Cardiac Arrhythmia & Sleep Apnea

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Objectives

- What happens during sleep
- Who are the high risk patients
- Arrhythmias in sleep apnea
- What are we monitoring for

What happens during sleep

2 easily measured parameters of the cardiovascular system

- Heart rate
- Blood pressure

Both controlled by the Autonomic Nervous System

1. Parasympathetic
2. Sympathetic

What happens during sleep

- Parasympathetic Nervous System
  - Mediated by the Vagus nerve→ Cardiac muscarinic receptors
    - Causes bradycardia
    - Decreases cardiac muscle contraction

What happens during sleep

- Sympathetic Nervous System
  - Impulse carried by the thoracic and lumbar nerves
    - Constriction of blood vessels
    - Increased heart rate→ SA node
    - Increased cardiac muscle contraction→ direct effect on the cardiac muscle

What happens during sleep

At night

- Blood pressure dips by 10%
- Heart rate slows down

(effect of posture, activity level, circadian influence and effect of sleep)

On awakening

- Blood pressure raises
- Increased heart rate

Gradual steady increases noted

(effect of increasing activity, postural change)

What happens during sleep

- Non-REM stages
  - Parasympathetic influence is dominant
    - Heart rate is reduced → bradycardia
    - Sinus pauses (over 2 seconds), AV blocks → due to parasympathetic effect on AV node
    - Respiratory sinus arrhythmia → indicates good cardiac health
      - HR accelerates with inspiration; decreases with expiration
    - No direct effect on Blood pressure
    - Effect most profound in slow wave sleep
  - Sympathetic activity reduced and stable
    - Reduced Blood Pressure

What happens during sleep

- REM stage
  - Predominant sympathetic state
  - Excitable and unstable state
  - significant fluctuations in heart rate, BP and respiration
  - Swings from tachycardia to bradycardia
  - Parasympathetic activity present but decreased

What happens during sleep

Table 2 Autonomic changes during sleep

Sleep stage	Parasympathetic tone	Sympathetic tone
Non-REM	↑	↓
REM	↓	(due to surges) ↑ ↓

REM, rapid eye movement.

What happens during sleep

- During an arousal
  - spontaneous, secondary to PLMS or respiratory event
    - Has a sympathetic effect (HR and BP)
    - Heart rate increases for 4-5 seconds; noted right before the arousal
    - Bradycardia with and following the arousal

What happens during sleep

"Normal" healthy individual

- Slower HR in Non-REM
- Variable HR and BP in REM
- Arousals increase HR and BP

What happens during sleep

Young individuals

Physically fit/athletes

Heavy laborers

Table 1 Normal rhythm changes during sleep in healthy subjects[1,2]

ECG finding	Prevalence
Sinus pause (>2 s)	4–10%
Sinus bradycardia (<40 bpm)	24%
First degree AV block	8–12%
Wenckebach second degree AV block	6–11%

AV, atrioventricular; bpm, beats per minute

What will happen when things are "Abnormal"

Who are the high risk patients

- MI
- Angina
- Heart failure
- Atrial fibrillation
- Long QT syndrome
- Brugada syndrome
- Medications
- Sleep Apnea

Who are the high risk patients

- MI, Angina
  - Increased risk between midnight to 6 am
  - In Non-REM sleep: reduced BP results in decreased coronary circulation → “non-demand” ischemia
  - In REM sleep: due to increased sympathetic activity → increased heart rate and higher demand from the cardiac muscle → ischemia
  - Post MI: heart function is impaired → arrhythmias
    - (tachycardia, ventricular premature beats);
    - arrhythmia risk decreases after initial 6 months following MI.

Who are the high risk patients

- Heart Failure
  - Oxygen desaturations can trigger tachycardia and result in arrhythmias
  - Cardiac chambers are remodeled (dilated or hypertrophied)
    - Promote areas for ectopic beats

Who are the high risk patients

- Atrial Fibrillation
  - Increased risk between midnight to 2 am
  - Risk doubled for A. fib when there is underlying sleep disordered breathing
    - Likely from sympathetic activity during REM
    - Hypoxemia
- Long QT syndrome, Brugada syndrome
  - Lethal ventricular arrhythmias/Torsades de pointes mainly occur at rest and during sleep

Who are the high risk patients

- Medications:
  - Beta blockers (Metoprolol, Carvedilol..)
  - Calcium Channel blockers (Verapamil, Amlodipine..)
    - They can cross the blood brain barrier and cause violent dreams/nightmares; sleep disruption
    - Induce profound hypotension in Non-REM sleep resulting in coronary ischemia
    - Due to reduced heart rate in Non-REM, other areas conduct a beat → ectopic beats

Who are the high risk patients

- Medications:
  - Drugs that cause QT interval prolongation
  - ❖ The longer pause can lead to ventricular arrhythmias and fatal events like Torsades de pointes
    - Antibiotics
      - Erythromycin, Clarithromycin, Ketoconazole, Quinine,
    - Antihistamines
      - Diphenhydramine, Hydroxyzine, Loratadine
    - Psychiatric drugs
      - Amitriptyline, Nortriptyline, Despiramine, Clomipramine, Doxepin..
      - Haldol, Ziprasidone, Lithium, Thioridazine
    - Type 3 anti-arrhythmic drugs
      - Amiodarone, Sotalol
    - Type 1 anti arrhythmic drugs
      - Quinidine, Flecainide

Sleep Apnea

Arrhythmias in Sleep Apnea

- During an apnea increased vagal tone

- Slowed heart rate
- Potential for Bradyarrhythmias

Arrhythmias in Sleep Apnea

- At the end of an apnea there is hypoxemia, hypercapnia

- Increases sympathetic activity

- Causes elevations in BP and HR

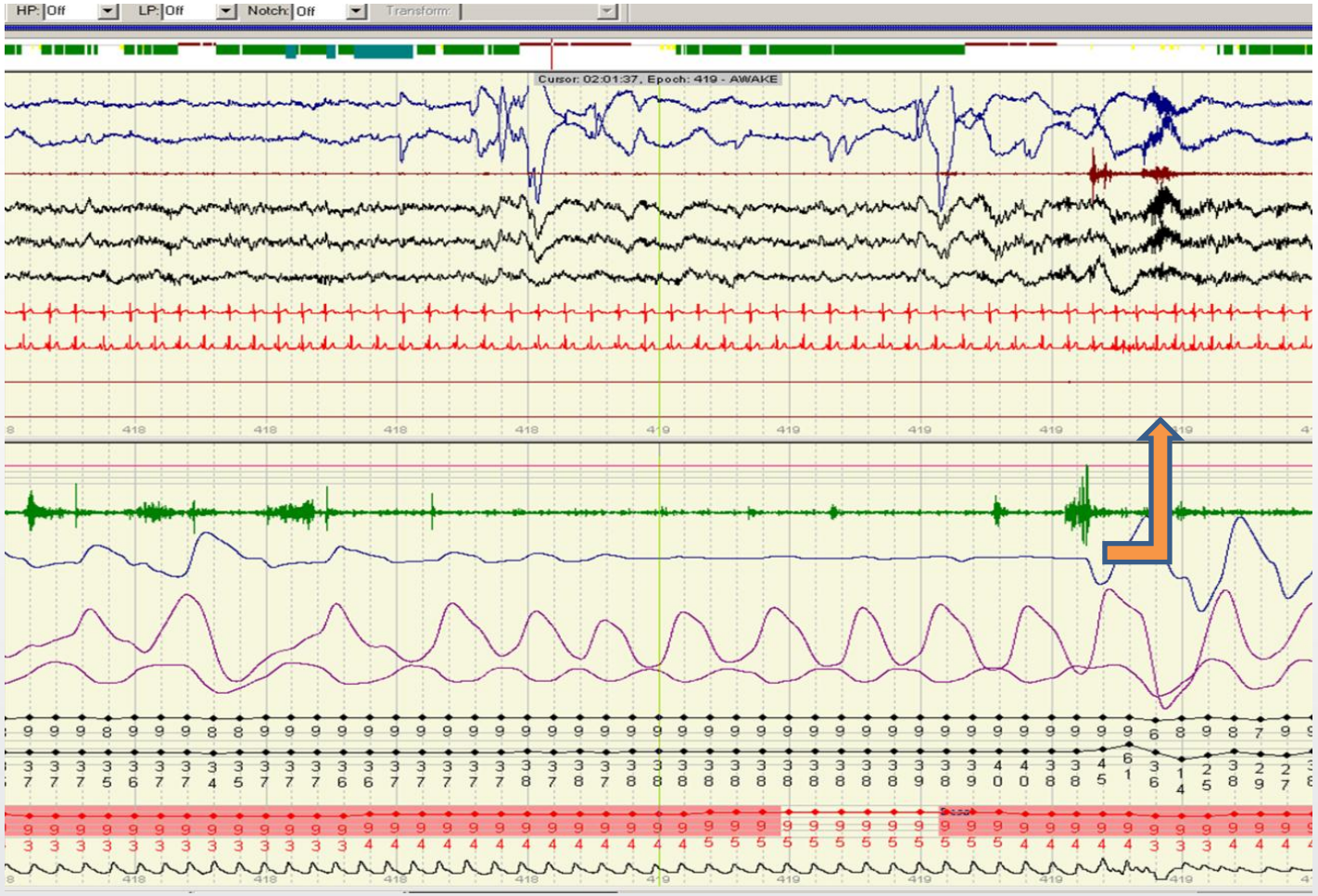
Arrhythmias in Sleep Apnea

- Apnea ends with an arousal

- Increased sympathetic activity
- Decreased parasympathetic activity

- Increased BP and HR

Arrhythmias in Sleep Apnea



Arrhythmias in Sleep Apnea

- Due to sleep disruption from respiratory events
  - Instability in normal sleep stage mediated sympathetic and parasympathetic activity
  - Increased sympathetic response
  - Hemodynamic instability (BP and HR)

Table 2 Autonomic changes during sleep

Sleep stage	Parasympathetic tone	Sympathetic tone
Non-REM	↑	↓
REM	↓	(due to surges) ↑ ↓

REM, rapid eye movement.

Arrhythmias in Sleep Apnea

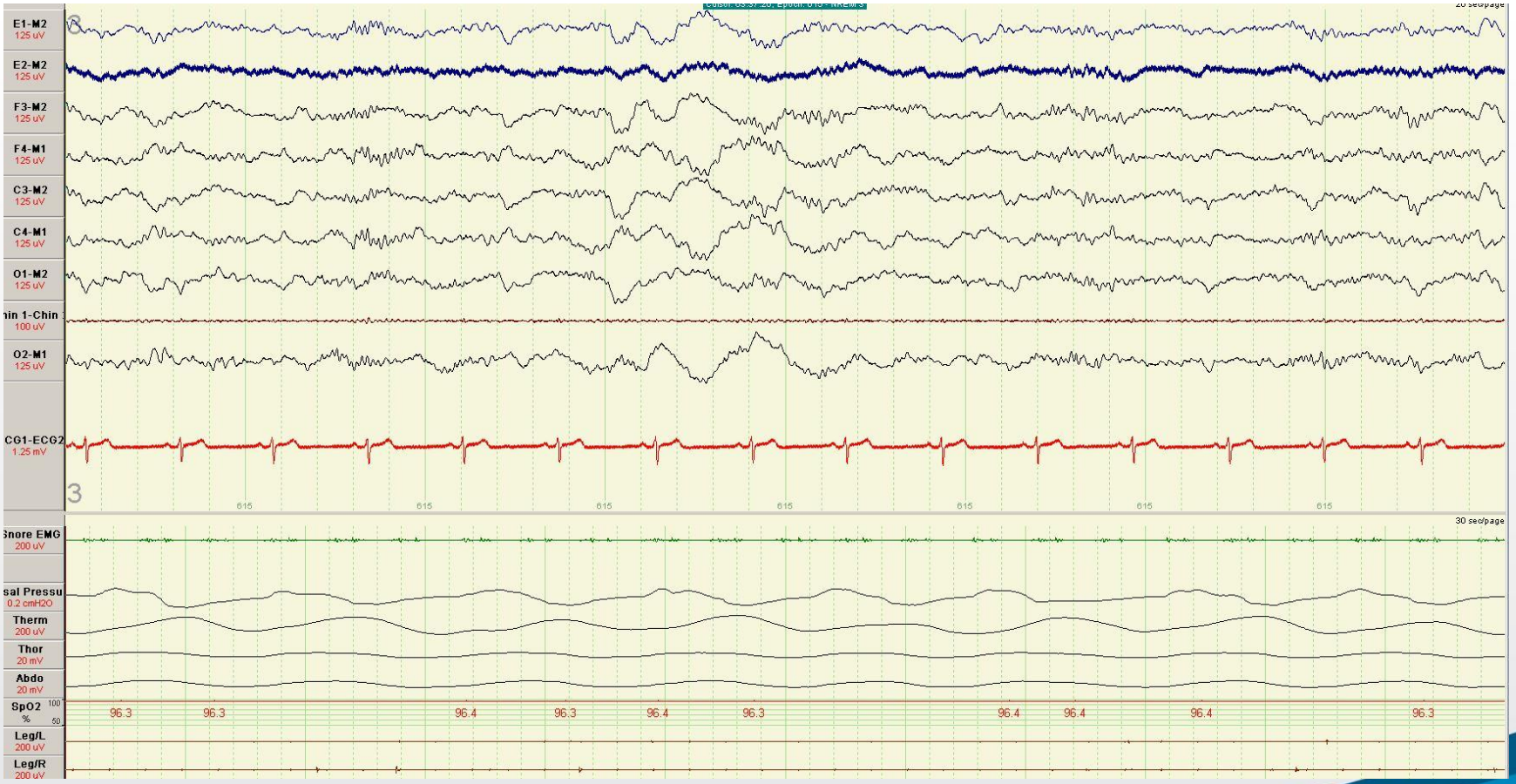
- Risk associated with frequency of apnea (moderate OSA) and degree of hypoxemia
- 50% of OSA patients have nocturnal arrhythmias
- OSA patients have 2-4 fold risk of having complex arrhythmia compared to non-OSA patients.

What should be look for

What should we look for

- AASM Scoring Manual 2012
  - "Recommends" reporting the following adult conditions
    - Sinus tachycardia → sustained HR greater than 90 bpm
    - Sinus bradycardia → sustained HR less than 40 bpm
      - "sustained" means greater than 30 seconds of a stable rhythm
    - Asystole → scored for a pause greater than 3 seconds

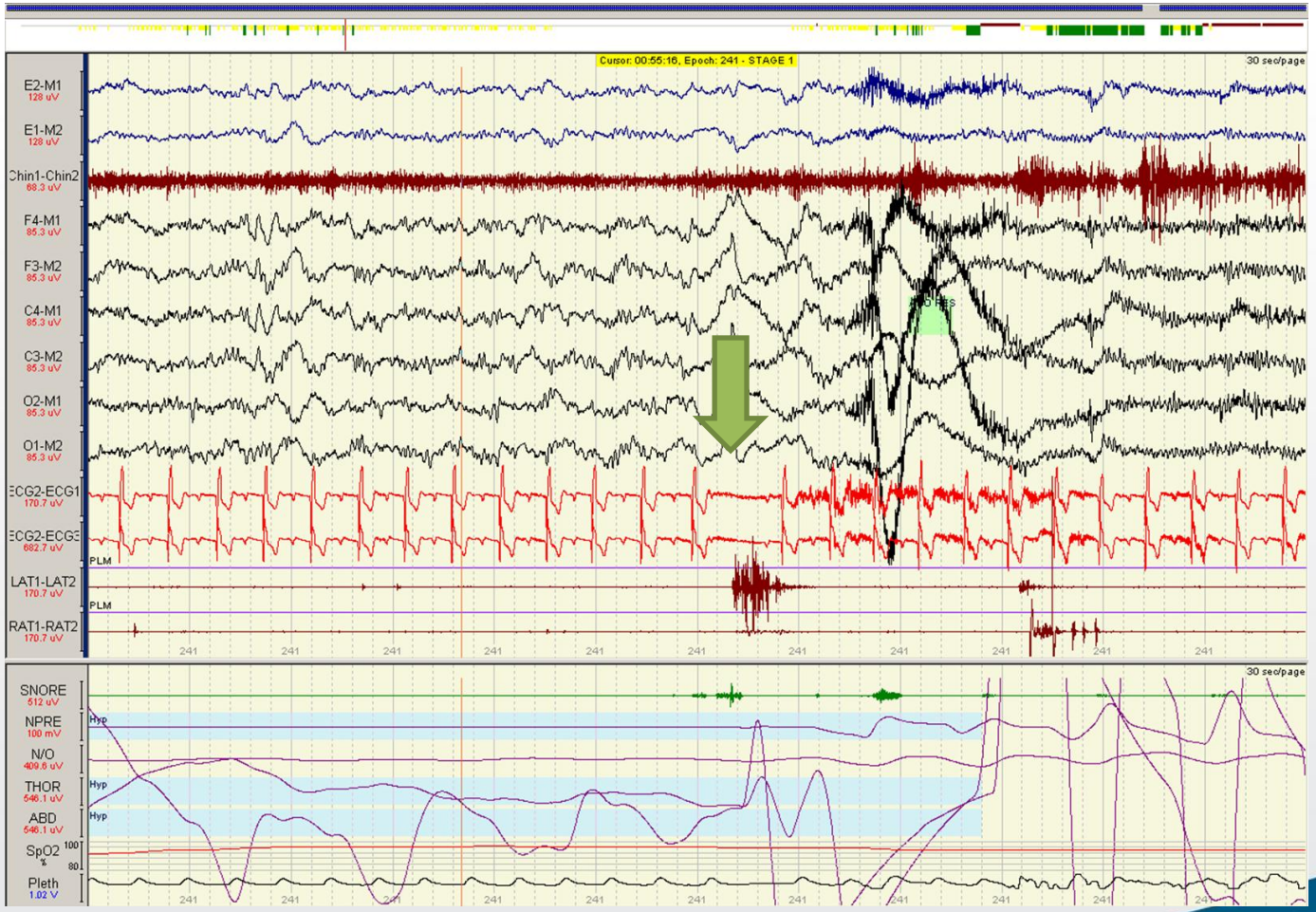
Sinus Bradycardia



Asystole

- Less than 3 seconds: normal
- 3-5 seconds pauses: no intervention required.
  - But if patient is symptomatic→ Assess patients use of beta blockers or calcium channel blockers
  - Contact on call physician
- 5 -10 second pauses: assess for symptoms; check BP.
  - Assess patients use of beta blockers or calcium channel blockers
  - If patient qualifies for CPAP therapy initiate it.
  - Notify on-call physician.

Sinus pause??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128 uV
E1-M2
128 uV
Chin1-Chin2
68.3 uV
F4-M1
85.3 uV
F3-M2
85.3 uV
C4-M1
85.3 uV
C3-M2
85.3 uV
O2-M1
85.3 uV
O1-M2
85.3 uV
ECG2-ECG1
170.7 uV
ECG2-ECG
682.7 uV
PLM
LAT1-LAT2
170.7 uV
PLM
RAT1-RAT2
170.7 uV
241
SNORE
512 uV
NPRE
100 mV
Hyp
N/O
409.6 uV
THOR
546.1 uV
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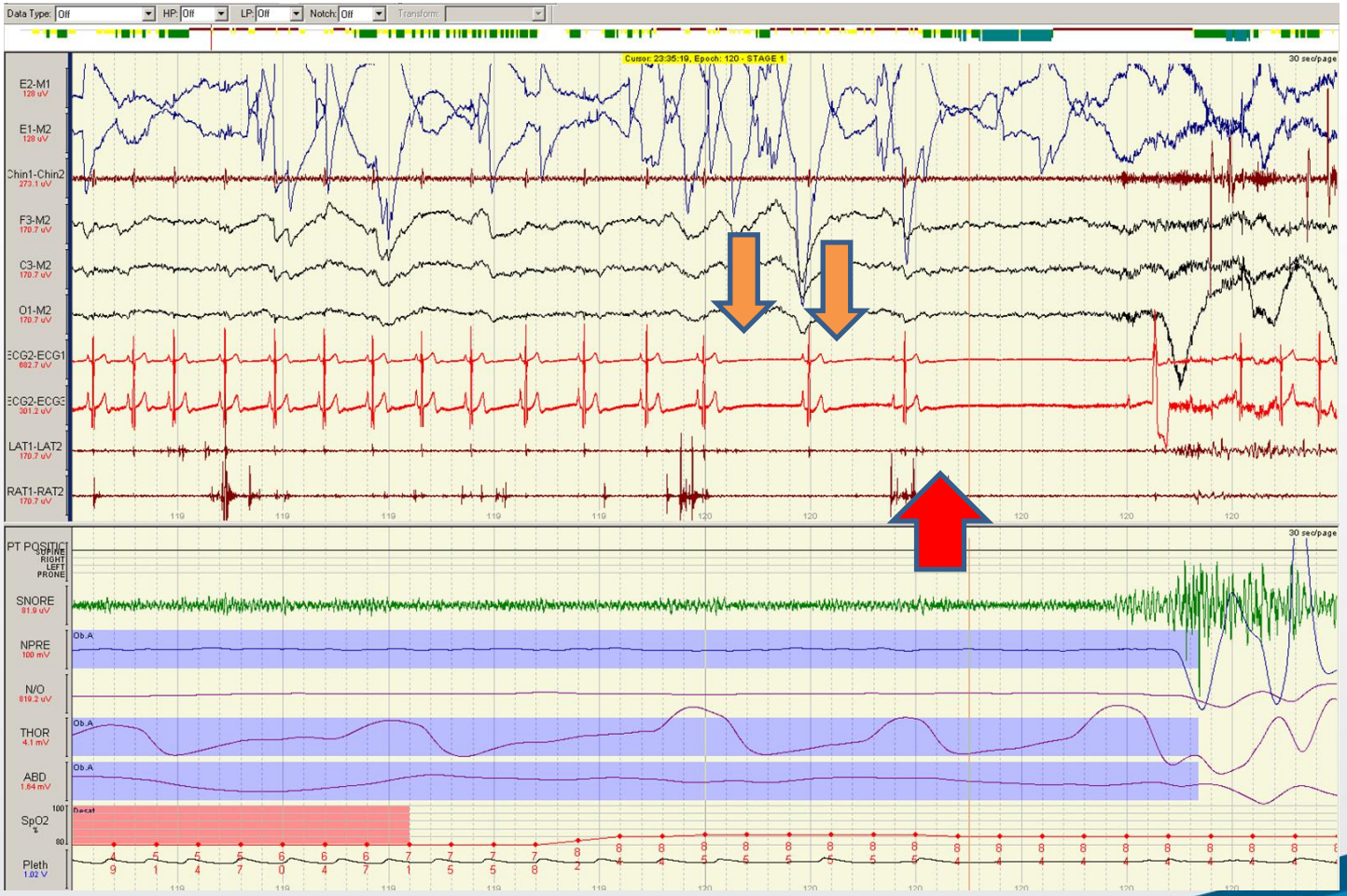
Asystole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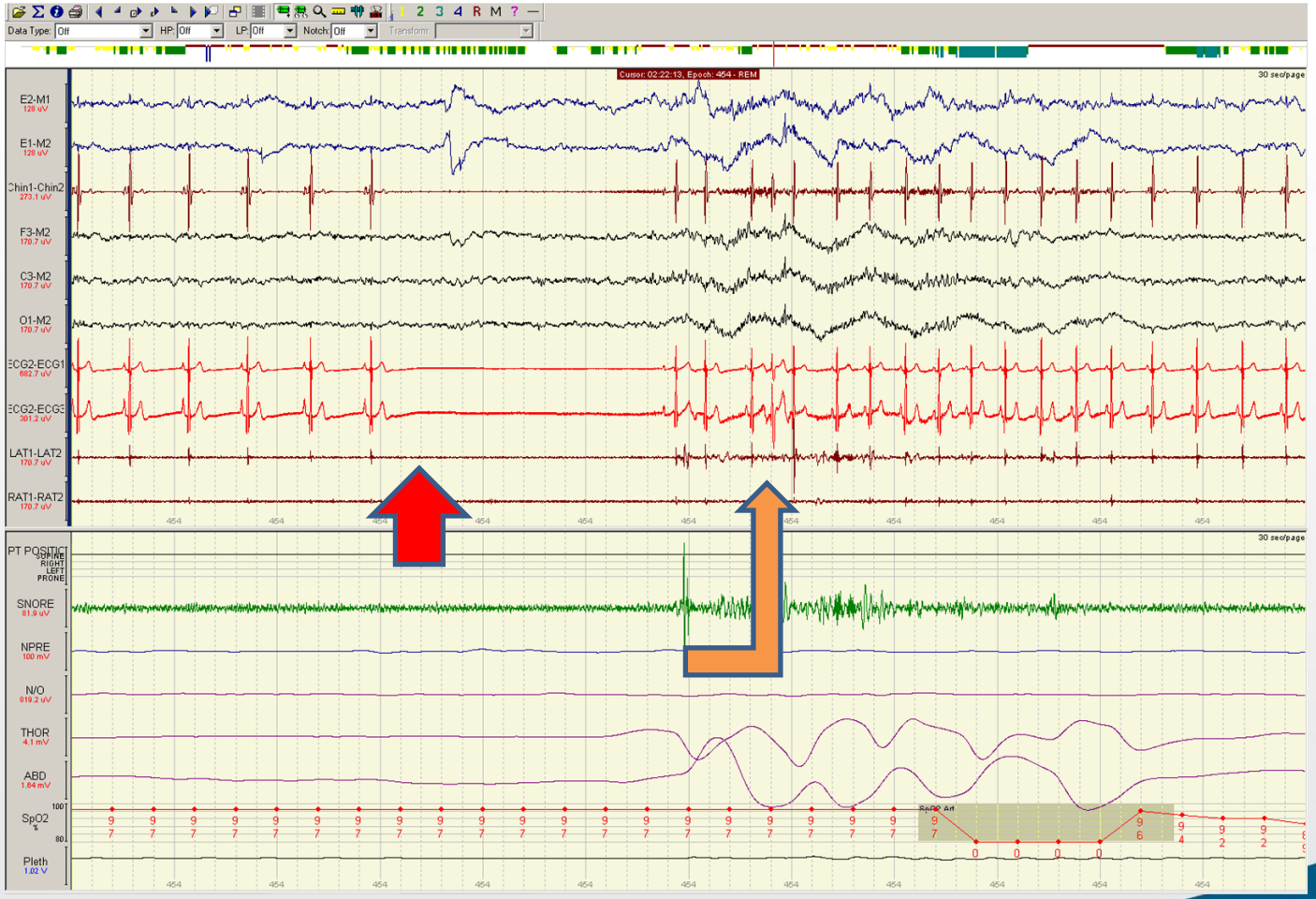
Asystole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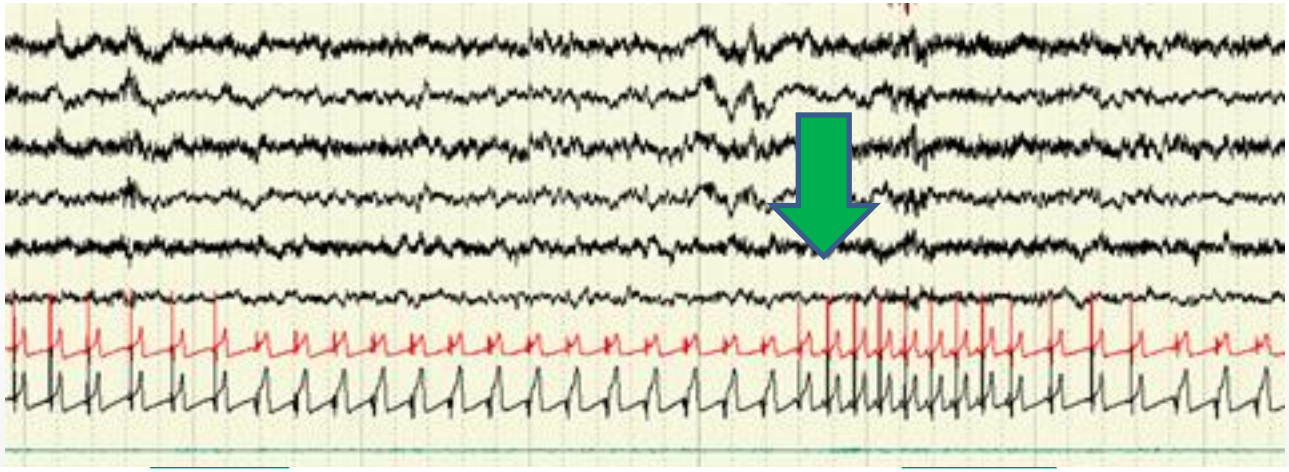
ECG2-ECG3
LAT1-LAT2
RAT1-RAT2
SNORE
NPRE
N/O
THOR
ABD
SpO2
Pleth

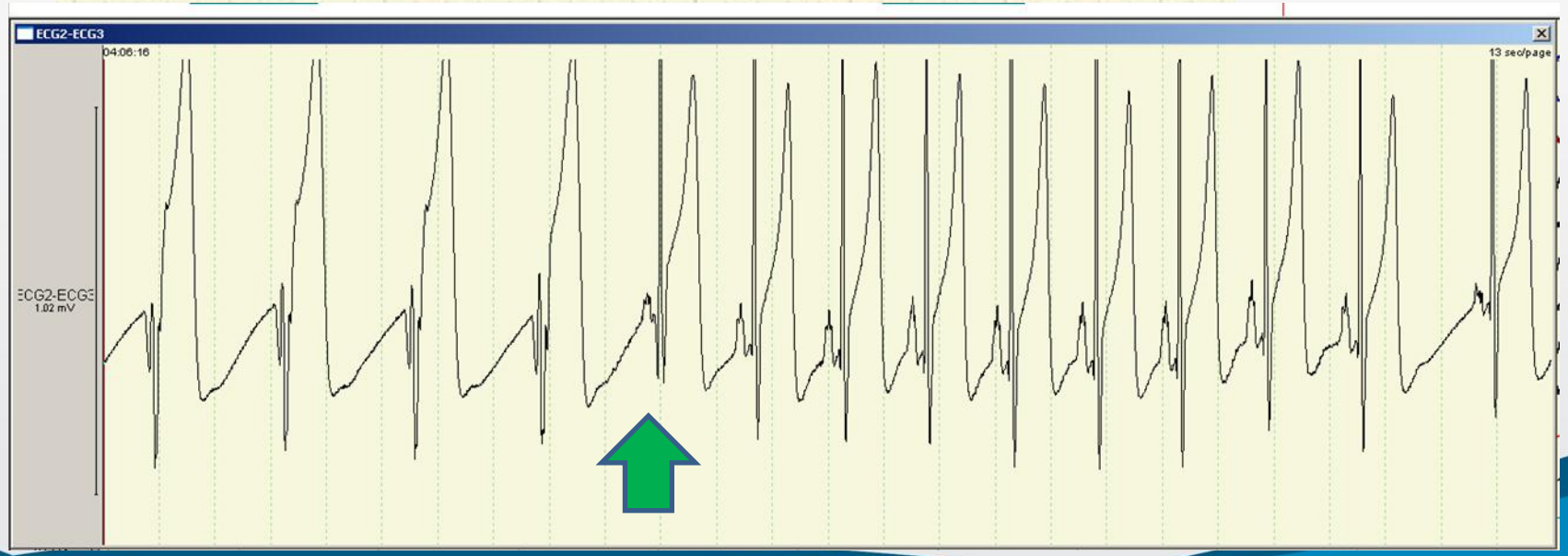
What should we look for

- AASM Scoring Manual 2012
  - "Recommends" reporting the following adult conditions
    - Wide complex tachycardia: consecutive 3 beat minimum; rate greater than 100 bpm; QRS greater than 120 milliseconds.
      - Sustained vs. Non-sustained
    - Narrow complex tachycardia: consecutive 3 beat minimum; rate greater than 100 bpm; QRS duration less than 120 milliseconds

Wide Complex Tachycardia

Narrow Complex Tachycardia

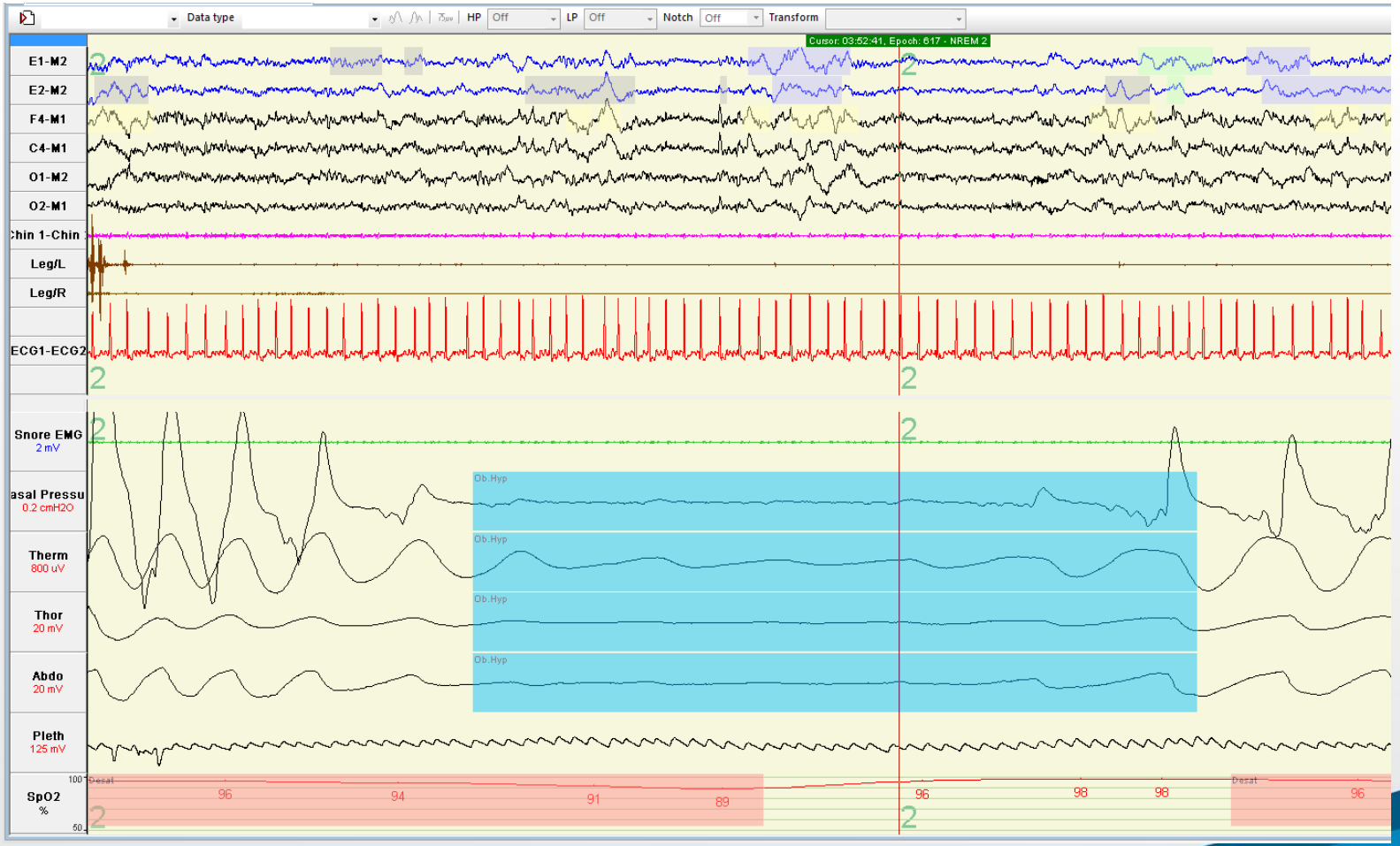




What should we look for

- AASM Scoring Manual 2012
  - "Recommends" reporting the following adult conditions
    - Atrial fibrillation: irregularly irregular ventricular rhythm; absence of P-waves
      - Does patient have history of it? Is it new onset?
      - Is patient symptomatic from it?
      - Check BP and HR
      - If patient is symptomatic or if unstable send to ER; notify on call physician

Atrial Fibrillation



What should we look for

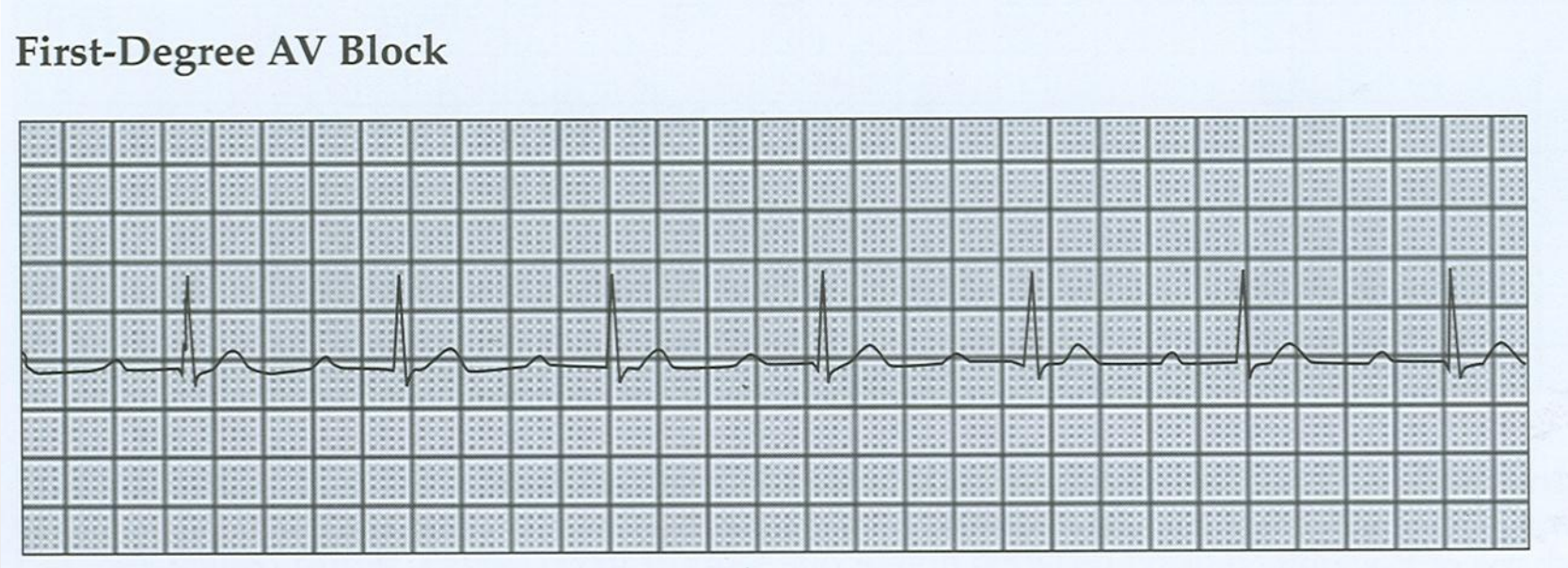
AV Block:

- AASM expects reporting of AV blocks if quality is sufficient for accurate scoring.
- Atrial beats are not conducting through to the ventricles at the AV node

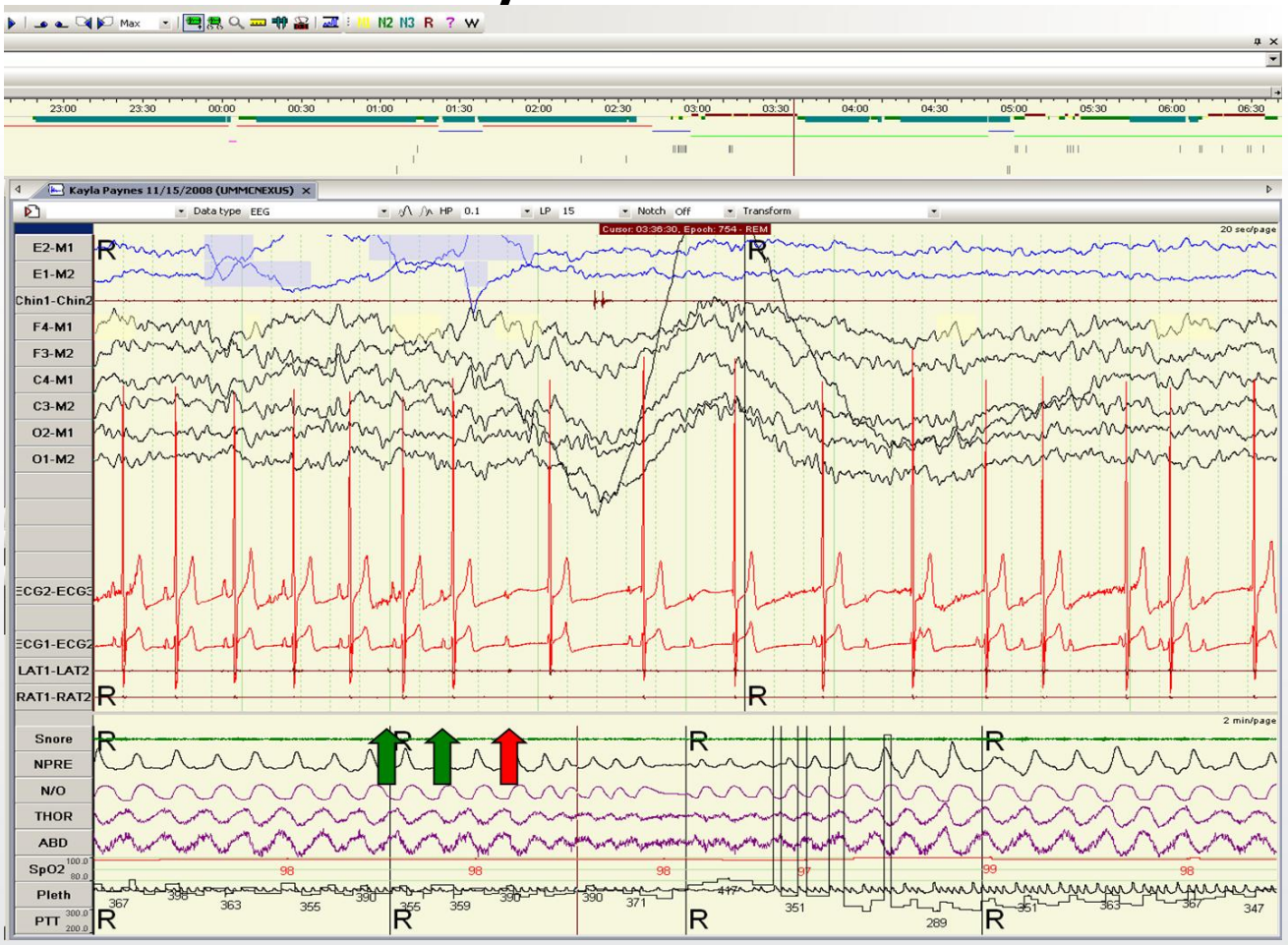
AV Block

- 1st degree AV block
  - Prolonged PR interval (greater than 0.2 seconds)
- 2nd degree AV block
  - Mobitz Type 1 (Wenkebach)
    - Slowly increasing PR interval from beat to beat until a dropped beat (QRS) occurs
  - Mobitz Type 2
    - Randomly dropped beats (QRS)
- 3rd degree AV block /Complete heart block:
  - Complete dissociation between atria and ventricles;
    - atrial rate faster than ventricular rate

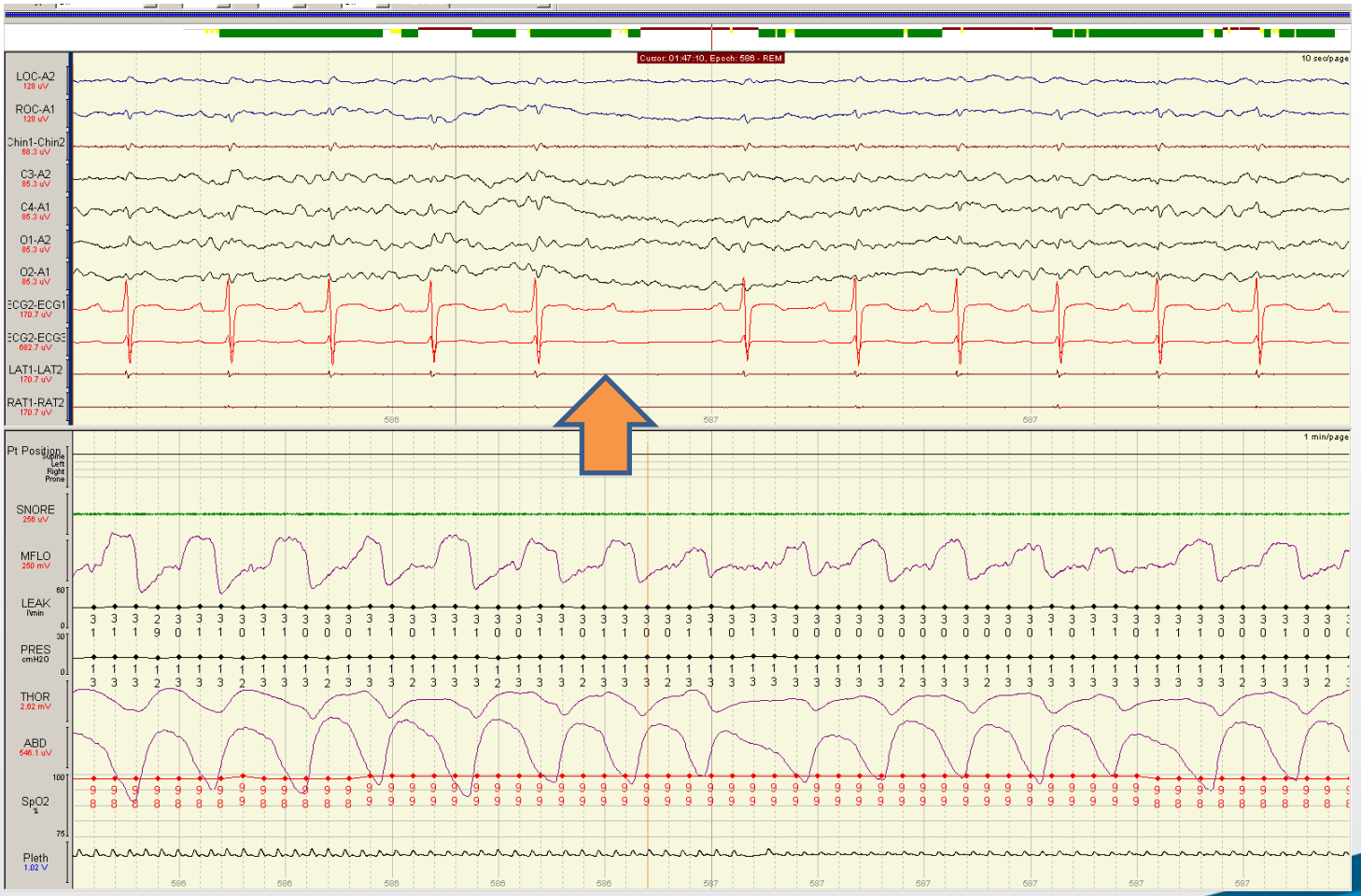
1st degree AV block



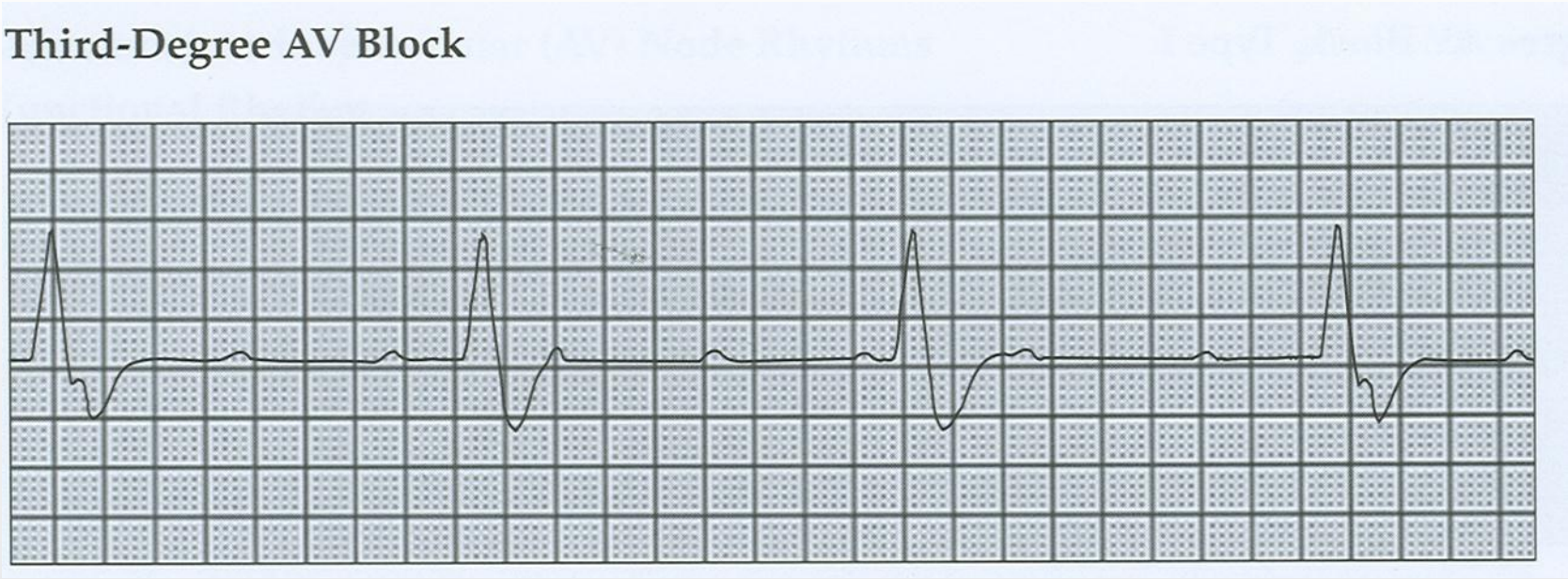
2nd degree AV block/Type 1 Mobitz/Wenkebach



2nd degree AV block Type 2 Mobitz



3rd degree AV block



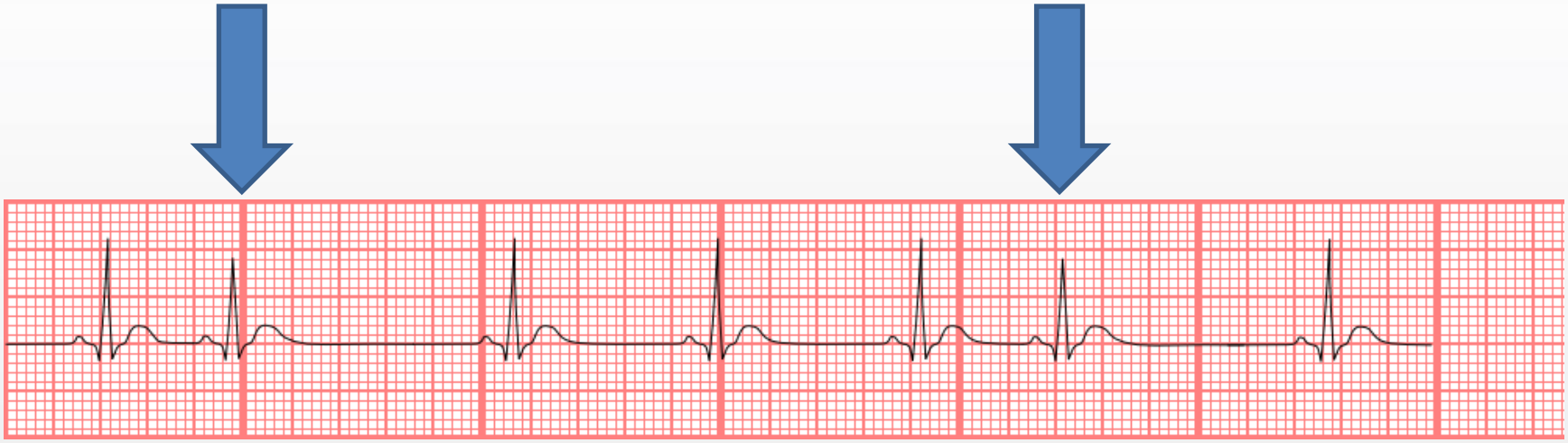
What should we look for

- Ectopic beats: (reported if felt to be clinically significant)
  - Premature atrial contractions
    - P-wave present; narrow QRS
  - Premature ventricular contractions
    - P wave absent; wide QRS complex
  - Premature junctional complexes
    - Originate from the AV junction; will not have a “p-wave” but will have a narrow QRS complex

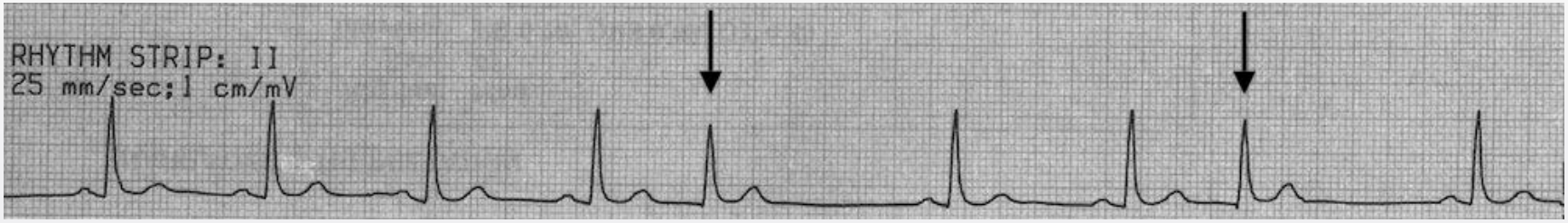
What should we look for

- Ectopic beats
  - Couplets, Triplets
  - Bigeminy → N, E, N, E..
  - Trigeminy→ N, N, E, N, N, E…
  - Quadrigeminy→ N, N, N, E, N,N, N, E…

Ectopic Beats



Ectopic Beats



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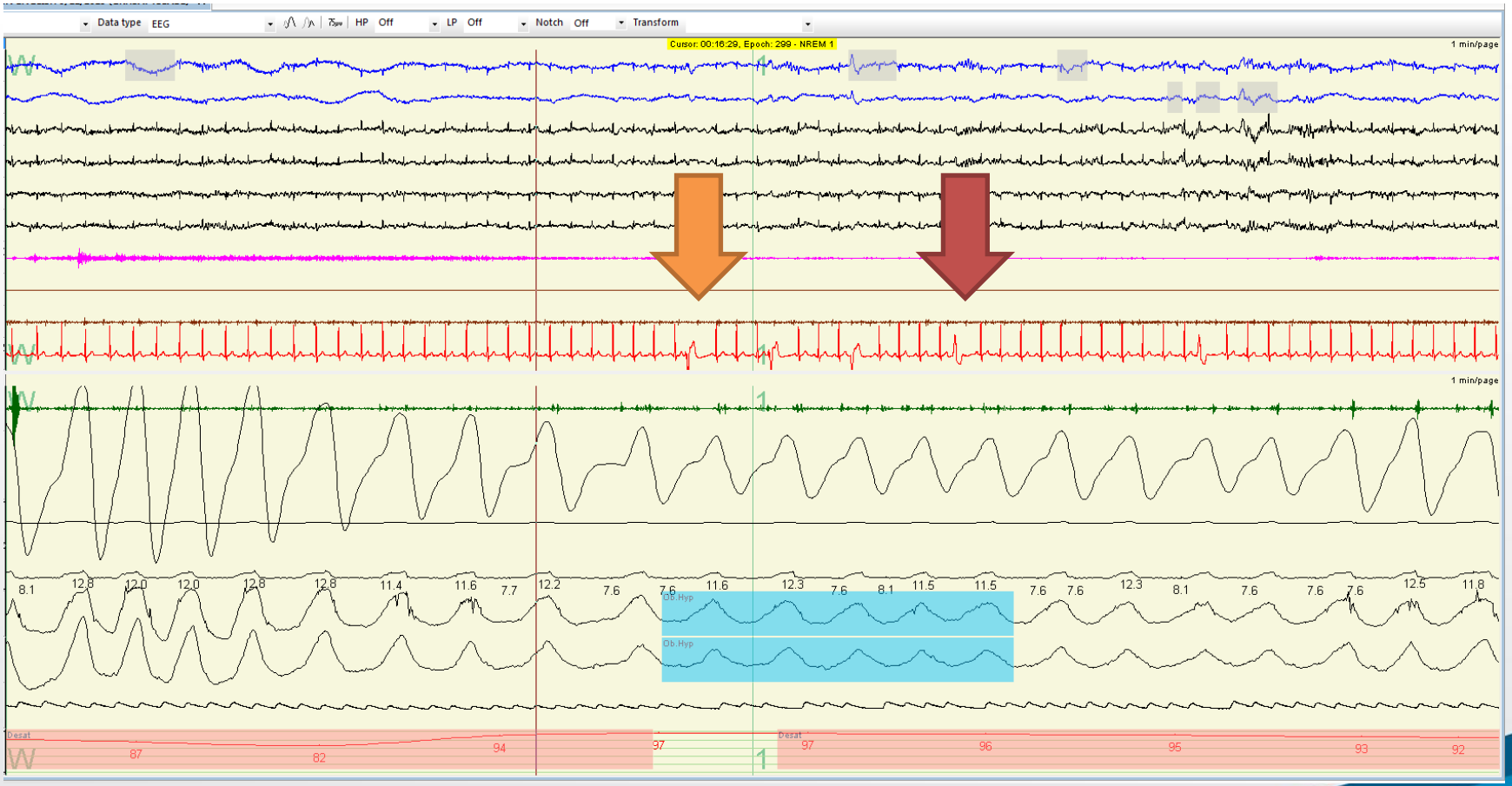
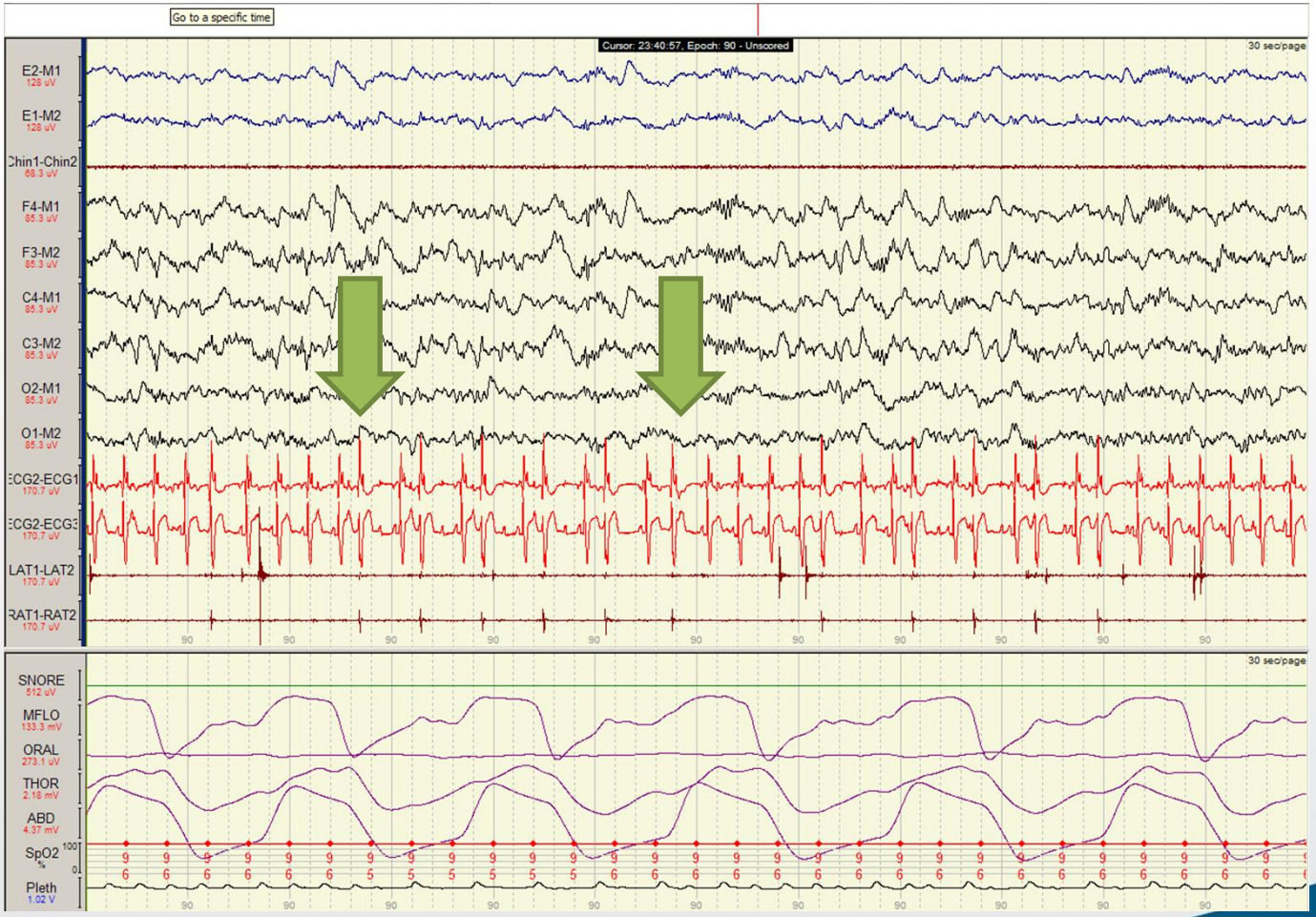
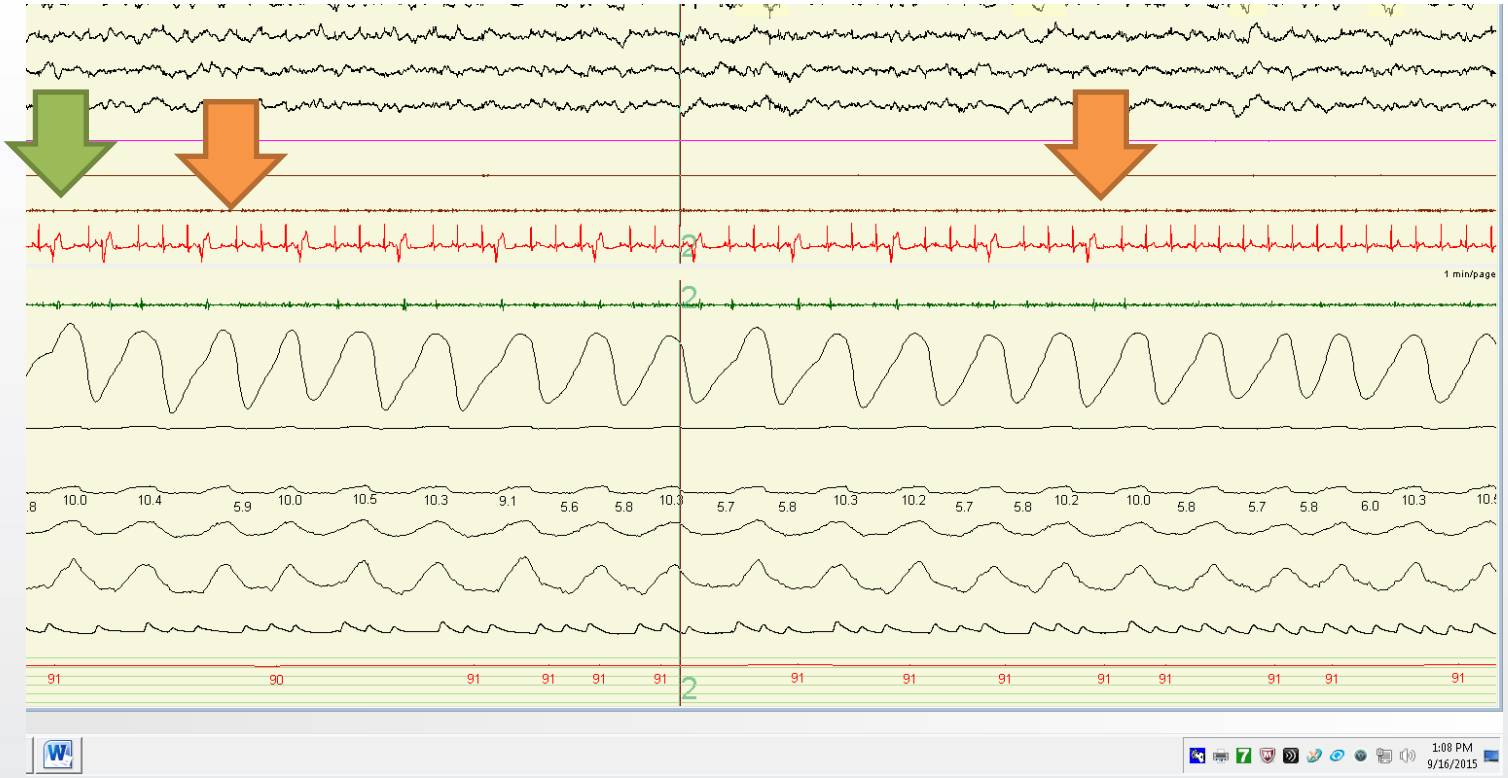


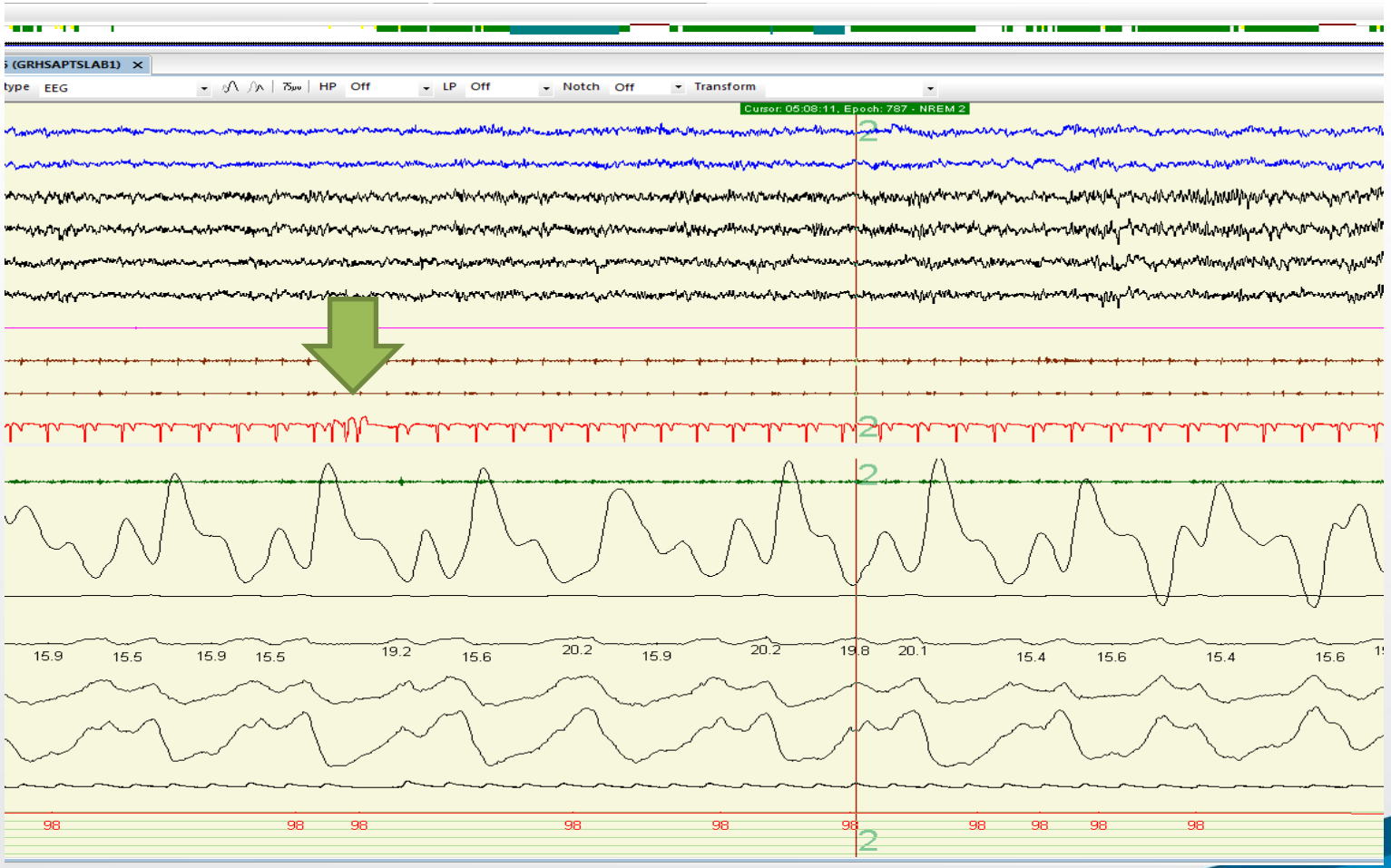
Ectopic beats



Ectopic Beats



Ectopic Beats



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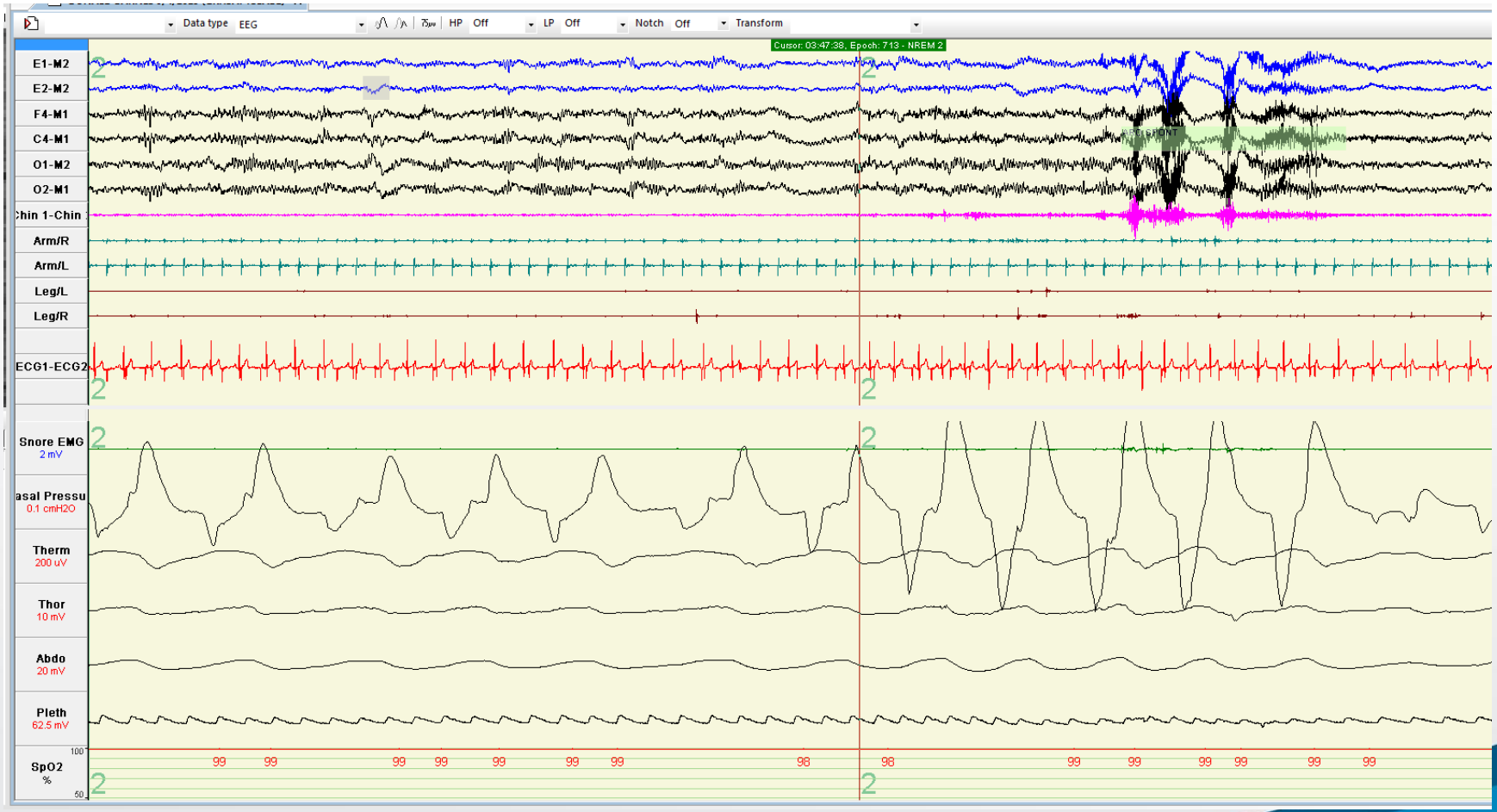
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Arm/R
Arm/L
Leg/L
Leg/R
ECG1-ECG2
Snore EMG
2 mV
asal Pressu
0.1 cmH2O
Therm
200 uV
Thor
10 mV
Abdo
20 mV
Pleth
62.5 mV
SpO2
%
100
50
99
98

References

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- Berry RB; Budhiraja R; Gottlieb DJ; Gozal D; Iber C; Kapur VK; Marcus CL; Mehra R; Parthasarathy S; Quan SF; Redline S; Strohl KP; Ward SLD; Tangredi MM. Rules for scoring respiratory events in sleep: update of the 2007 AASM Manual for the Scoring of Sleep and Associated Events