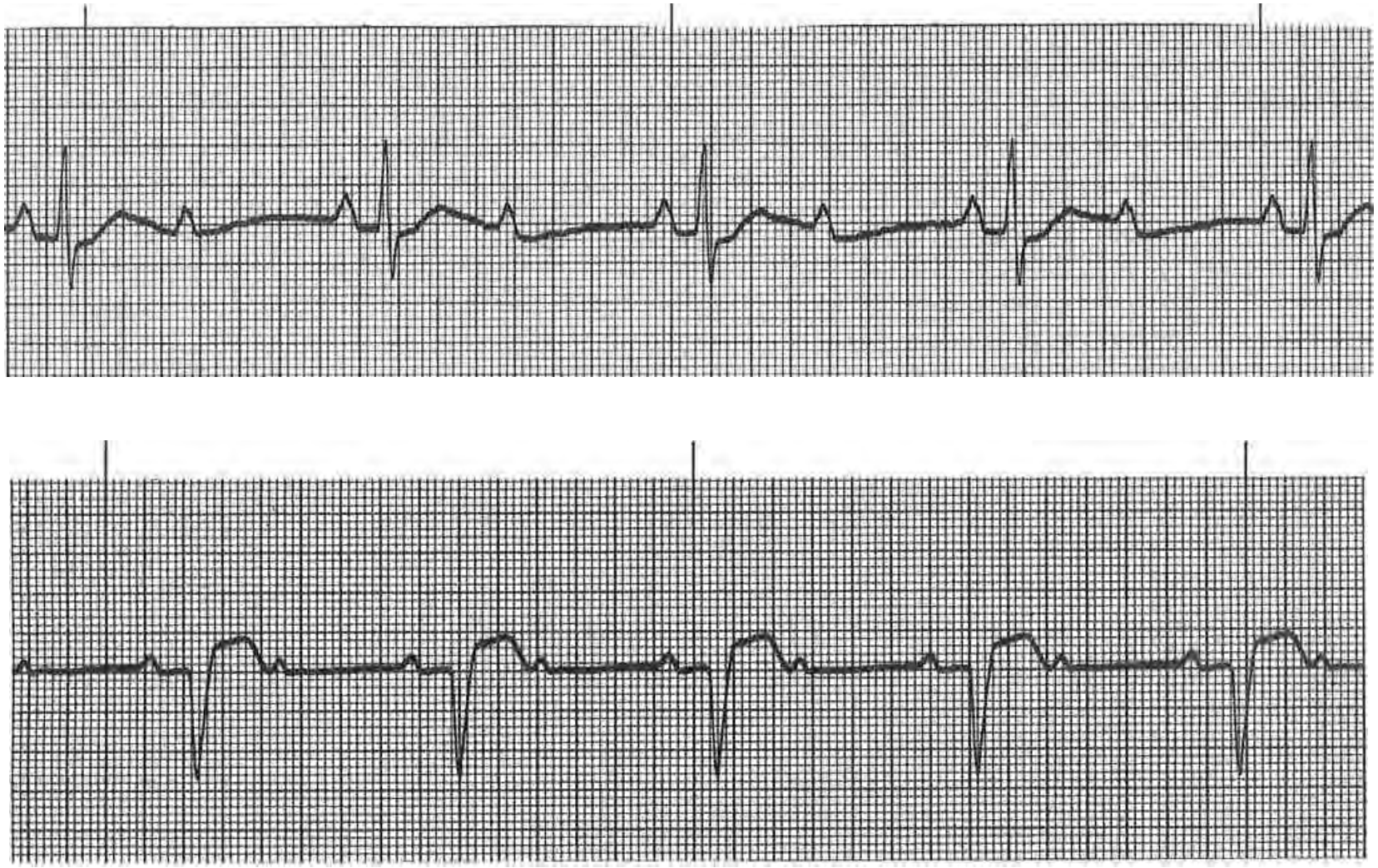
- Cause
  - Inferior MI, increased vagal tone, meds (BB, CCBs, digitalis), hyperkalemia, …
- Temporary and resolves spontaneously
- Asymptomatic usually, may become bradycardic
- Monitor for advancing AV block

Second-Degree AV Block, Type II



Rate: Atrial – sinus rate. Vent depends on conduction, slow
Rhy: Regular atrial rhy. Vent usually reg, may be irregular
P-wave: Sinus, 2+ P waves per QRS. Map out to each other
PR: Fixed, may be normal or prolonged
QRS: <120 ms usually but may be prolonged if at BB level

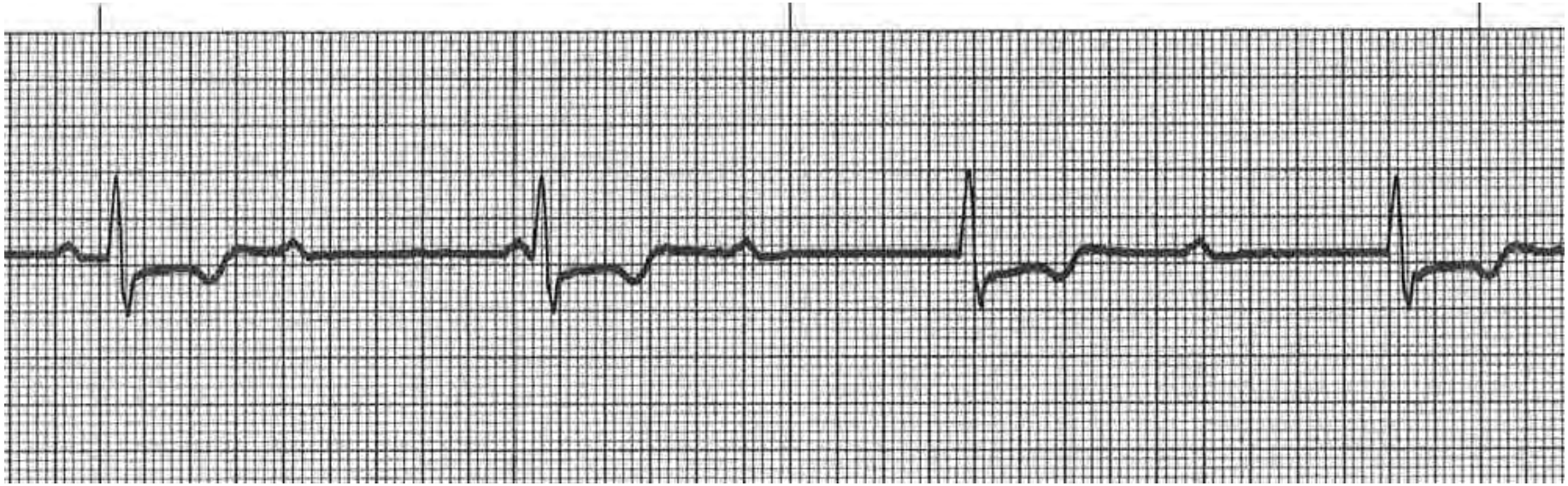
2nd AV Block Type II



2nd AV Block Type II

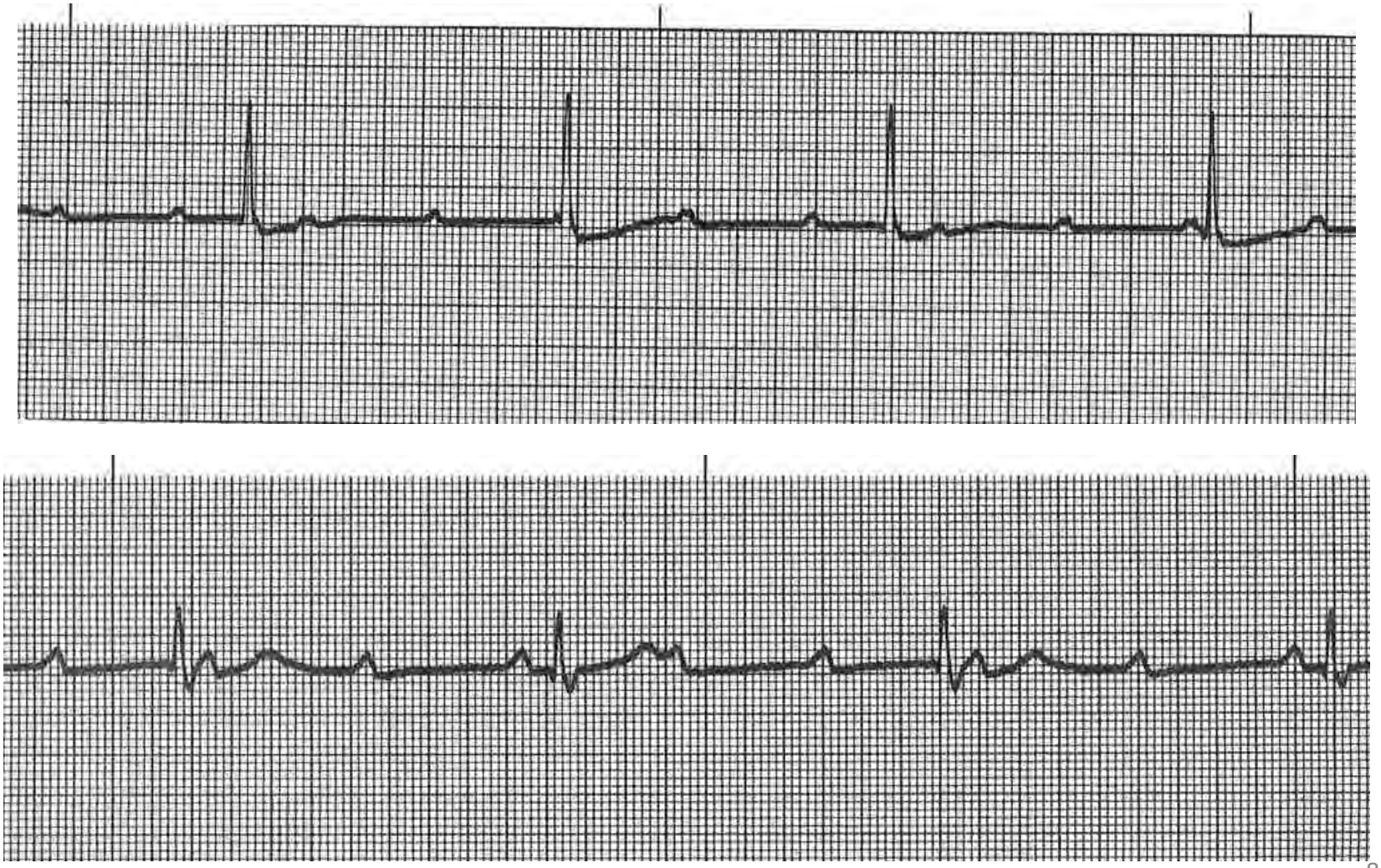
- Causes
  - Anterior MI, acute myocarditis, degeneration of conduction system in elderly (not induced by drugs or increasing parasympathetic tone)
- Usually presents with significant bradycardia
- Less common, more serious, monitor for 3rd AV block
- Treat: pacemaker, avoid atropine if wide QRS

Third-Degree AV Block



Rate: Atrial at sinus rate. Vent: 40-60 if AV node, 20-40 if Vent
Rhy: Regular atrial rhy. Ventricular is regular usually
P-wave: Sinus but no consistent relationship with QRS. Can be hidden in QRS, ST or T waves.
PR: Not consistent
QRS: <120 ms if at AV node, prolonged if at BB level

3rd Degree AV Block



3rd AV Block

- Causes
  - CAD, MI, congenital HD, cardiac surgery, dig toxicity
- Presents usually as significant ventricular brady
- Symptoms of hypotension, dyspnea, CP, syncope, HF
- Serious, life threatening,
- Treat: pacemaker. Avoid atropine.

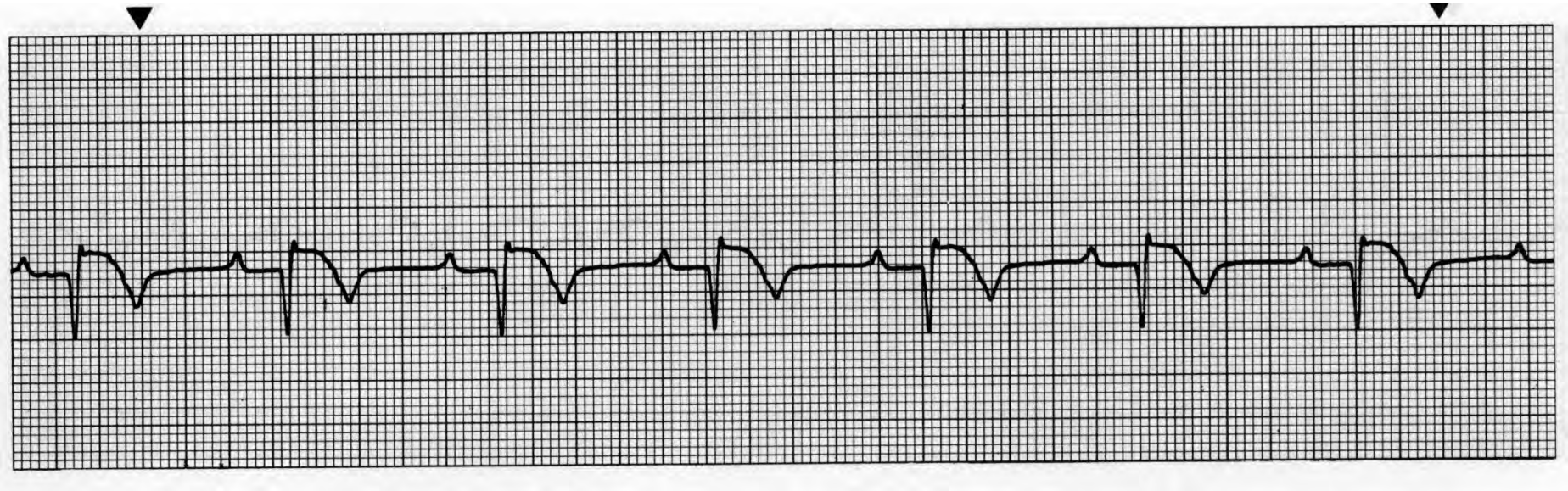
Homework Assignment

- Complete the following rhythm strips:
- Work in pairs, 10 minutes

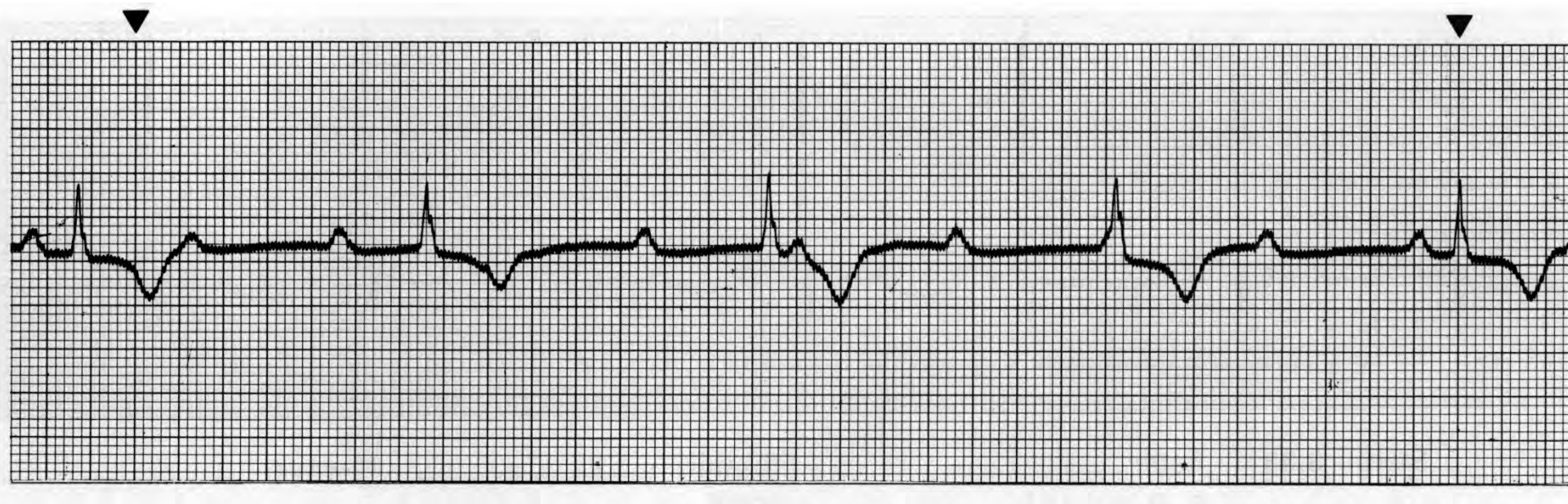
- 9-12

Practice 9

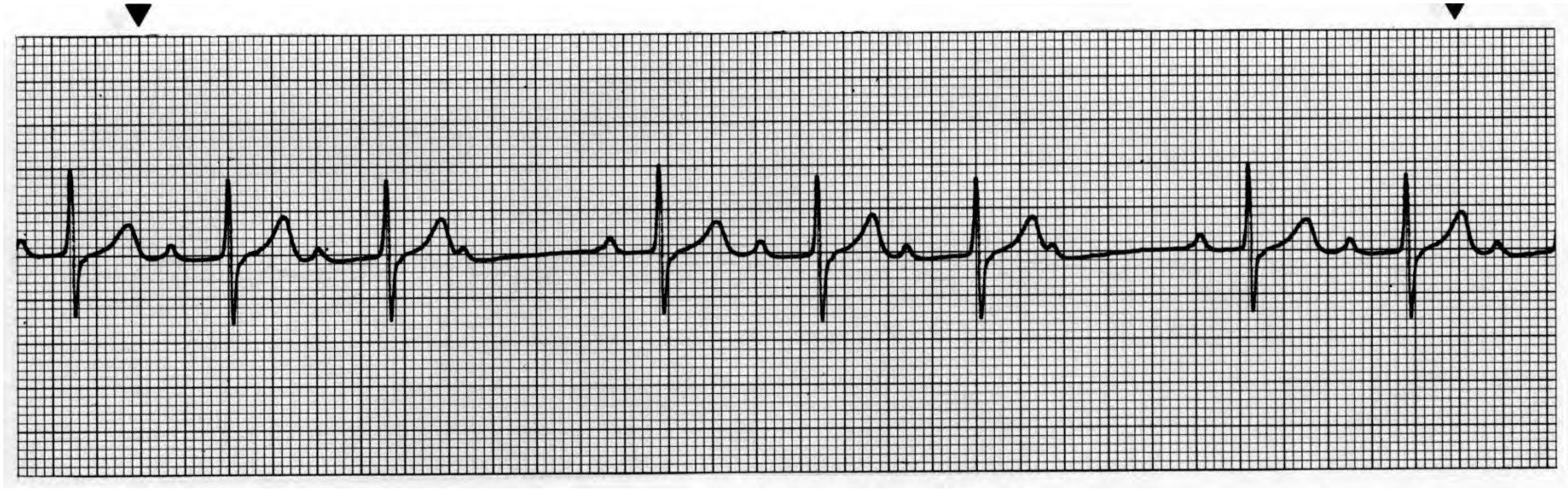
Practice 10



Practice 11



Practice 12



VENTRICULAR ARRHYTHMIAS

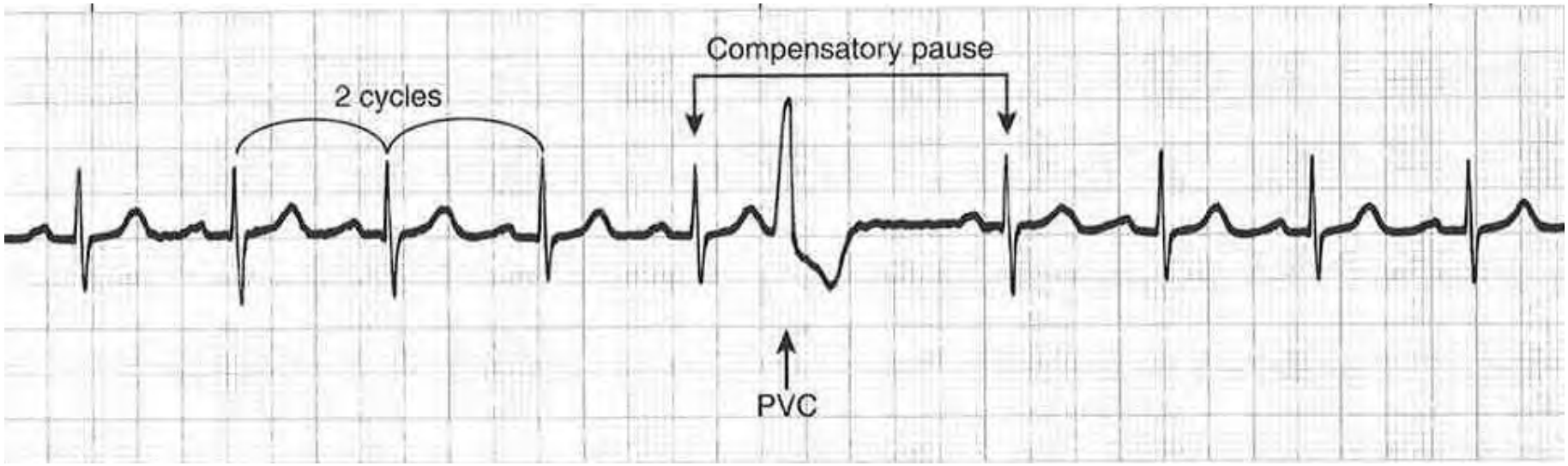
Ventricular Arrhythmias

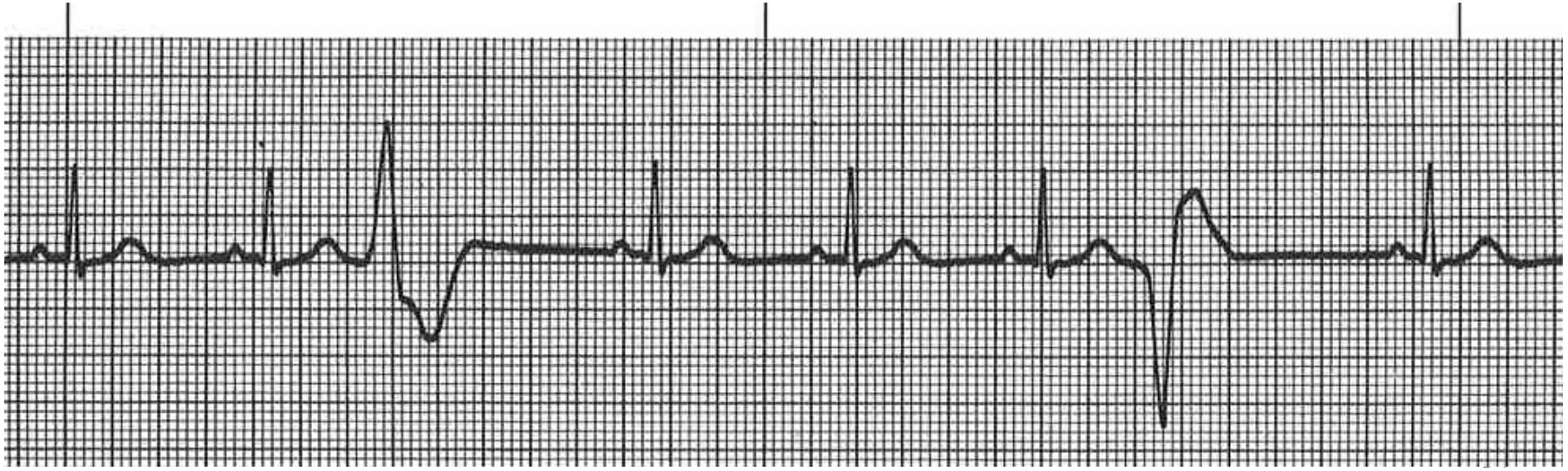
- Originate below the bundle of His
- No access to the conduction system
- Results in abnormal ventricular depolarization
- Abnormally shaped and prolonged QRS
- ST-T waves in opposite direction of QRS
- No P waves produced in Ventricular rhythms

Premature Ventricular Contraction

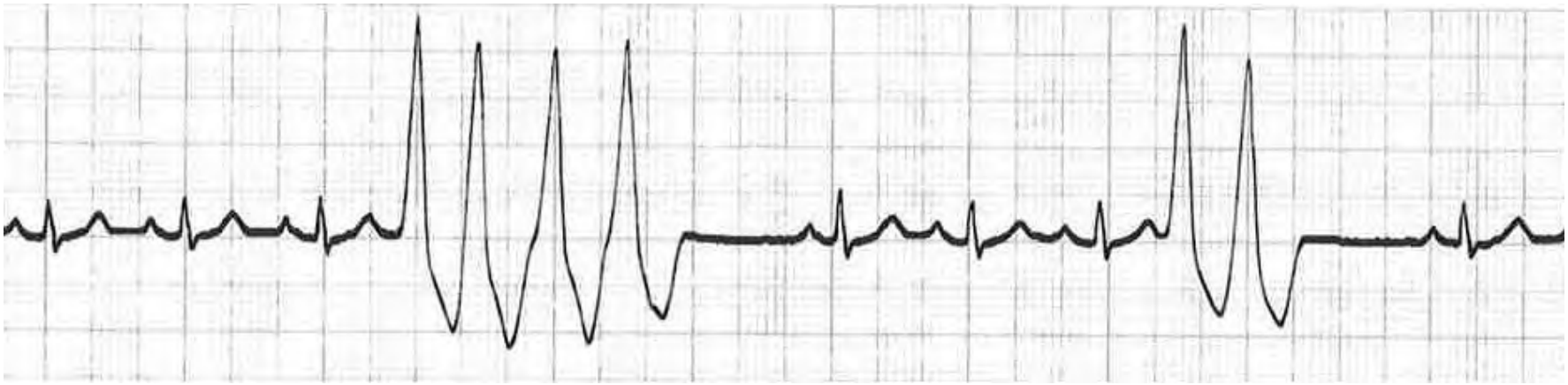
Rate: That of underlying rhythm
Rhy: Underlying rhythm is regular, Irregular with PVC
P-wave: None associated with PVC
PR: Not measurable with PVC beat
QRS: PVC is ≥120 ms

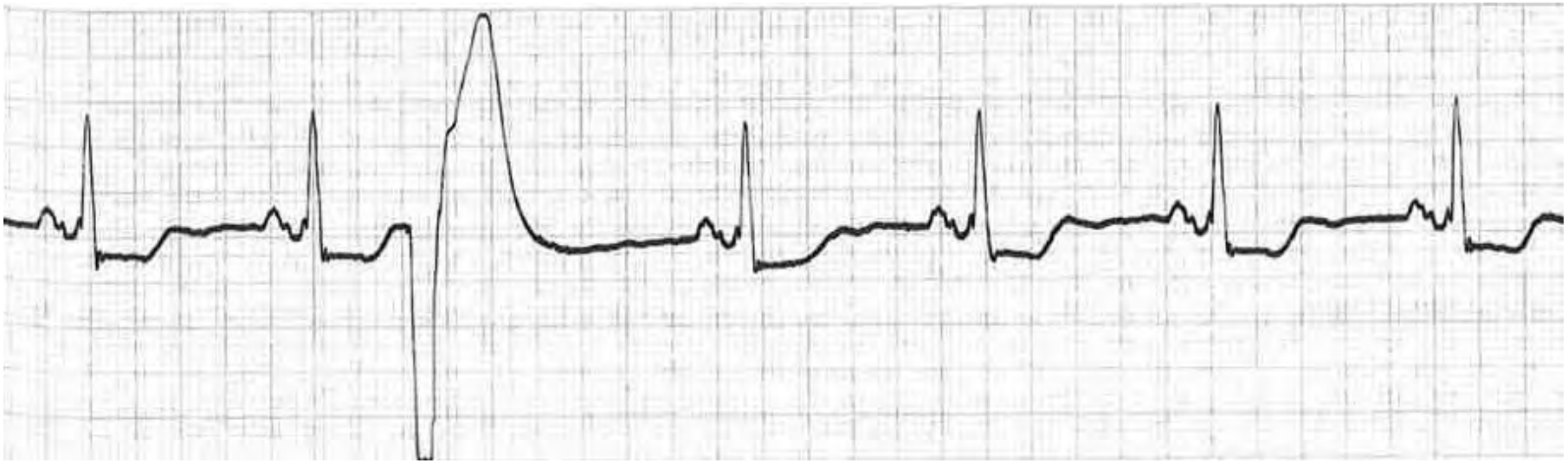
PVCs





PVCs

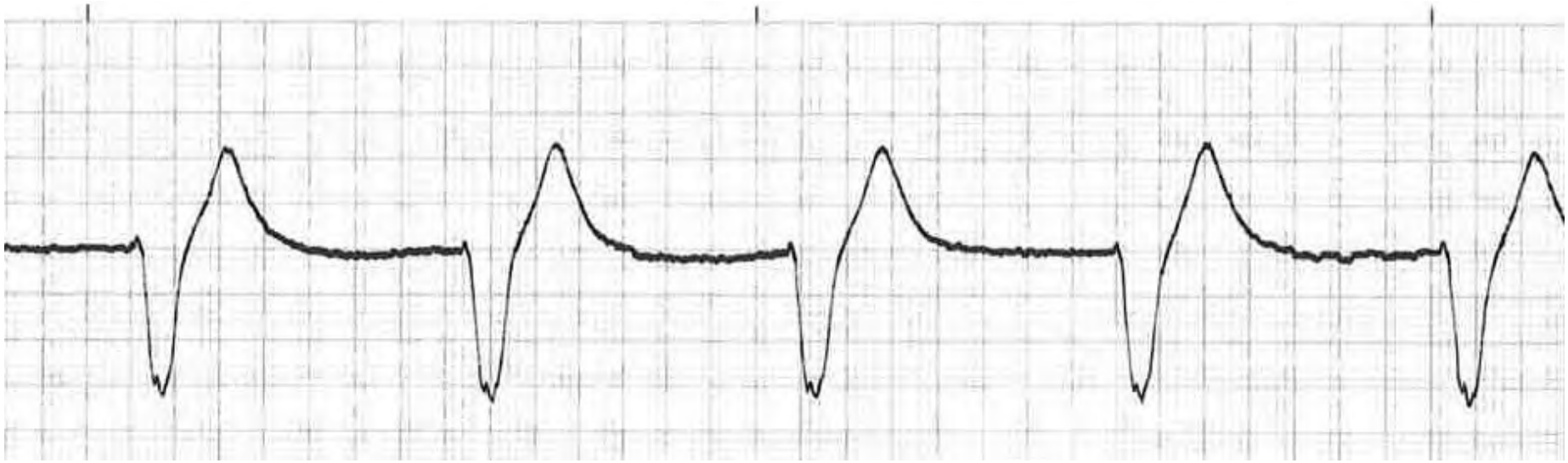




PVCs

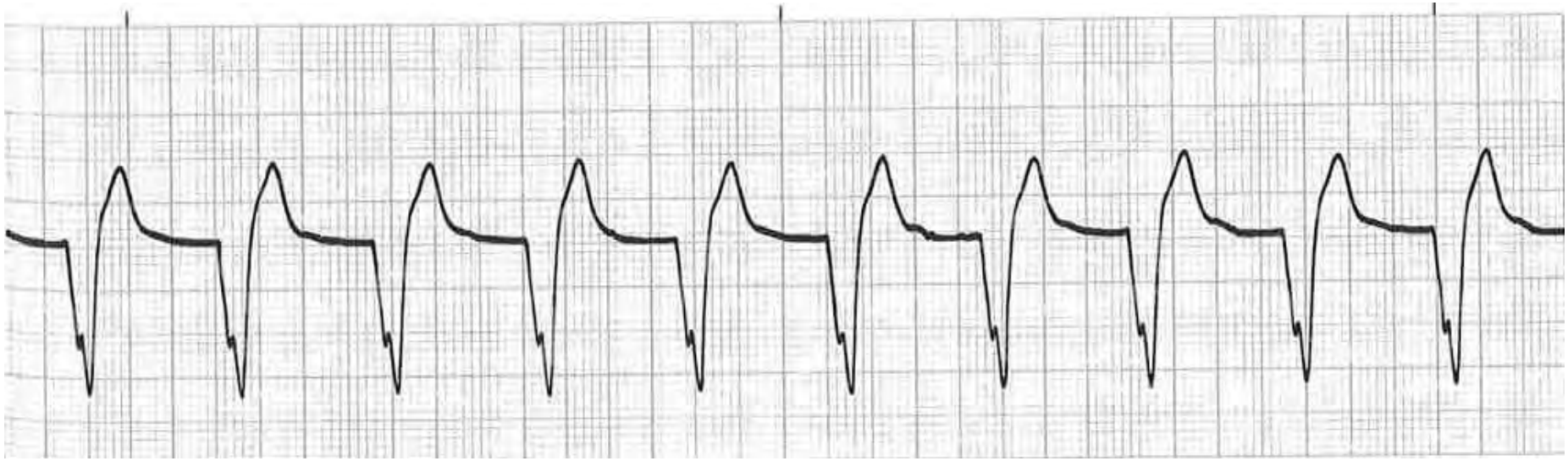
- Causes
  - Myocardial ischemia, injury, hypoxia, HTN, HF, drugs, EOTH, tobacco, caffeine, cocaine……
- Usually asymptomatic, “skip a beat”
    - If frequent, may be more symptomatic
- Treatment depends on cause (O_2)
  - If more than 6/min consider antiarrhythmic

Idioventricular Rhythm



Rate: 30 – 40 bpm
Rhy: Regular
P-wave: Absent
PR: Not measurable
QRS: ≥120 ms

Accelerated Idioventricular Rhythm

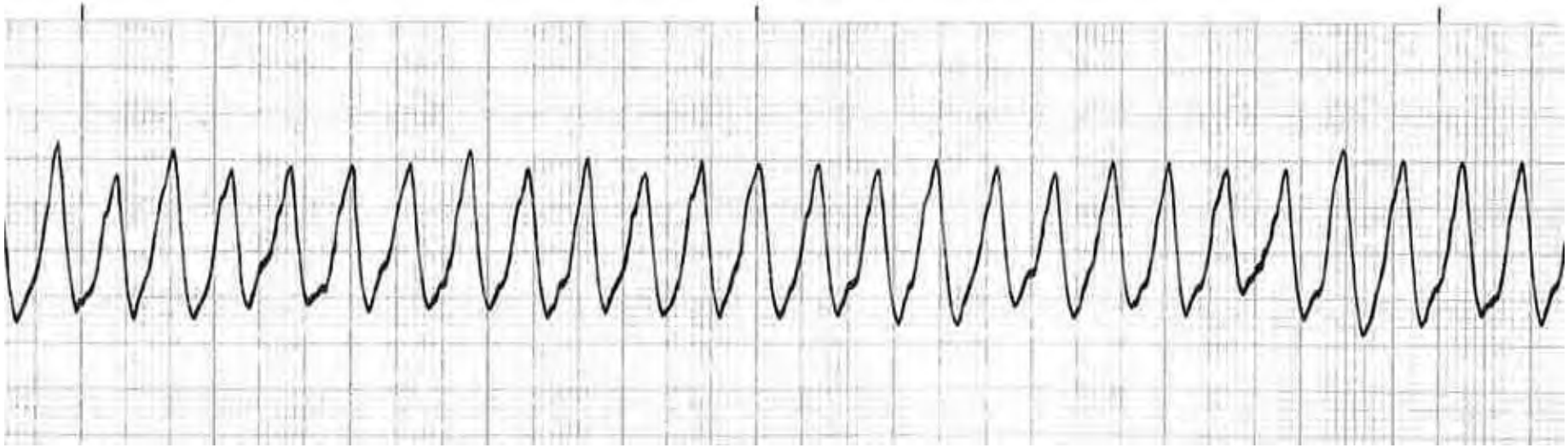


Rate: 50 - 100bpm
Rhy: Regular
P-wave: Absent
PR: Not measurable
QRS: ≥120 ms

Ventricular Tachycardia

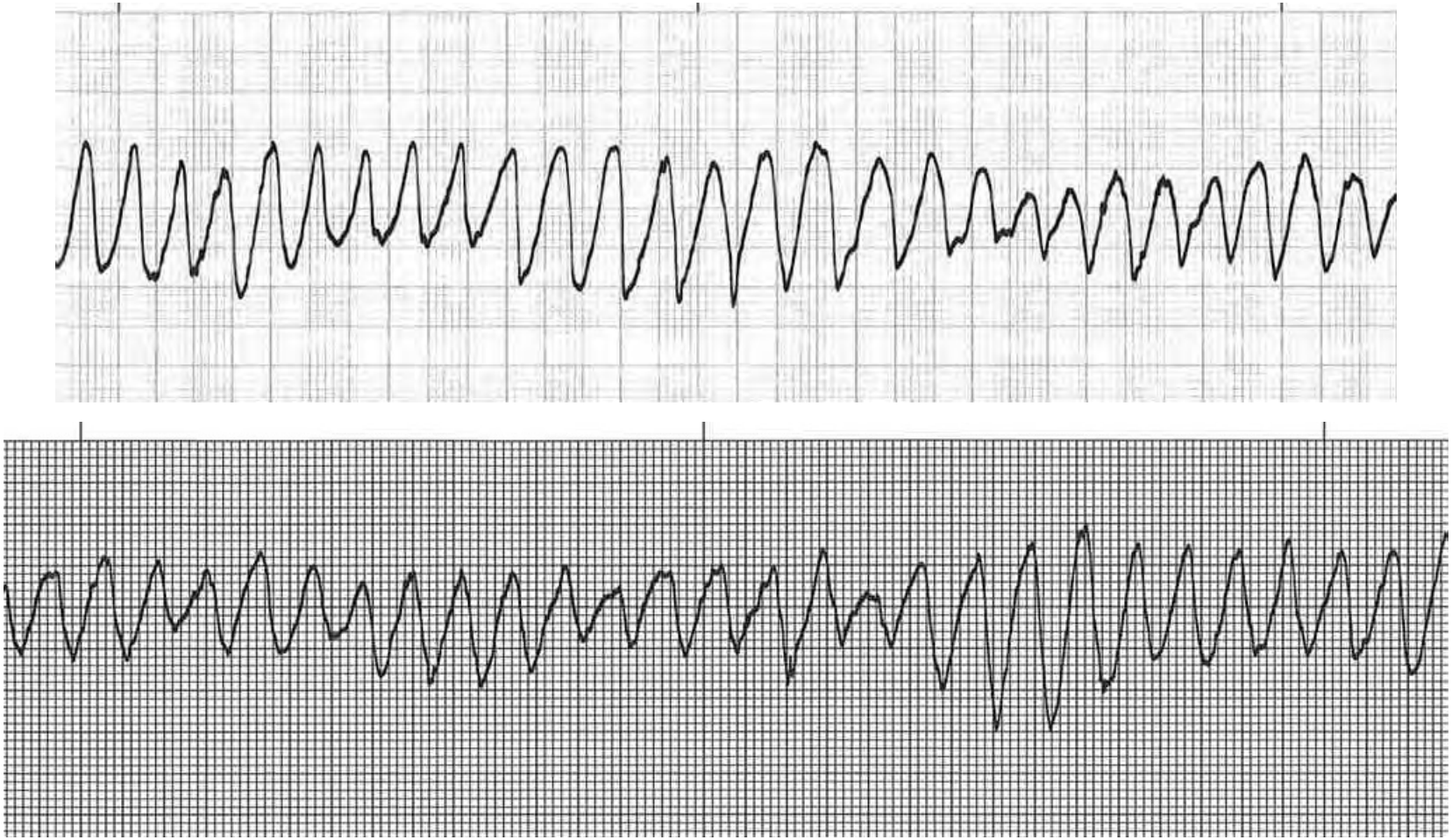
- Lots of causes, usually bad situations
- Treatment per ACLS protocols
- Depends on patient stability
- Monomorphic or Polymorphic

Ventricular Tachycardia

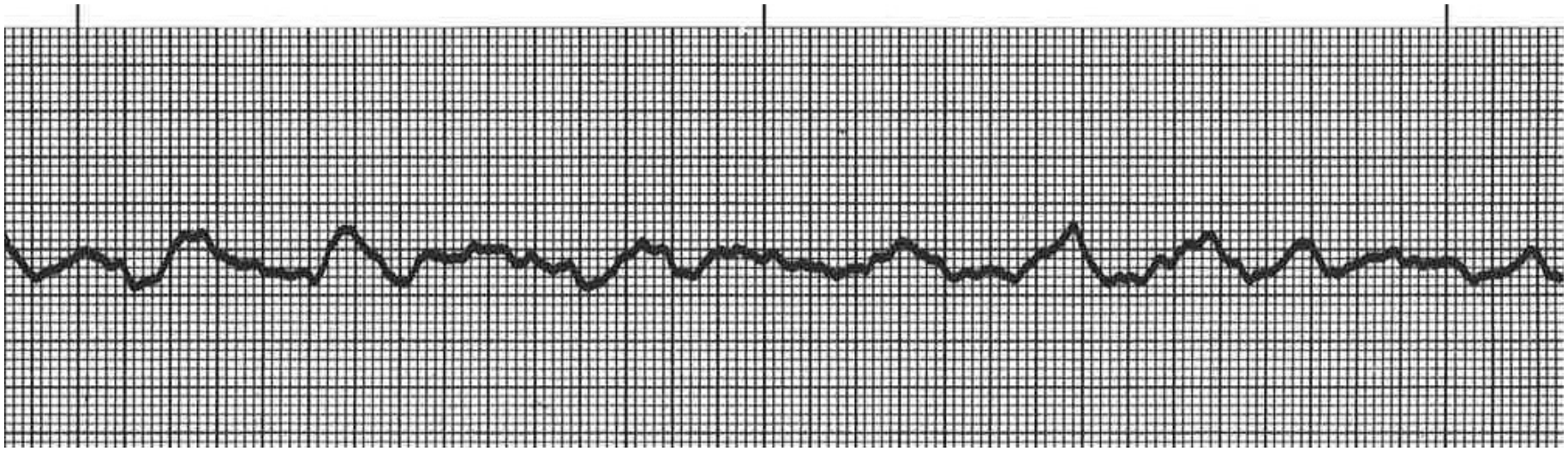


Rate: 140 – 250 bpm
Rhy: Regular, but can be slightly irregular
P-wave: Absent
PR: Not measurable
QRS: ≥120 ms

Torsade de Points
Polymorphic Ventricular Tach

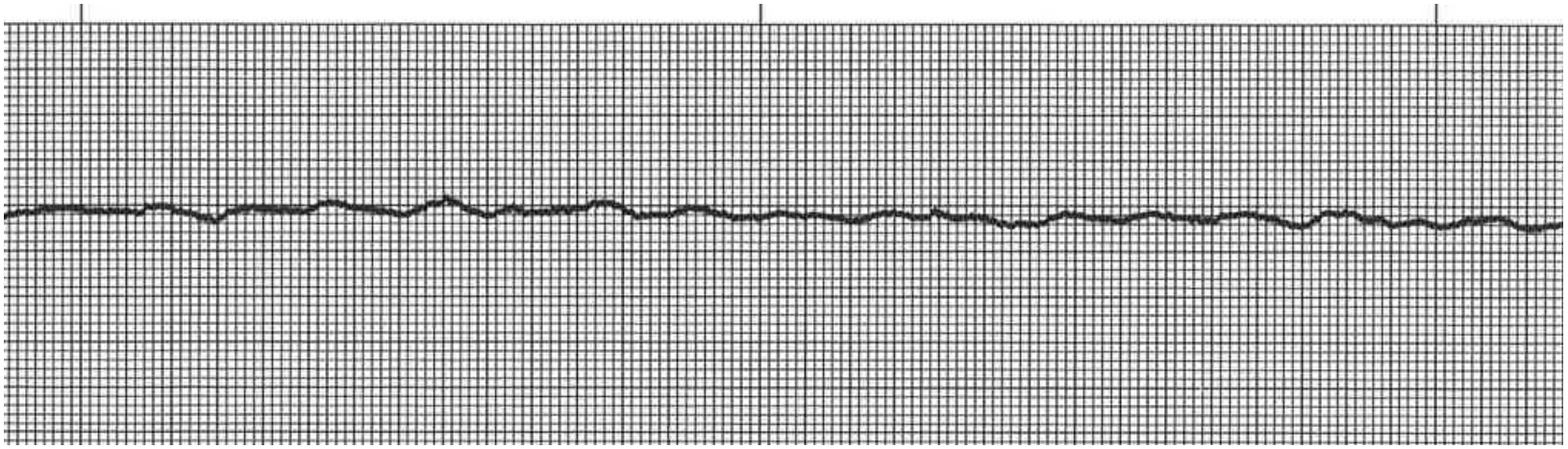


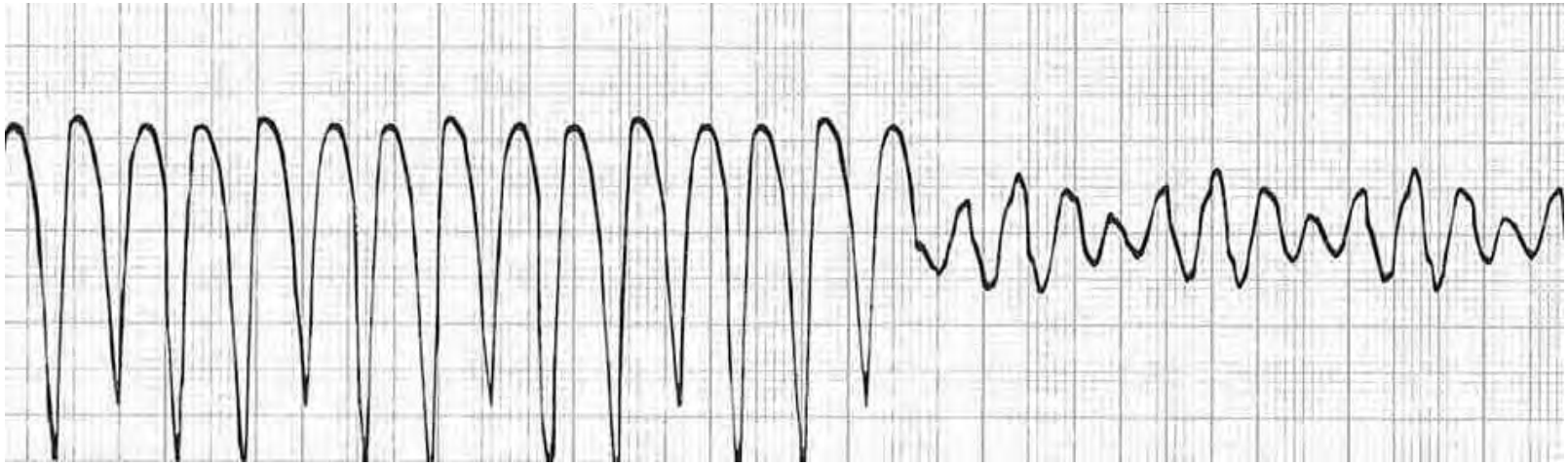
Ventricular Fibrillation



Rate: Not measurable
Rhy: Irregular, chaotic
P-wave: Absent
PR: Not measurable
QRS: Absent

Ventricular Fibrillation

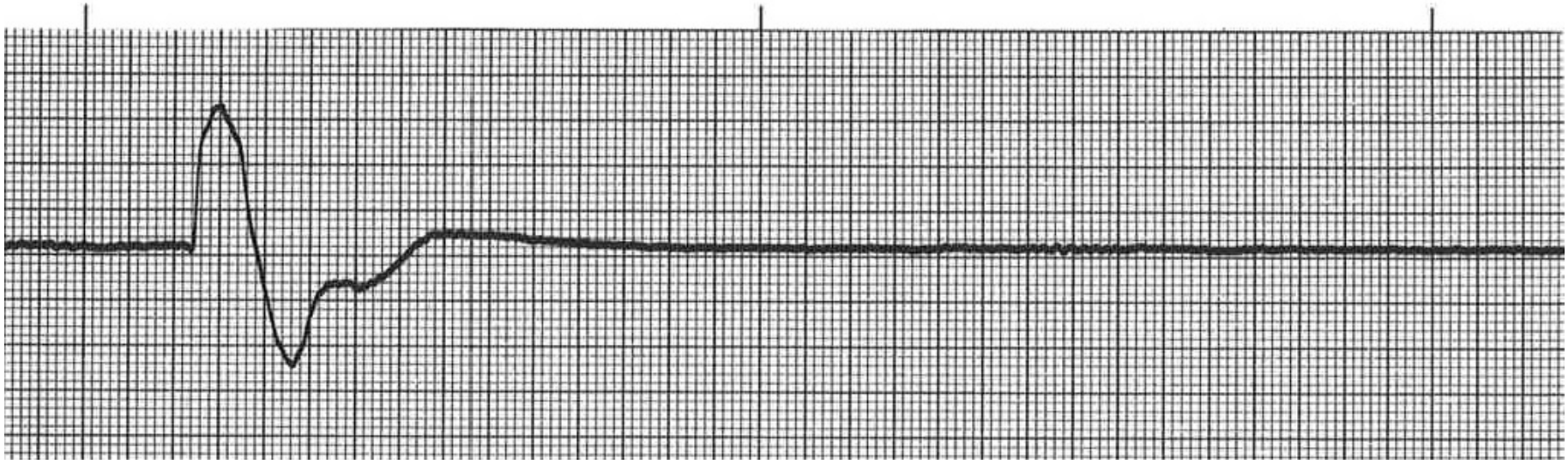




Ventricular Fibrillation

- Most common cause of cardiac death in MI
- Complete loss of cardiac output, immediately unconscious, death imminent
- Treatment per ACLS protocols

Ventricular Standstill (Asystole)



Rate: If atrial present, atrial rate. No ventricular rate
Rhy: If atrial present, atrial rhythm. No ventricular rhythm
P-wave: If present, P waves without QRS
PR: Not measurable
QRS: Absent

Asystole

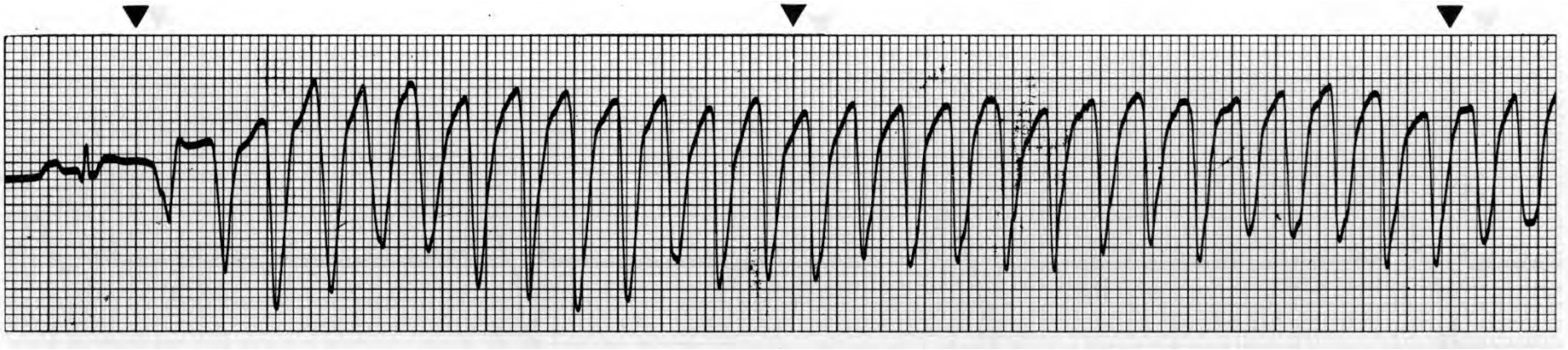
- Essentially a dead patient
- Verify asystole, check monitoring leads
- Focus treatment on underlying cause (5H/5Ts)
- What not to do

Homework Assignment

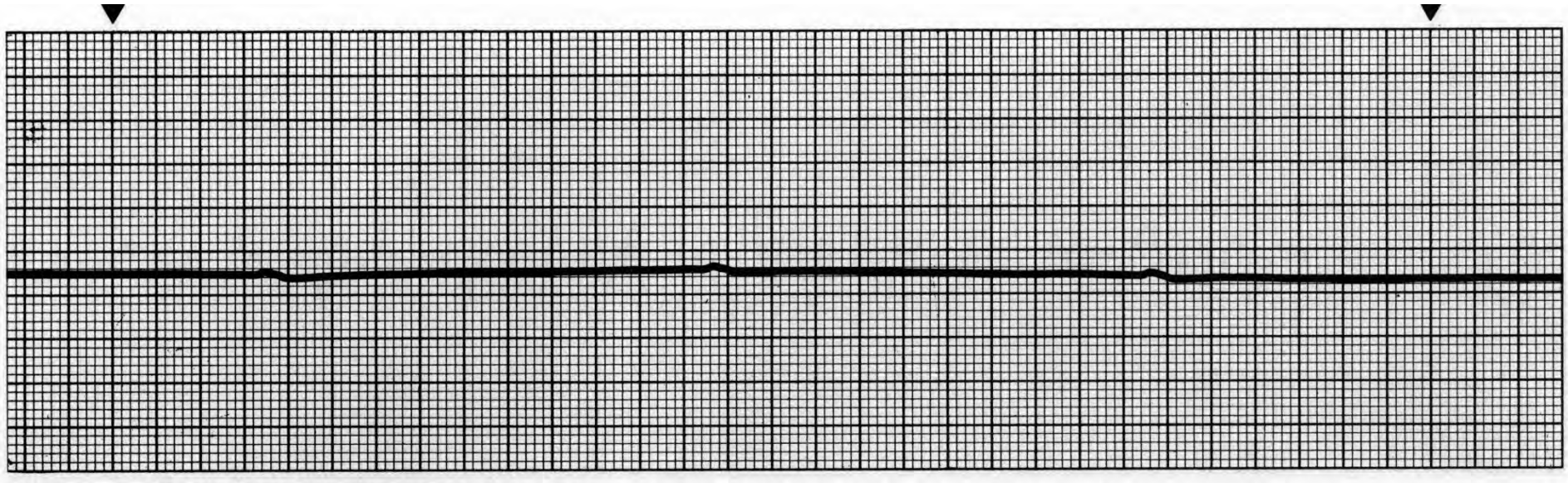
- Complete the following rhythm strips:
- Work in pairs, 10 minutes

- 13 -16

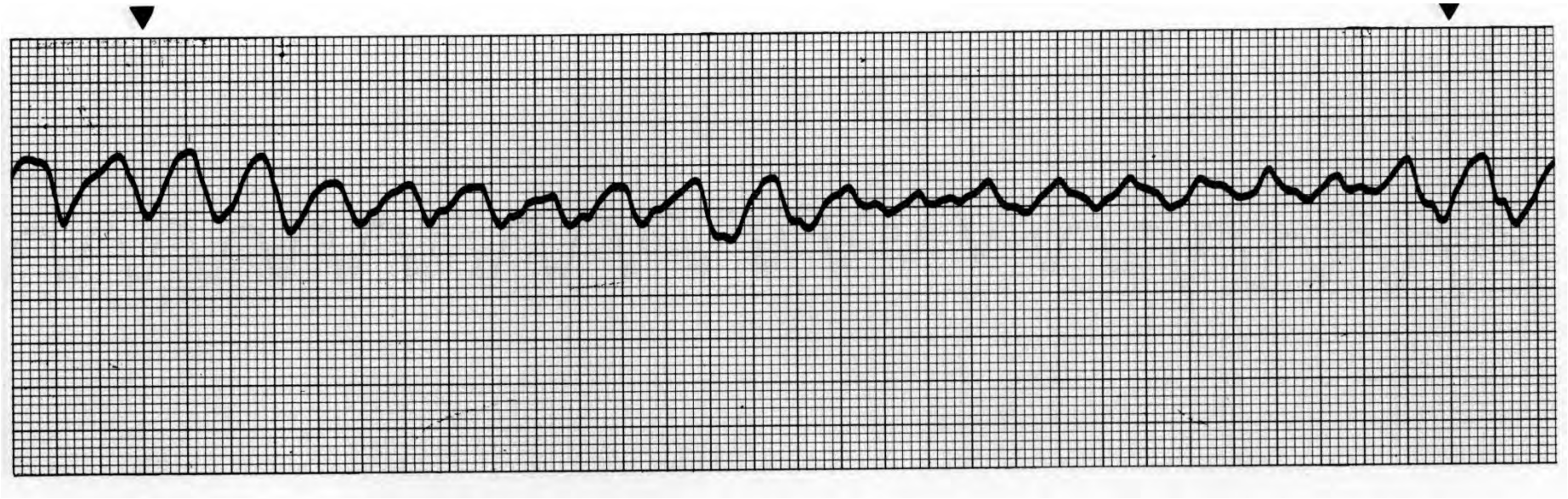
Practice 13



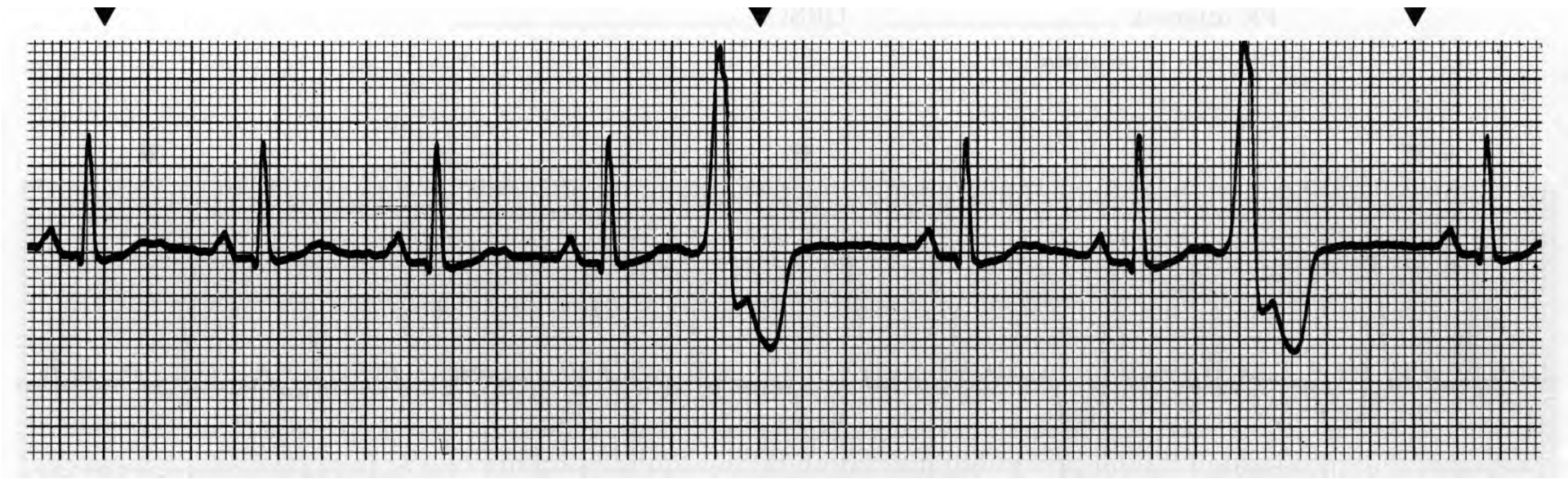
Practice 14



Practice 15



Practice 16



Heart Rate Clues to Diagnosis

- 40-60 bpm: Sinus bradycardia
- 60-100 bpm: NSR
- 100-150 bpm: Sinus tach
- 150-250 & regular: PSVT/PAT
- Variable, but usually fast: A-fib, A-flutter
- > 110 with wide QRS: V-tach

Rhythm Clues

- Regular Rhythms
  - NSR, Sinus tach
  - Sinus brady
  - PSVT/PAT
  - Ventricular Tach
- Irregular Rhythms
  - Atrial Fib
  - Atrial Flutter*
  - 2nd AV Block II*
  - No rhythm
    - Ventricular Fib
    - Asystole

* Can be a Regular rhythm

Presence of P-Waves

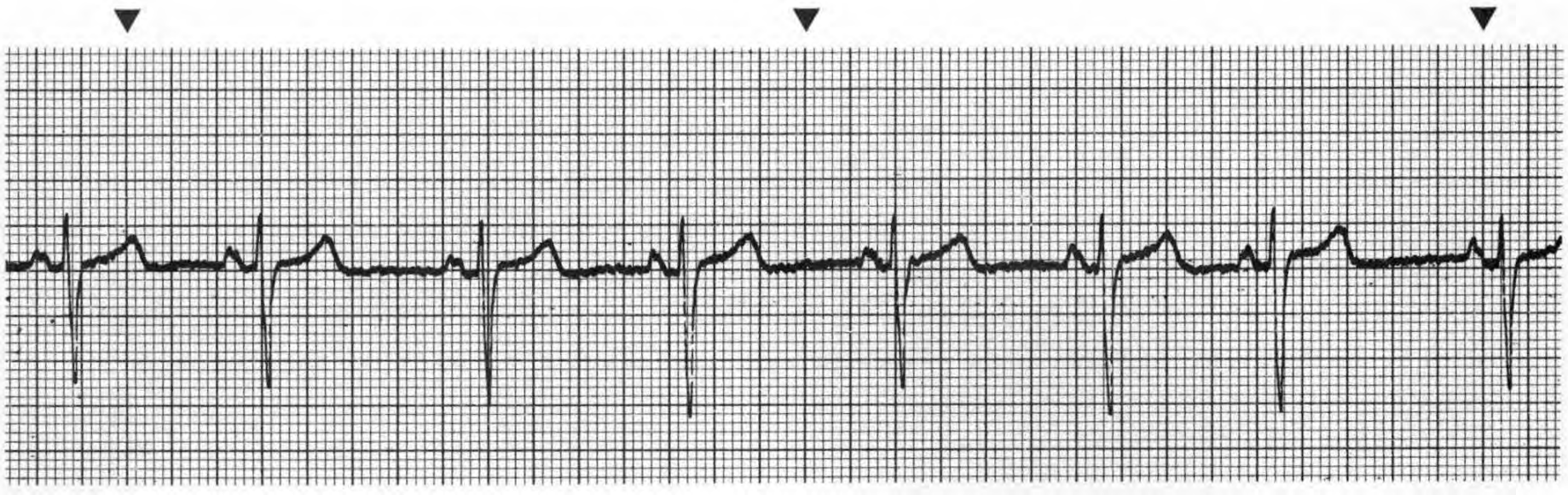
- Normal P-waves
  - NSR, Sinus Tach
  - Sinus bradycardia
  - AV Blocks usually
- Abnormal waves
  - Atrial Flutter
- Loss of P-waves
  - PSVT
  - Atrial Fibrillation
  - Ventricular Tach
  - Ventricular Fib
  - Asystole

Take Home Points

- Develop an organized process to evaluate rhythm strips
- Follow a process each time interpreting rhythm strips
- Buy a decent textbook as a resource
- Practice, Practice, Practice

Unknown 1

Unknown 2



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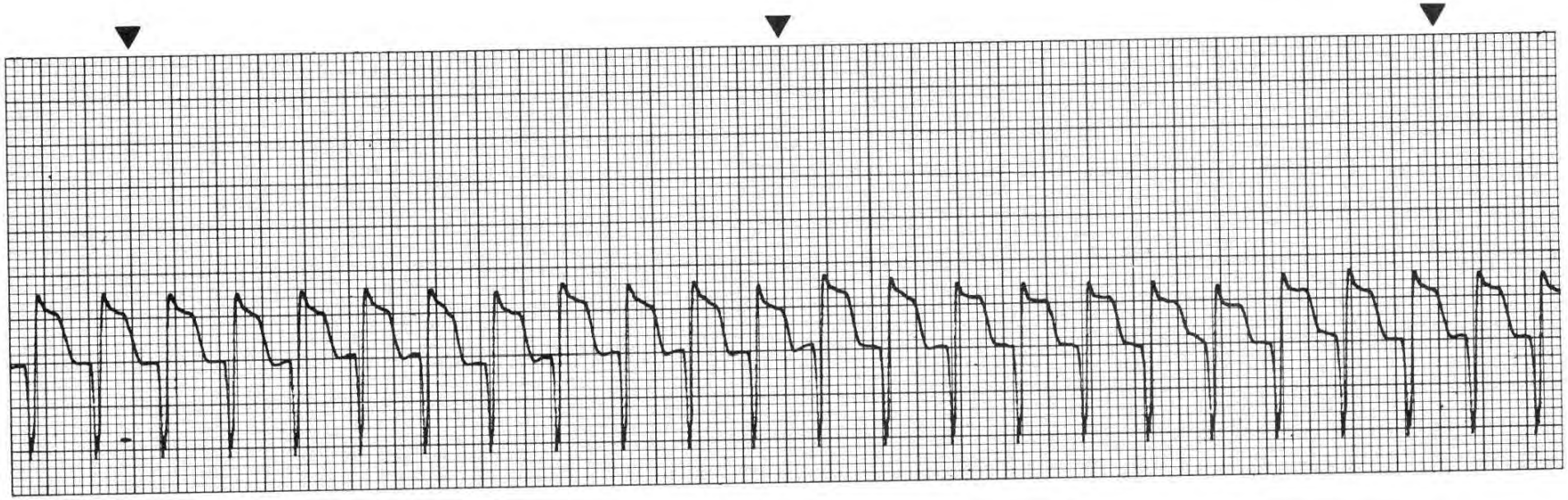
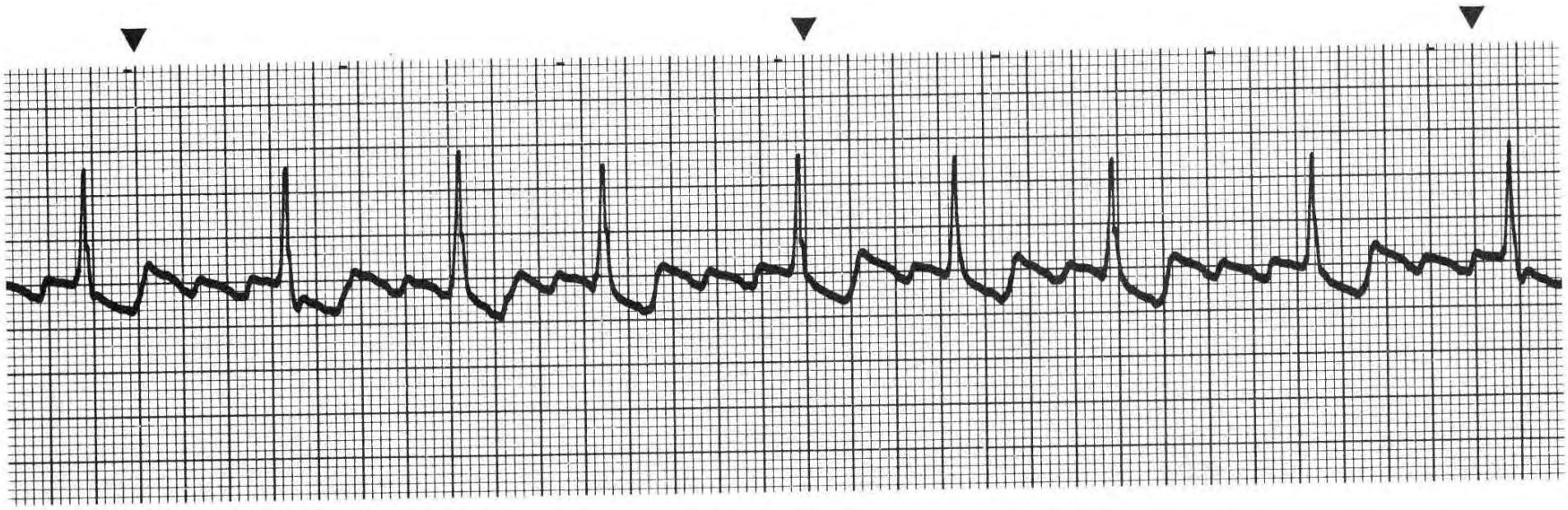


Unknown 4

Unknown 5



Unknown 6

Contact Information

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References

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Hampton J, Adlam D, and Hampton J. 150 ECG Cases, 5th Ed. 2019. Elsevier. 978-0702074585

Up-to-Date