

## Polysomnography: Staging & Scoring

Dr Biju Thomas MD, DNB, FRCPCH, CCT, RPSGT, RST  
 Senior Consultant in Paediatric Respiratory Medicine  
 KK Women's and Children's Hospital  
 Singapore

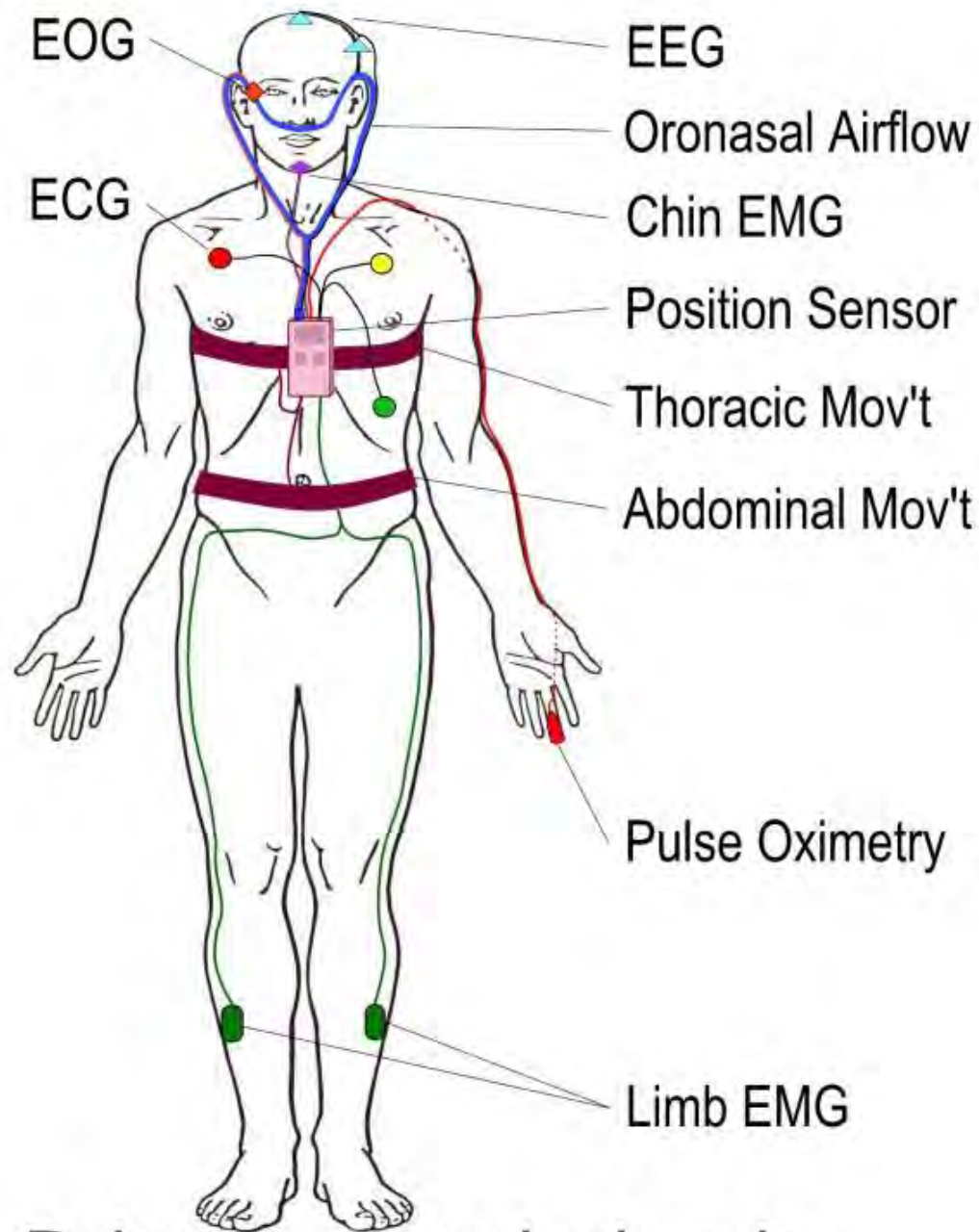


KK Women's and  
 Children's Hospital  
 SingHealth



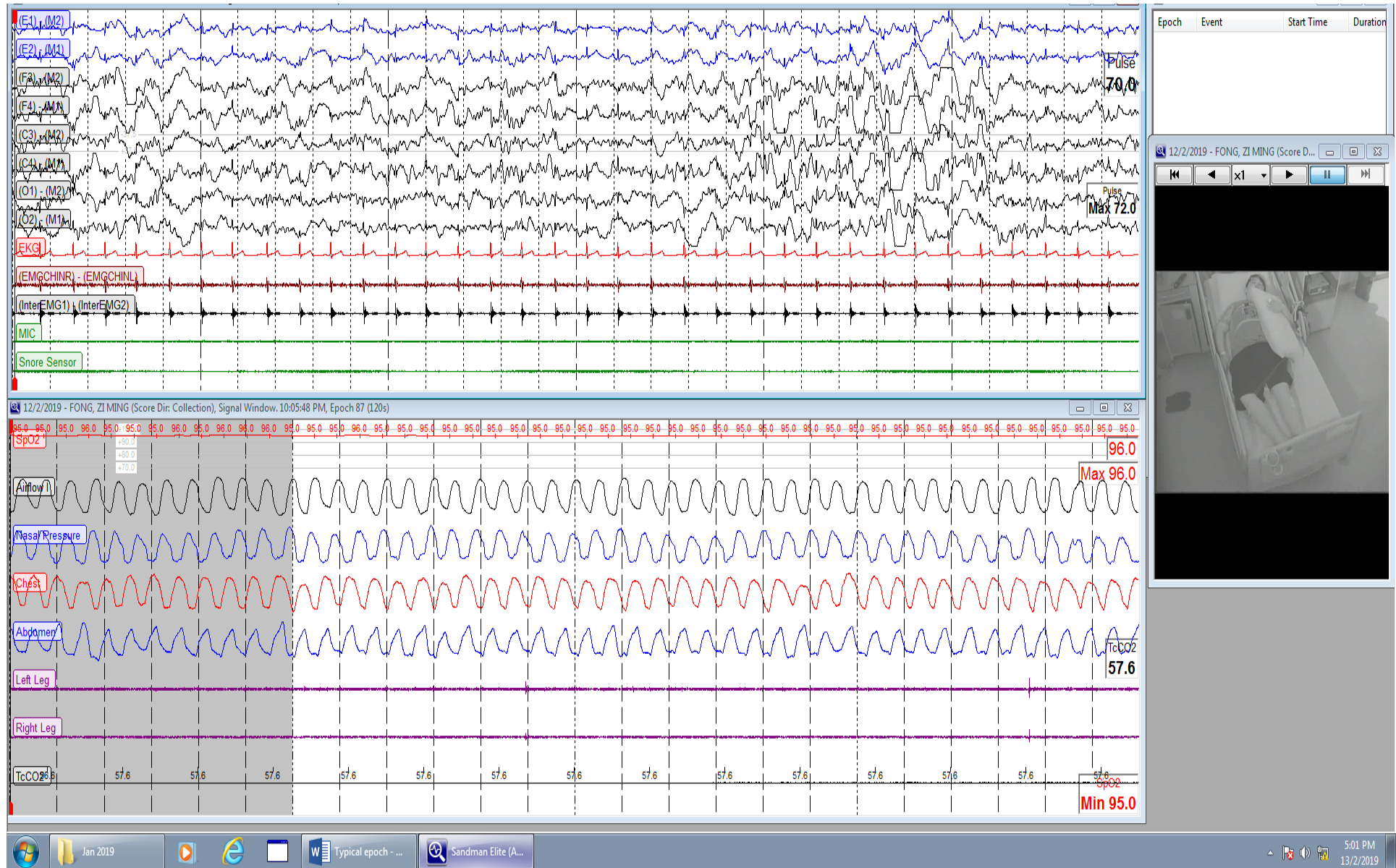
# Purpose and structure of the talk

- » To give an overview of staging and scoring of PSG
- » To highlight **the differences between adults and children** in terms of staging and scoring of sleep.
  - Sleep staging rules
  - Respiratory rules



## Polysomnography Leads

# Typical PSG montage





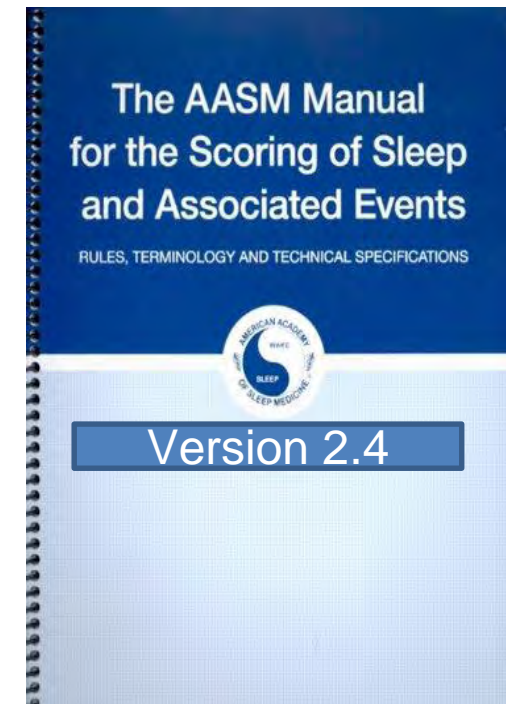
# Staging and Scoring guidelines

## » Rechtschaffen & Kales

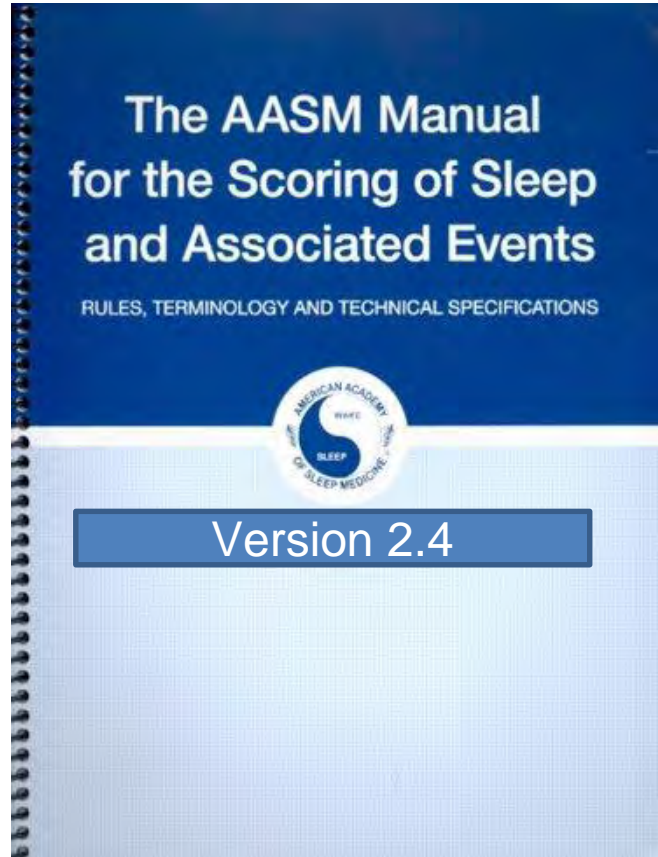
(Allan Rechtschaffen & Anthony Kales 1968)

## » AASM 2007 – first AASM manual

## » AASM 2018 *version 2.5*

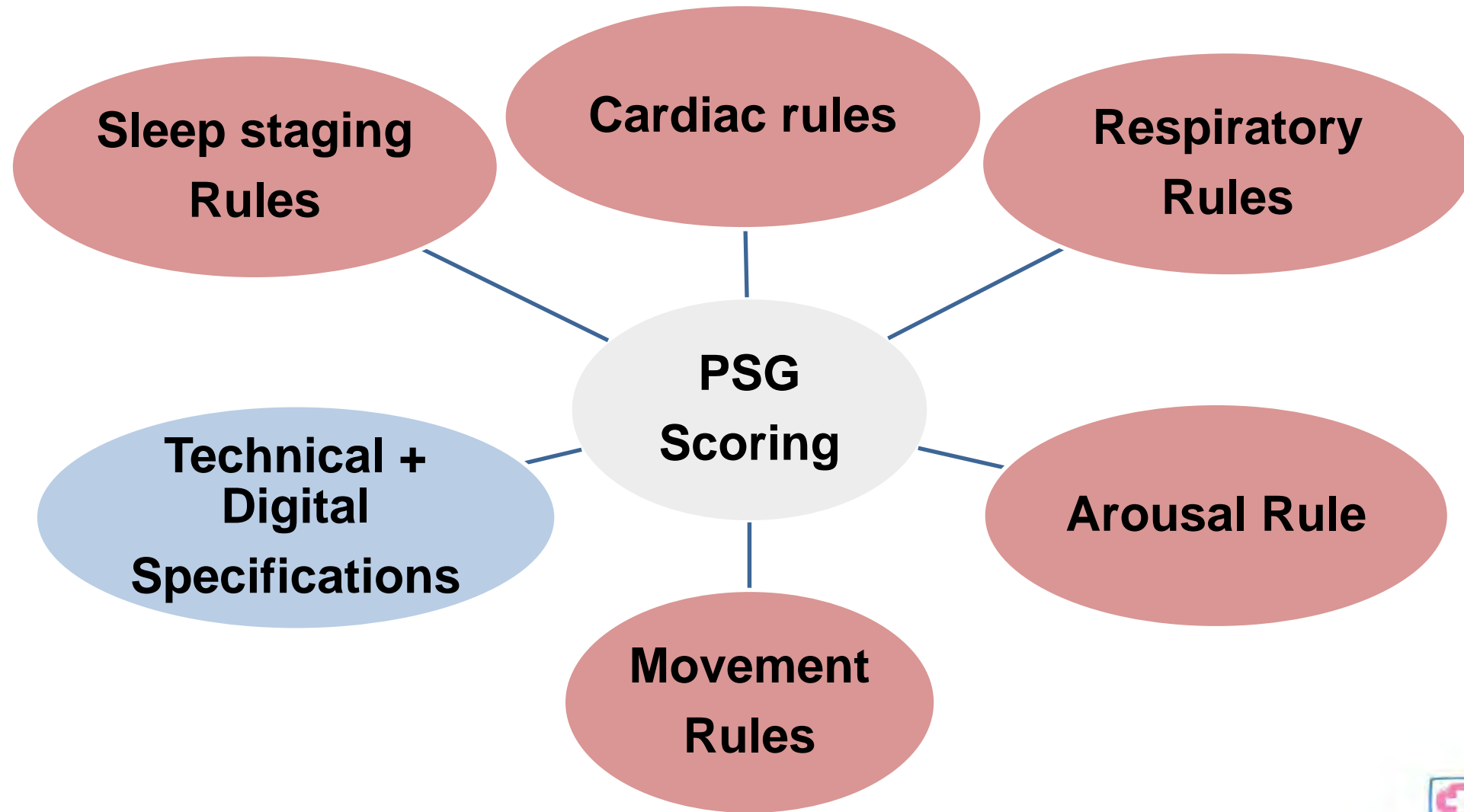


# AASM 2017



- » User Guide
- » PSG: parameters to be reported
- » Technical & Digital specifications
- » Sleep staging rules
- » Arousal Rule
- » Cardiac Rules
- » Movement Rules
- » Respiratory Rules
- » Home Sleep Apnea Testing Rules for Adults
- » Development process, Procedural notes, Glossary

# AASM 2017





# SCORING SLEEP STAGES

ADULTS

CHILDREN

INFANTS





## Paediatric Sleep Stage Scoring Rules

- Can be applied to **≥ 2 months post-term** or older
- No precise upper age boundary for paediatric visual rules
- Children < 2 months post-term: Paediatric Task Force Review paper & AASM 2017\*

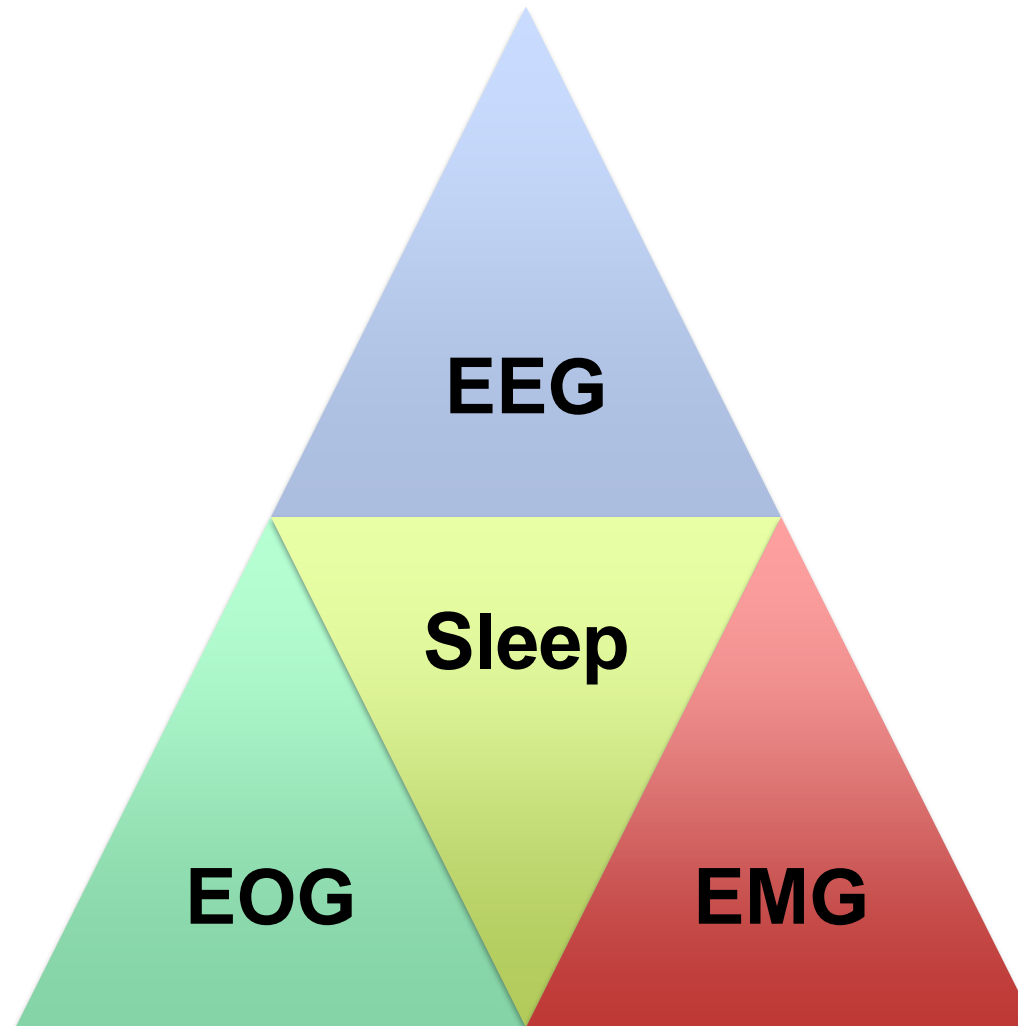
J Clin Sleep Med 2007; 3: 201-40

Journal of Clinical  
Sleep Medicine

### The Visual Scoring of Sleep and Arousal in Infants and Children

Madeleine Grigg-Damberger, M.D.<sup>1</sup>; David Gozal, M.D.<sup>2</sup>; Carole L. Marcus, M.B.B.Ch.<sup>3</sup>; Stuart F. Quan, M.D.<sup>4</sup>; Carol L. Rosen, M.D.<sup>5</sup>; Ronald D. Chervin, M.D.<sup>6</sup>; Merrill Wise, M.D.<sup>7</sup>; Daniel L. Picchietti, M.D.<sup>8</sup>; Stephan H. Sheldon, D.O.<sup>9</sup>; Conrad Iber, M.D.<sup>10</sup>

# Scoring of Sleep Stages

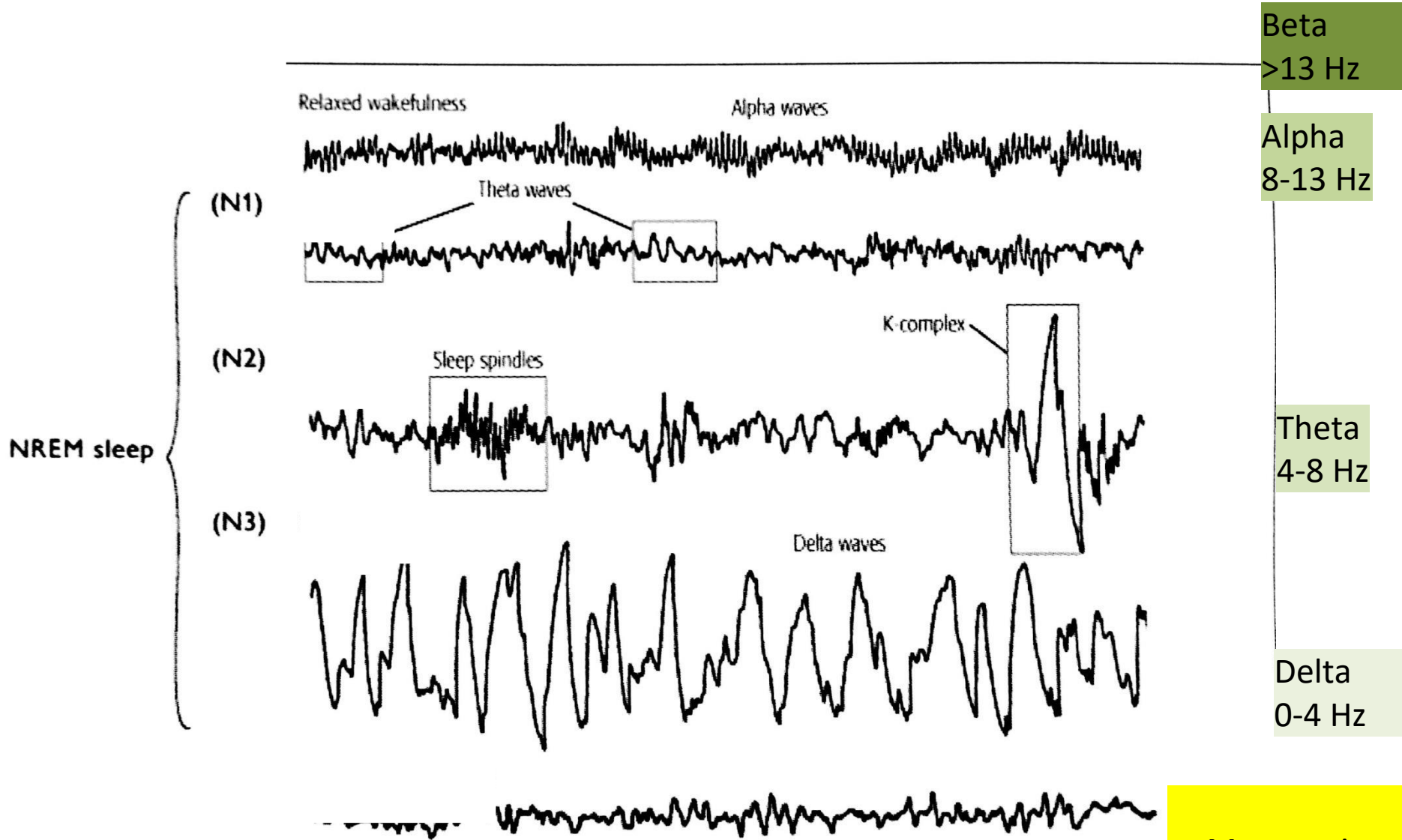


# Scoring of Sleep Stages



Pattern  
Recognition

# Typical EEG patterns



Mnemonic  
"D-TAB"

## General Scoring of Sleep Stages

### Adults

- Stage W (Wakefulness)
- Stage N1 (NREM 1)
- Stage N2 (NREM 2)
- Stage N3 (NREM 3)
- Stage R (REM)

### Children ( $\geq 2m$ post term)

- Stage W (Wakefulness)
- Stage N1 (NREM 1)
- Stage N2 (NREM 2)
- Stage N3 (NREM 3)
- **Stage N (NREM)**
- Stage R (REM)

- Score sleep stages in 30 seconds, sequential epochs, commencing at the start of the study.
- Assign a stage to each epoch.
- If 2 or more stages co-exist in a single epoch, assign the stage comprising the greatest portion of the epoch



# Stage W

- Alpha Rhythm
- Chin EMG
- Eye Movements
  - Reading
  - Slow
  - Rapid
  - Blinks



## Scoring Stage W: Definitions

Criterion	Definition
<b>Alpha rhythm</b>	<b>8 – 13 Hz</b> , Occipital region with eye closure, attenuates with eye opening (older children and adults)
<b>Eye Blinks</b>	Conjugate vertical eye movements, 0.5 – 2 Hz, Present in Stage W with eyes open or closed
<b>Reading Eye Movements</b>	Conjugate, slow phase followed by a rapid phase in the opposite direction, as the subjects reads
<b>Rapid Eye Movements (REM)</b>	Conjugate, <b>irregular</b> , sharply peaked, <b>initial deflection &lt; 500 msec</b> . Seen in stage W (with eyes open when subjects scan the environment), but <b>characteristic of Stage REM</b> .
<b>Slow Eye Movements (SEM)</b>	Conjugate, <b>regular</b> , sinusoidal eye movements, with an <b>initial deflection lasting &gt; 500 msec</b> .(Stage W eyes closed and N1)
<b>Posterior Dominant Rhythm (PDR)</b>	Occipital, Relaxed wakefulness, Eyes closed, attenuates with eye opening Slower in infants and young children: 3.5-4.5 Hz (3–4m), 5-6Hz (5-6m), 7.5-9.5 Hz (3 years); Amplitude >50 $\mu$ V

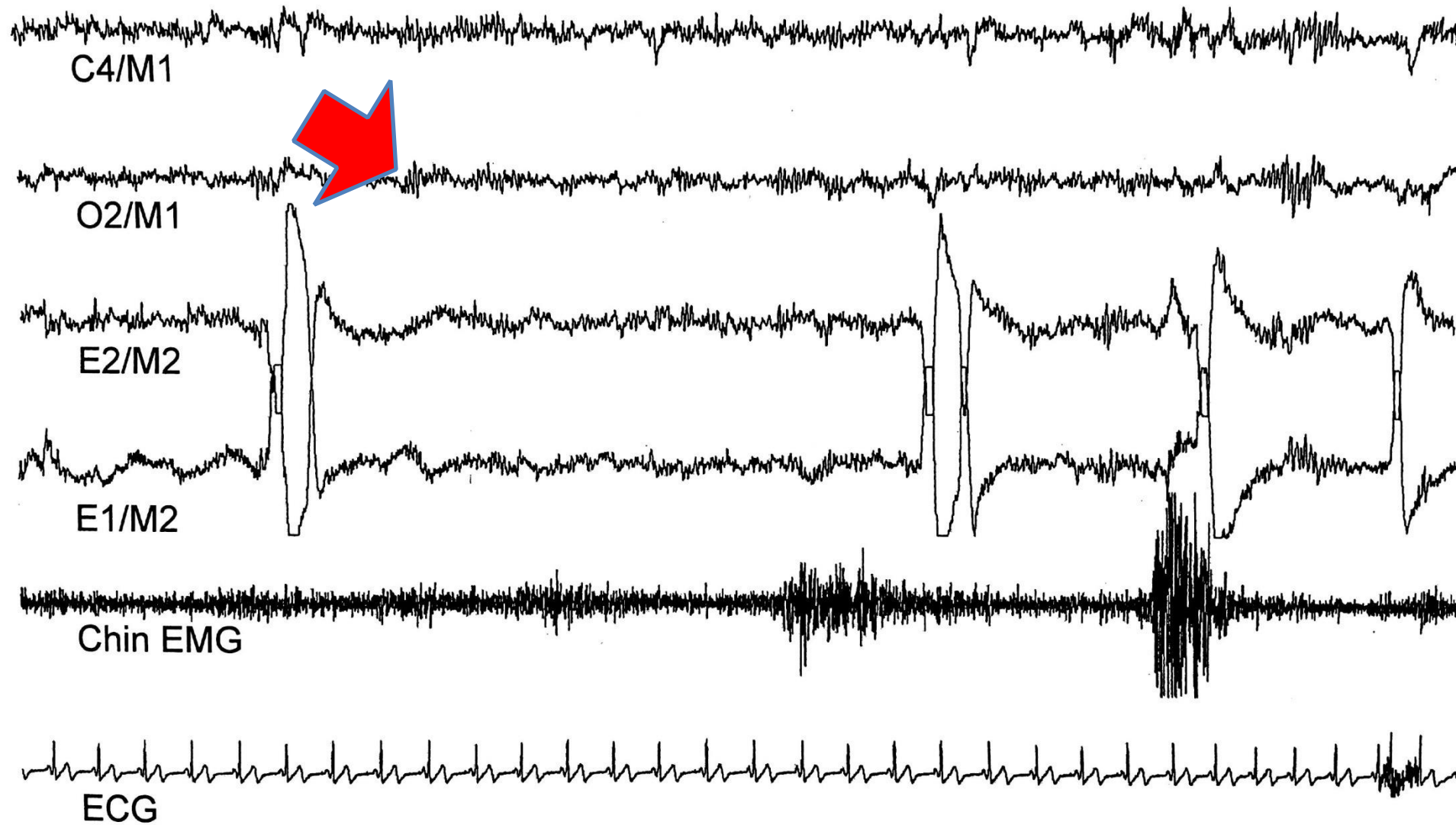
## Scoring Stage W

### If Alpha rhythm/PDR +

- Score as Stage W when **>50%** of the epoch has reactive **Alpha rhythm or age appropriate PDR**, over the occipital region.

### If no discernible Alpha/PDR

- Score as Stage W, if **ANY** of the following is present in >50% of the epoch.
  - Eye Blink (0.5-2Hz)
  - Reading Eye Movement
  - Rapid Eye Movement with normal or high chin EMG



## STAGE WAKE – EYES OPEN

# Stage N1

- Low Amplitude, Mixed Frequency EEG (LAMF)
- Vertex sharp waves
- Chin EMG active
- Slow Eye Movements

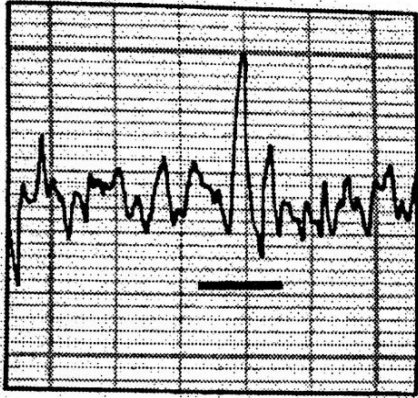
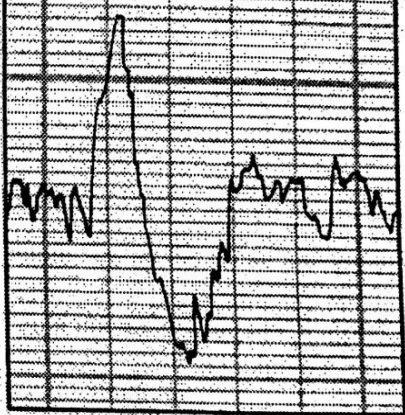




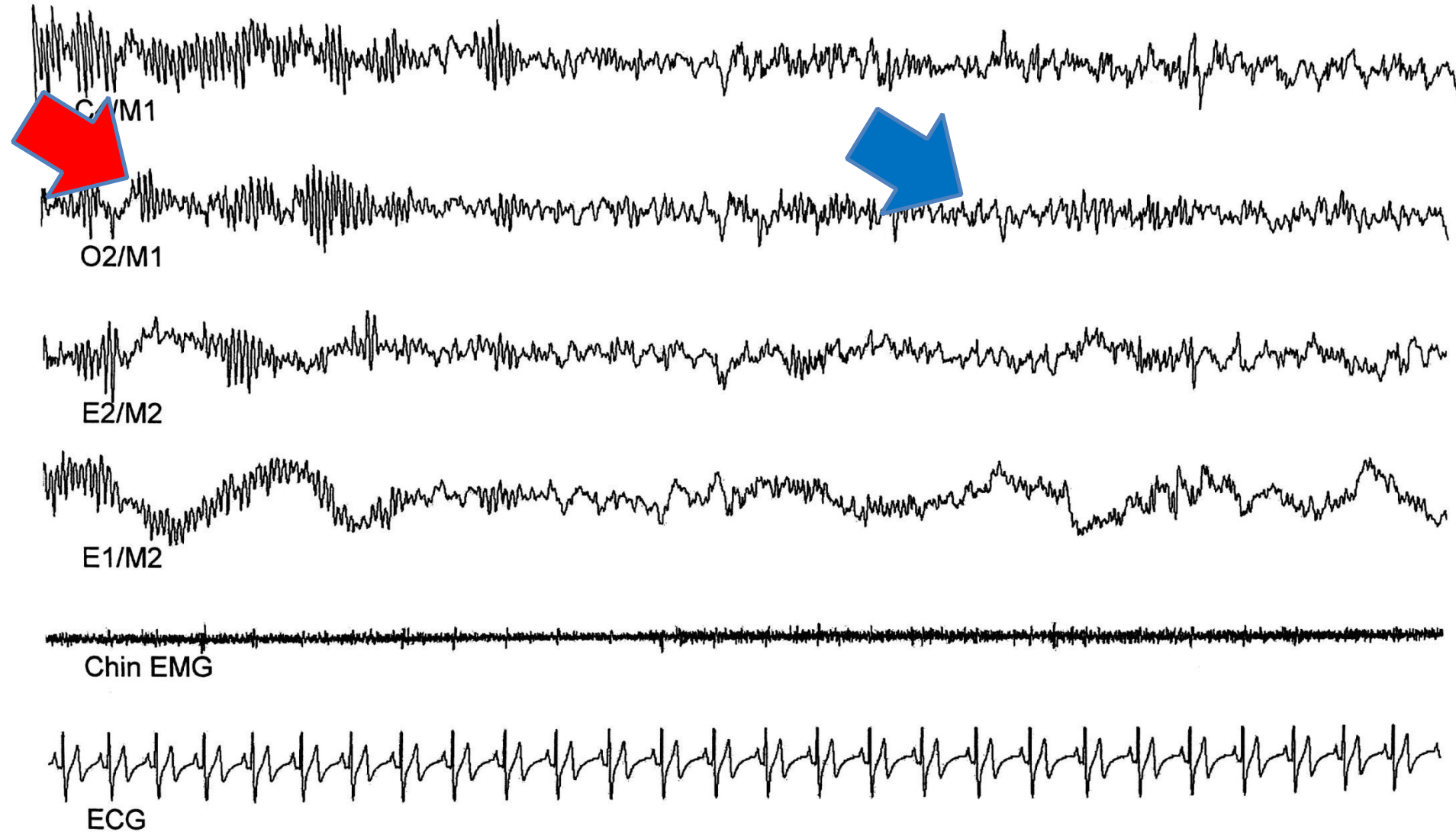
## Scoring N1: Definitions

Criterion	Definition
<b>Slow eye movements (SEM)</b>	Conjugate, reasonably <b>regular</b> , sinusoidal eye movements, with an <b>initial deflection lasting &gt;500 msec</b> . (also seen in W with eyes closed)
<b>Low-amplitude, mixed frequency EEG activity (LAMF)</b>	Alpha rhythm is replaced by <b>low-amplitude mixed frequency (4-7 Hz)</b> activity >50% of the epoch.
<b>Vertex sharp waves (V waves)</b>	<p><b>Sharply contoured waves</b> with a duration &lt;0.5 sec, maximal over the <b>central region</b> and distinguishable from the background activity. Monophasic <b>surface negative sharp waves</b>, typically lasts &lt;200 msec, can occur in bursts or runs, <b>most often seen during transition from Stage W to N1</b>, but can occur in N1 and N2.</p> <p>Typical V waves first appear at 4-6m post term.</p>
Sleep onset	The start of the first epoch scored as any stage other than stage W. Usually, this will be the first epoch of N1 in most subjects.

## Scoring N1: Definitions

Slow eye movements (SEM)	Conjugate, reasonably regular, sinusoidal eye movements, with an initial deflection lasting >500 msec.
Low-amplitude, mixed frequency EEG activity	Low-amplitude, predominantly 4-7 Hz activity.
<b>Vertex sharp waves (V waves)</b>	  <p><b>Vertex wave</b>                      <b>K-complex</b></p>
Sleep onset	The start of the first epoch scored as any stage other than stage W. Usually, this will be the first epoch of N1 in most subjects.

# LAMF EEG replacing Alpha rhythm



**SLEEP ONSET – STAGE 1 SLEEP**

## Scoring N1: Adults

In subjects who generate alpha rhythm	Score N1, if the alpha rhythm is attenuated and replaced by <b>low-amplitude mixed-frequency activity (LAMF)</b> for >50% of the epoch.
In subjects who do not generate alpha rhythm	Score N1 commencing with the earliest of <b>ANY</b> of the following phenomena.  <ol style="list-style-type: none"><li>1. <b>EEG: 4-7Hz</b>, slowing of background frequencies by <math>\geq 1</math> Hz from those of stage W.</li><li>2. <b>Vertex sharp waves</b></li><li>3. <b>Slow eye movements</b></li></ol>

## Scoring N1: Children

In subjects who generate posterior dominant rhythm (PDR)

Score N1, if the PDR is attenuated or replaced by low-amplitude mixed-frequency activity for >50% of the epoch.

In subjects who do not generate posterior dominant rhythm (PDR)

Score N1 commencing with the earliest of ANY of the following phenomena.

1. LAMF EEG: 4-7Hz, slowing of background frequencies by  $\geq 1-2$  Hz from those of stage W.
2. Vertex sharp waves
3. Slow eye movements
4. Rhythmic anterior theta activity
5. Hypnagogic hypersynchrony
6. Diffuse or occipital predominant, high amplitude, rhythmic 3-5 Hz activity



## Rhythmic anterior theta (RAT) activity:

Commonly seen in **adolescents and young adults**

Runs of **5-7 Hz**, rhythmic theta activity

Maximal over the **frontal or front-central** regions.

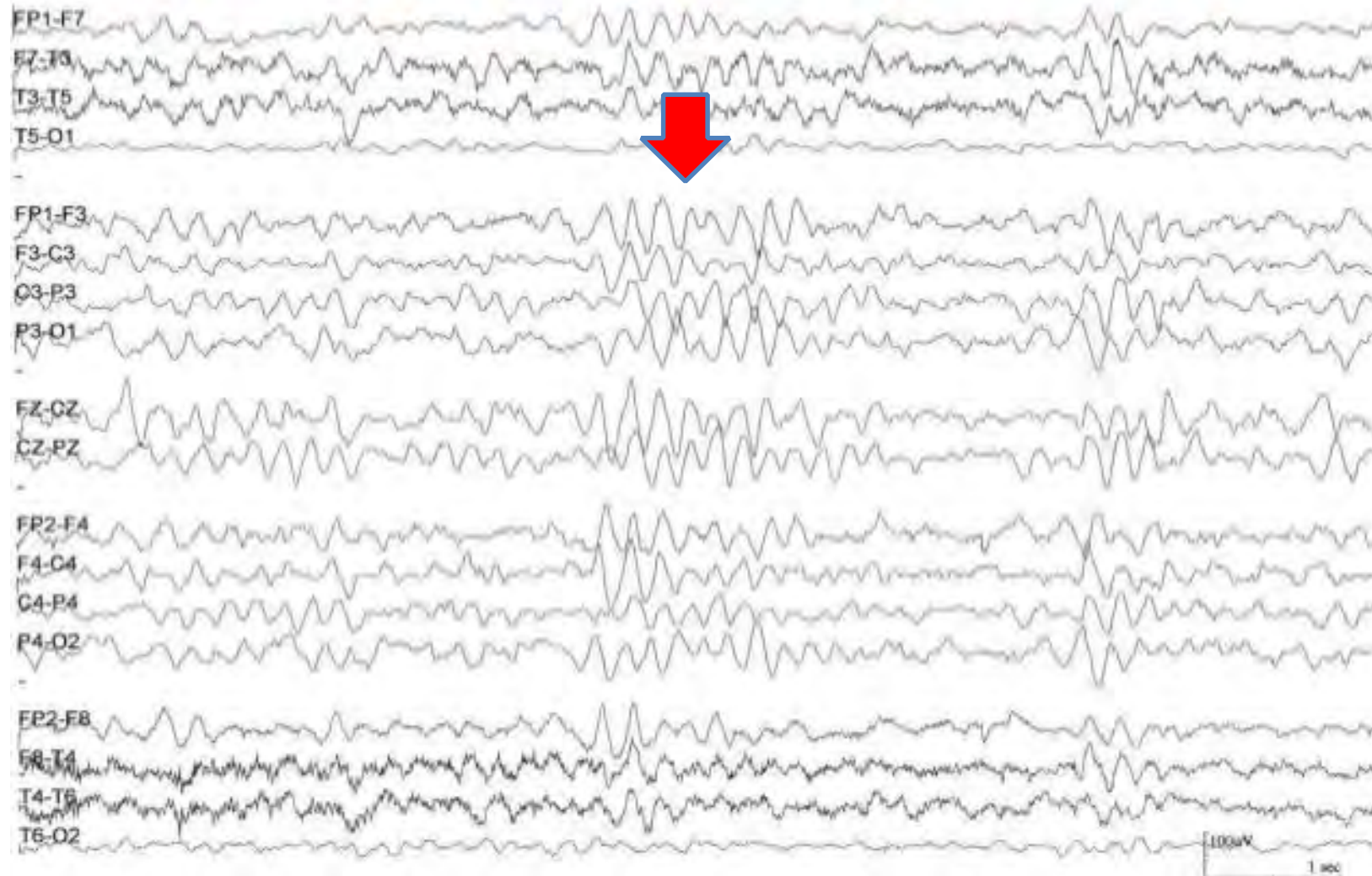
## Hypnagogic hypersynchrony:

A distinctive EEG pattern of drowsiness and N1.

Seen in **3m – 13 years**

Paroxysmal bursts of **3-5Hz**, high voltage (**up to 350 $\mu$ V**) waves

# Hypnagogic Hypersynchrony



# Stage N2

- Low Amplitude, Mixed Frequency EEG (LAMF)
- K complex
- Sleep spindles
- Chin EMG low
- Minimal/No Eye Movements



## Scoring N2: Definitions

EEG Feature	Definition
<b>K complex</b>	<ul style="list-style-type: none"><li>• Well-delineated, <b>negative, sharp wave immediately followed by a positive</b> component, standing out from the background EEG</li><li>• Total <b>duration <math>\geq 0.5</math> seconds</b></li><li>• Maximal amplitude in <b>pre-frontal and frontal</b> derivations</li><li>• Arousal associated K complex: Arousal that is concurrent with the K complex or commences within 1 second after termination of K complex.</li></ul>
<b>Sleep spindle</b>	<ul style="list-style-type: none"><li>• A train of distinct sinusoidal waves with a frequency of 11-16 Hz (most commonly <b>12-14 Hz</b>), low amplitude.</li><li>• Duration <b><math>\geq 0.5</math> seconds.</b></li><li>• Maximal amplitude in <b>central</b> derivations</li></ul>

# Scoring N2: Rules are same for adults and children

## Beginning

In the absence of criteria for N3, if **EITHER or BOTH** of the following occur during the **first half of that epoch or the last half of the previous epoch** (Definite Stage N2)

- **≥ 1 non-arousal associated K complexes**
- **≥ 1 sleep spindles**

EOG usually shows no eye movements in N2, but SEM may persist

Chin EMG in N2: Variable amplitude, lower than W, may be as low as R

## Continuation

- Epochs with **low-amplitude, mixed-frequency (LAMF) EEG**
- Preceded by epochs containing EITHER non-arousal associated K complexes or sleep spindles.

## End

Transition to W, N1, N3 or R  
Arousal/major body movement



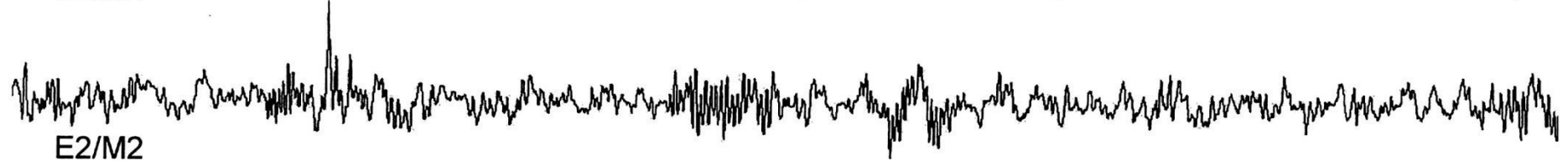
Sleep spindle



C4/M1



O2/M1



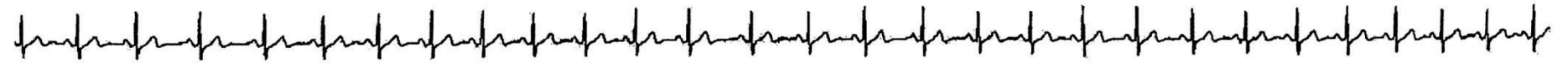
E2/M2



E1/M2



Chin EMG



ECG

## STAGE 2 SLEEP (SAMPLE A)

# Stage N3

- Slow Wave Activity
- Chin EMG low
- Minimal/No Eye Movements



**Scoring rules for Stage N3 are same for adults and children (>2 m)**

(i). **Slow wave activity in  $\geq 20\%$**  of epoch

- Frequency = 0.5-2 Hz
- Peak to peak amplitude  $>75\mu\text{V}$
- Frontal region (F4-M1, F3-M2)

(i). **Slow wave activity in  $\geq 20\%$**  of epoch

- Frequency = 0.5-2 Hz
- Peak to peak amplitude  $>75\mu\text{V}$  (**100-400  $\mu\text{V}$** )
- Frontal region (F4-M1, F3-M2)

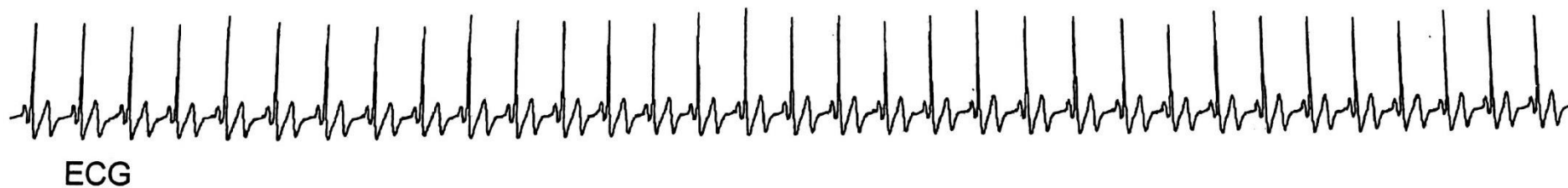
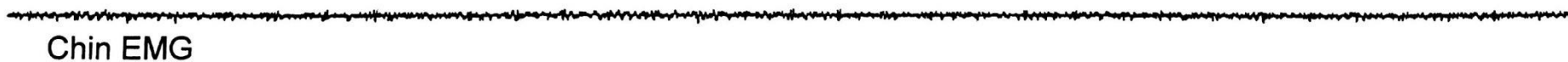
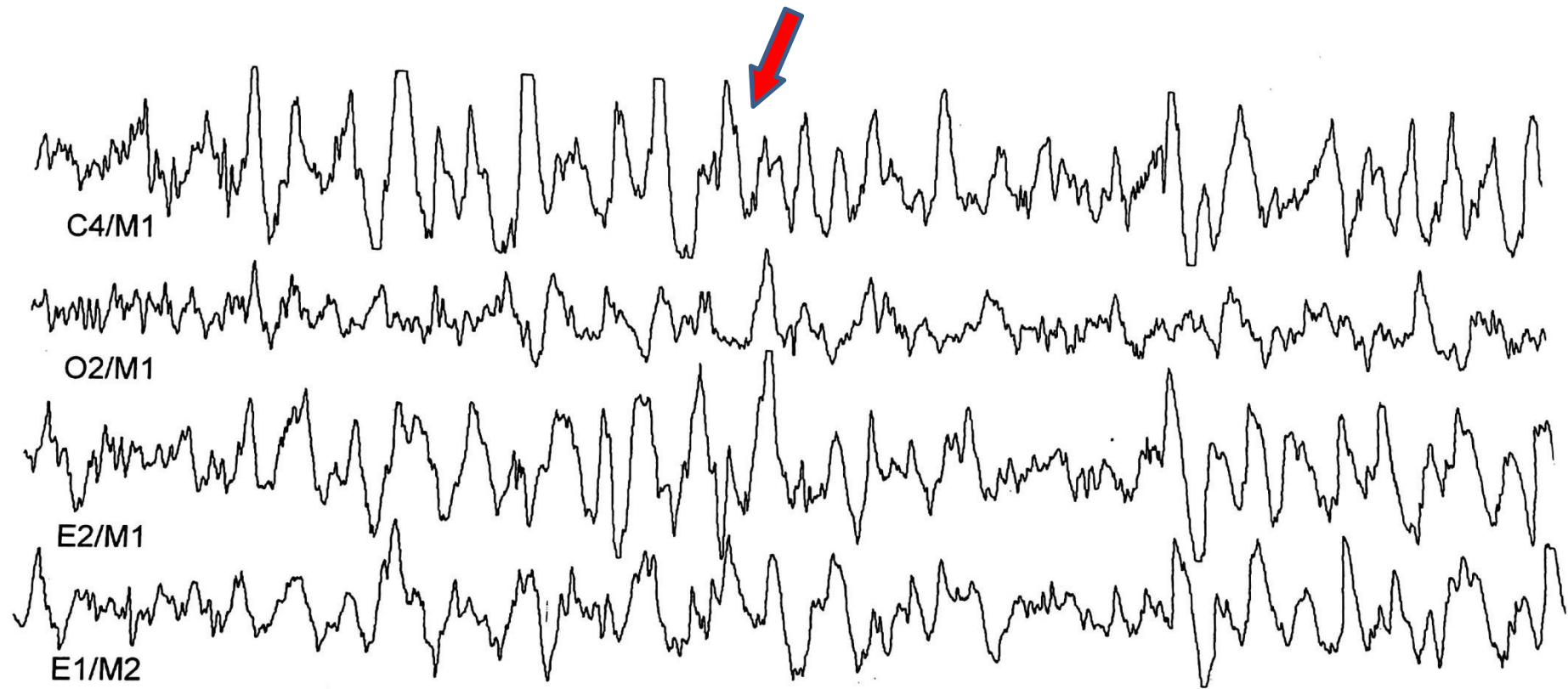
**NOTES**

Sleep spindles and K complexes may be present in N3.

**Eye movements** are not typically seen.

**Chin EMG is low** (lower than N2, may be as low as Stage R)

First appears as early as 2months, Typically seen by 3-4.5 months.





# Stage R

- Low Amplitude, Mixed Frequency EEG (LAMF)
- Saw tooth waves
- Rapid Eye Movements
- Chin EMG lowest
- Transient Muscle activity



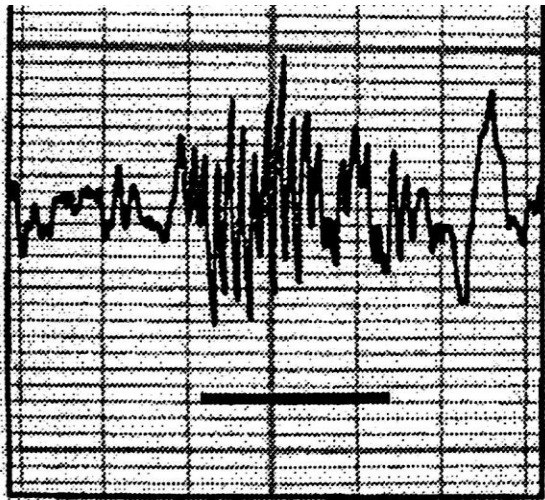


**Scoring rules for Stage N3 are same for adults and children (>2m)**

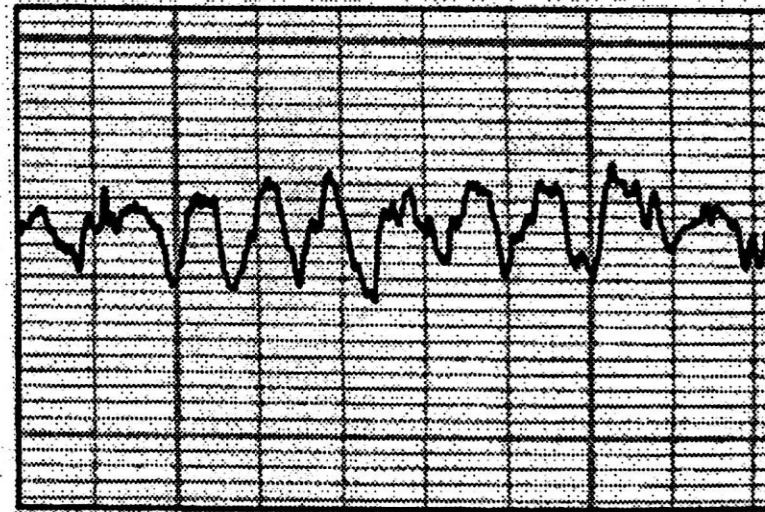
<b>Criterion</b>	<b>Definition</b>
<b>REM</b>	Conjugate, <b>irregular</b> , sharply peaked, with initial deflection <b>&lt;500 msec</b> .
<b>Low chin EMG</b>	Chin EMG is at its <b>lowest</b> level
<b>Sawtooth waves</b>	Trains of <b>sharply contoured or triangular</b> , serrated <b>2-6 Hz</b> waves, Maximal over <b>central</b> , often preceding a burst of REM.
<b>Transient muscle activity</b>	Short irregular bursts of EMG activity  Duration <0.25 sec.  May be seen in chin EMG/leg EMG/EOG or EEG

Scoring rules for Stage N3 are same for adults and children (>2m)

Criterion	Definition
REM	Conjugate, <b>irregular</b> , sharply peaked, with initial deflection <b>&lt;500 msec.</b>



Sleep spindle



Sawtooth waves

## Scoring Stage R

Rules	Score Stage R
1	<p>Sleep epochs with <b>ALL THREE</b> of the following:</p> <ul style="list-style-type: none"><li>- Low-amplitude mixed frequency (LAMF) EEG without K complexes or sleep spindles</li><li>- Low chin EMG tone for the majority of the epoch</li><li>- REM at any position within the epoch</li></ul>
2	<p>For epochs following <math>\geq 1</math> Stage R epoch, <u>continue to score Stage R</u> (even if no REM), if <b>ALL</b> of the following are present</p> <ul style="list-style-type: none"><li>- <u>LAMF EEG without K complexes or sleep spindles</u></li><li>- <u>Chin EMG remains low</u> for majority of the epoch.</li><li>- No intervening arousal</li><li>- No SEM following an arousal or Stage W.</li></ul>

**Children: Scoring R follows the same rule as in adults**

**Rules** | **Stop scoring Stage R**

3. Stop scoring stage R when one or more of the following occur:

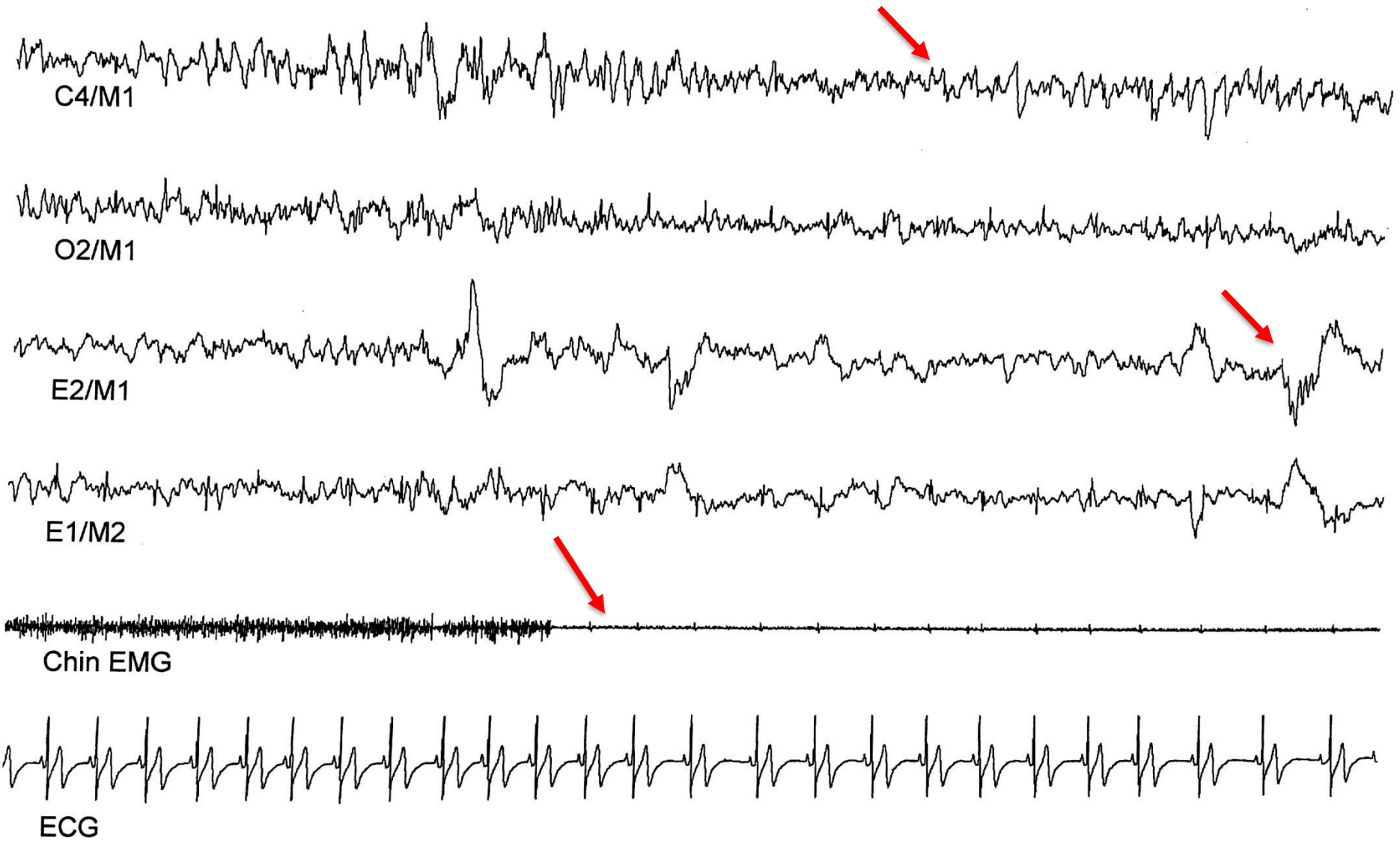
(i). Transition to **Stage W or N3**

(ii). Criteria for **Stage N1** are met with increase in chin EMG tone for the majority of the epoch

(iii). **Arousal** followed by low amplitude mixed frequency EEG and SEM: Stage N1  
Arousal followed by low amplitude mixed frequency EEG, NO SEM, low chin EMG:  
Stage R

(iv). A **major body movement** followed by low amplitude mixed frequency EEG and SEM, without non-arousal associated K complexes or sleep spindles : Stage N1. Major body movement followed by low amplitude mixed frequency EEG, NO SEM and low chin EMG: Stage R.

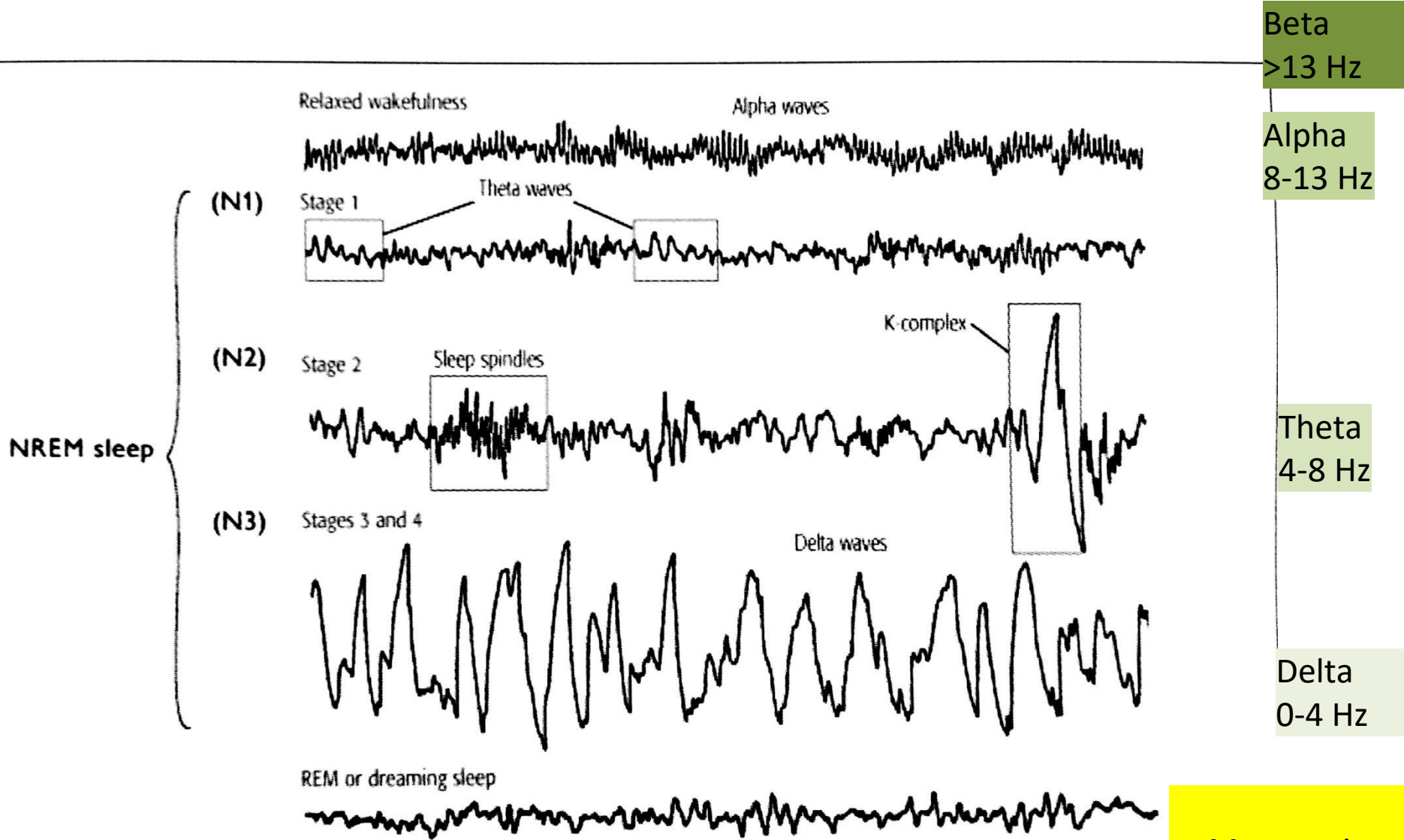
(v). One or more **non-arousal associated K complexes or sleep spindles** in the first half of the epoch in the absence of REM; Score as Stage N2



# ONSET OF REM SLEEP



# Typical EEG patterns





## Evolution of EEG patterns in children

Criterion	First appear by (post – term)	Present in all by (post – term)
Sleep spindle	4-6 weeks	2 – 3 months
K complexes		3 – 6 months
Slow wave activity ( $\geq 75 \mu\text{V}$ , 0.5-2.0 Hz, Typically frontal region)	2 months Amplitude 100-400 $\mu\text{V}$	4 – 5 months
Discernible NREM stages of N1, N2 or N3	4 months	5 – 6 months
Posterior dominant rhythm -Occipital -Relaxed wakefulness -Eyes closed	3 – 4 months (3.5-4.5 Hz)	5 – 6 months (5-6 Hz) 3 years (7.5-9.5 Hz) Amplitude $\geq 50 \mu\text{V}$
Vertex Sharp Waves	4-6 months	
Hypnagogic hypersynchrony	3-6 months	3-5Hz, 75-350 $\mu\text{V}$ , maximal over central/frontal/frontocentral, paroxysmal bursts, begins abruptly, Seen in N1 and N2

## Infants: Scoring of Sleep Stages

Infants 0-2 months post-term

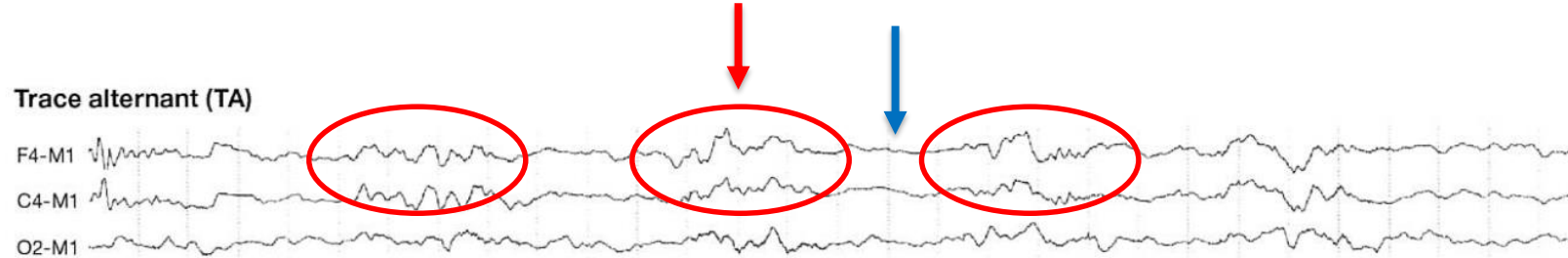
- Stage W (Wakefulness)
- Stage N (NREM): Quiet Sleep
- Stage R (REM): Active Sleep
- Stage T (Transitional):  
Indeterminate Sleep

Consider

- Behavioural observation
- Regularity of respiration
- EEG, EOG and chin EMG patterns

- Score sleep stages in 30 seconds, sequential epochs, commencing at the start of the study.
- Assign a stage to each epoch.
- Score sleep onset as the first epoch of sleep. Often this is stage R (till 2-3m age)
- If  $\geq 2$  stages co-exist in a single epoch, assign the stage comprising the greatest portion of the epoch.
- If  $\geq$  PSG characteristics are discordant for stage R or N, score the epoch as T.

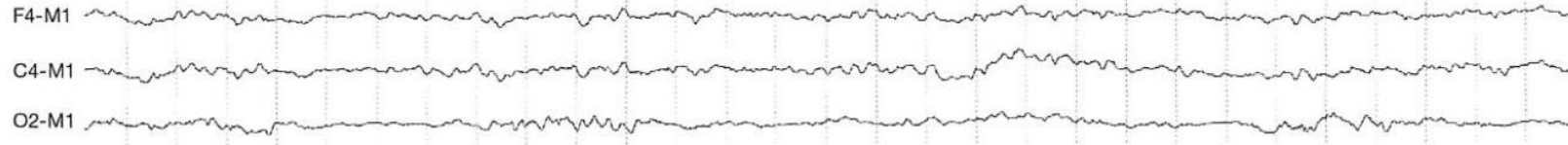
## Infants: EEG characteristics of sleep stages



Stage	Discontinuous Patterns	EEG characteristics
<b>N</b>	<b>Trace Alternant (TA)</b>	<p><b>At least 3 alternating runs</b> of bilaterally symmetrical synchronous <b>high voltage (50-150<math>\mu</math>V)</b> bursts of <b>1-3Hz delta activity</b>, lasting 5-6 sec (range 3-8 sec) <b>alternating with</b> periods of lower amplitude (25-50<math>\mu</math>V), <b>4-7Hz theta activity</b> (range 4-12 sec)</p> <p>First appears at 37 weeks CA                      Predominant EEG pattern at 40 weeks CA                      Unlikely to be seen after 44 weeks CA                      TA is replaced by HVS activity after 44 weeks                      After 42 weeks the Inter Burst Interval (IBI) is of higher amplitude and lasts only 1-2 sec.</p>

## Infants: EEG characteristics of sleep stages

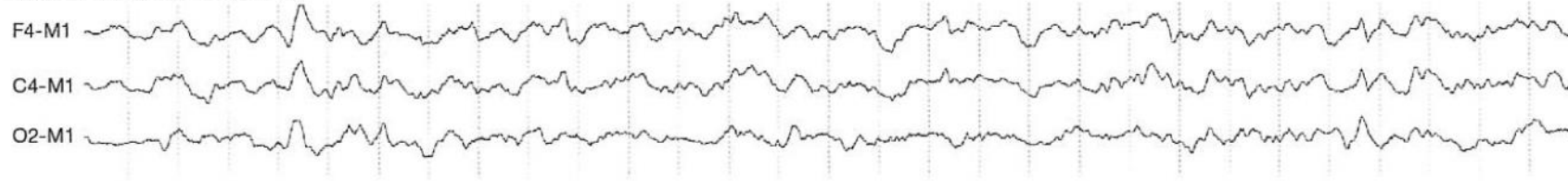
### Low voltage irregular (LVI)



Stage	Continuous Patterns	EEG characteristics
R, W	<b>Low Voltage Irregular (LVI)</b>	Continuous Low voltage mixed frequency (LVMF) with delta and predominantly theta activity.

## Infants: EEG characteristics of sleep stages

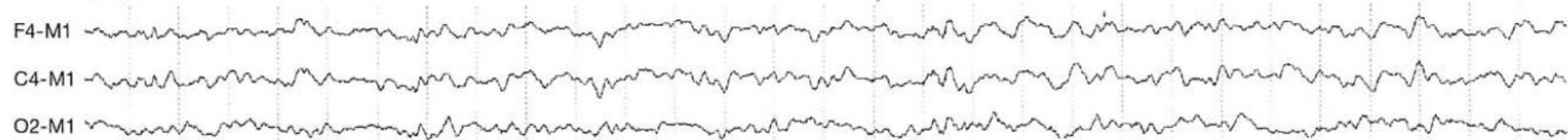
### High voltage slow (HVS)



Stage	Continuous Patterns	EEG characteristics
N Rarely R	<b>High Voltage Slow (HVS)</b>	Continuous, synchronous, symmetrical, predominantly high voltage (100-150 $\mu$ V), 1-3Hz delta activity. Occipital or central predominance Mature EEG pattern of Stage N sleep at term

## Infants: EEG characteristics of sleep stages

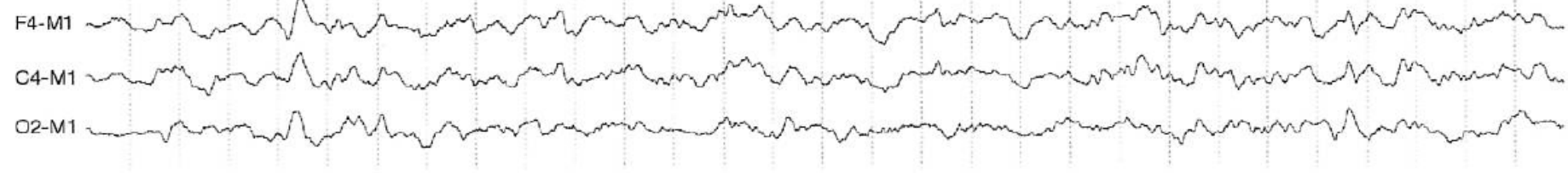
### Mixed (M)



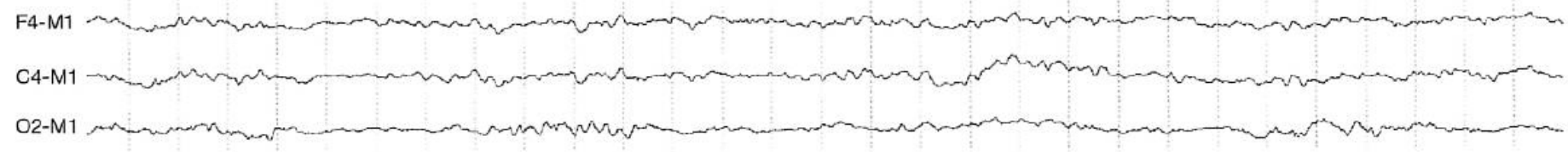
Stage	Continuous Patterns	EEG characteristics
W, R Rarely N	Mixed (M)	Both high voltage slow and low voltage polyrhythmic components; intermingled with little periodicity. Amplitude is lower than that seen in the HVS pattern



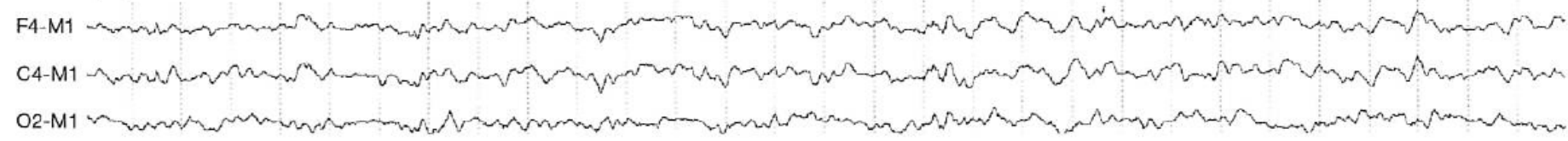
### High voltage slow (HVS)



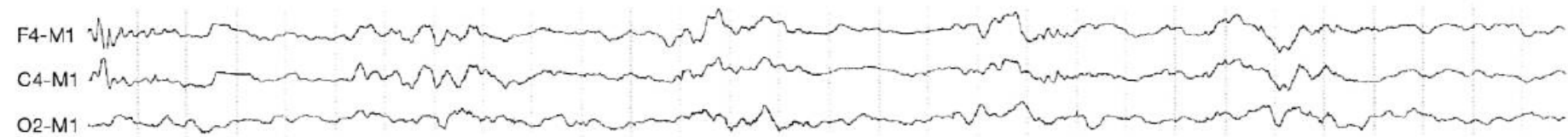
### Low voltage irregular (LVI)



### Mixed (M)



### Trace alternant (TA)



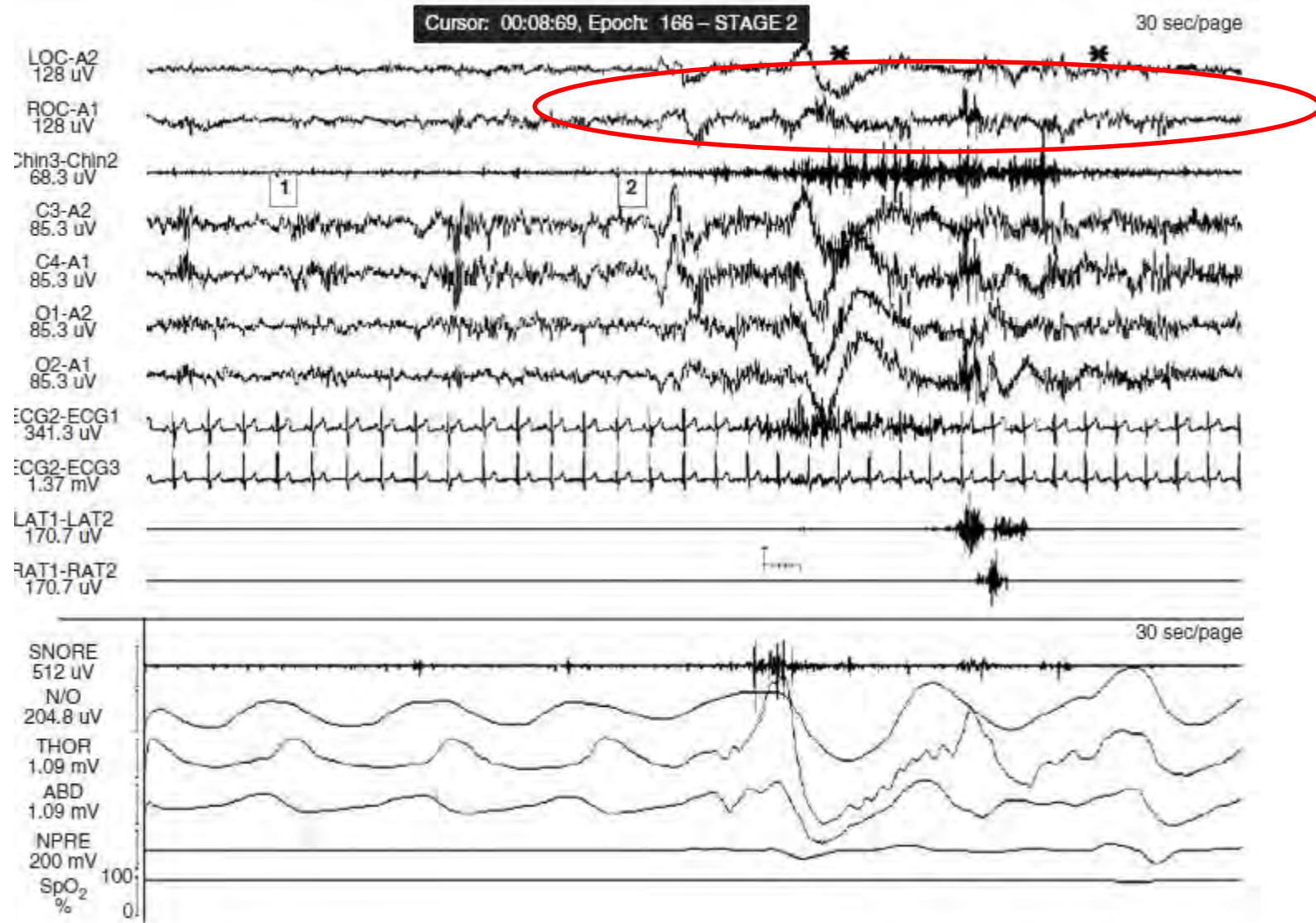
## Infants: Summary of sleep stage characteristics

Stage	Behavioural	Respiration	EEG	EOG	Chin EMG
Wake	Eyes open Crying Feeding	Irregular	Low Voltage Irregular or Mixed	Blinks Scanning EMs REM	Present
N	Eyes closed Periodic Sucking Startle-occasional Less movements	<b>Regular</b>	Trace Alternant or High Voltage Slow or Mixed or Sleep spindles	Eyes closed No EMs	Present or Low
R	Eyes closed Small movements	Irregular  Periodic breathing	Low Voltage Irregular or Mixed	REM or Eyes closed with no EMs	Low $\pm$ Transient muscle activity

## Arousal Scoring arousals

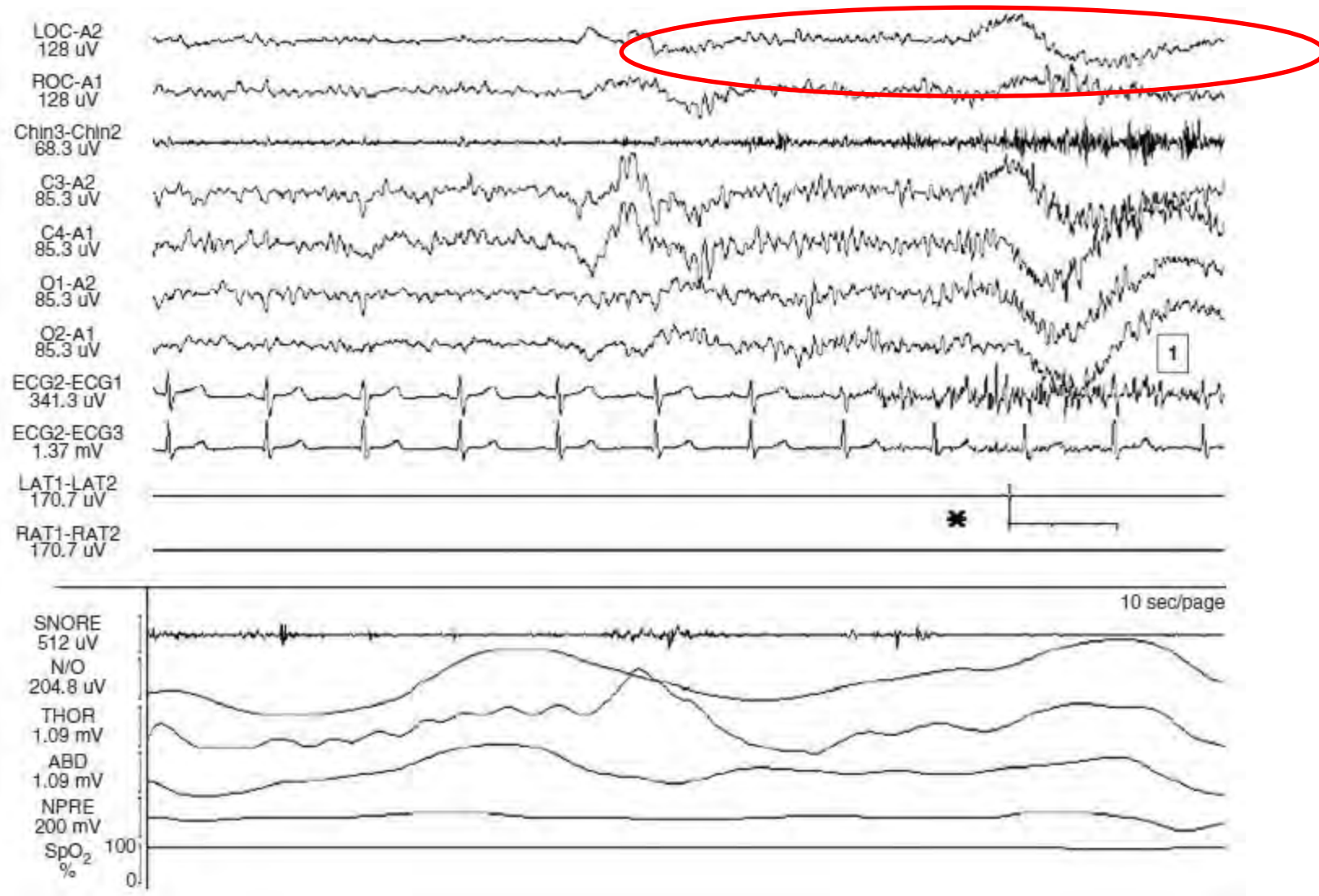
- **Abrupt shift of EEG frequency** including alpha, theta and/or frequencies  $>16$  Hz (but not spindles) that **lasts  $\geq 3$  sec**, with **at least 10sec of stable sleep** preceding the change.
- **Arousal in REM** requires a concurrent increase in submental EMG lasting at least 1 sec.

# Arousal





# Arousal



## Respiratory rules

Adult criteria applies to  $\geq 18$  years

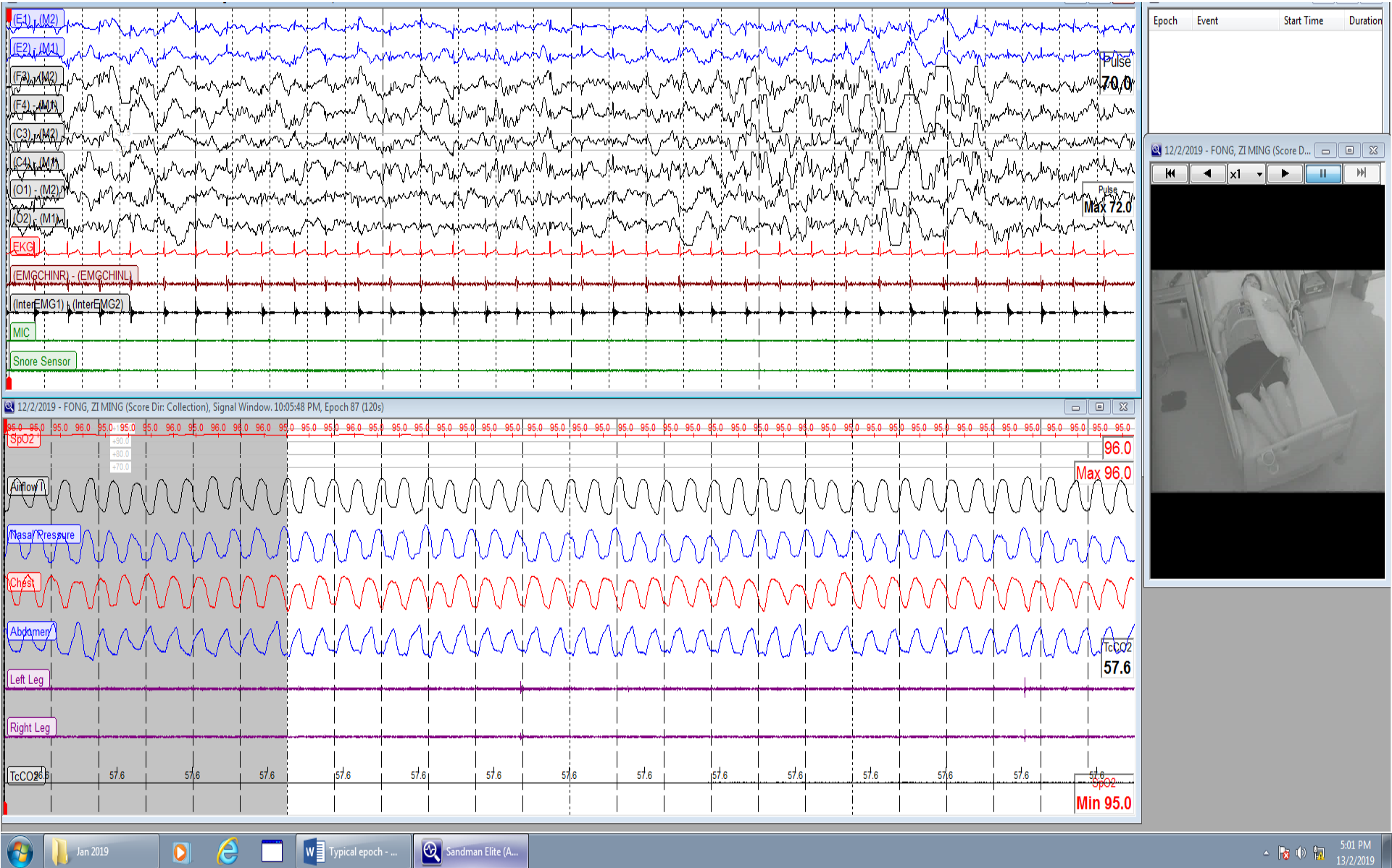
Use paediatric criteria for  $<13$  years

$\geq 13$  years may be scored using adult criteria (optional)

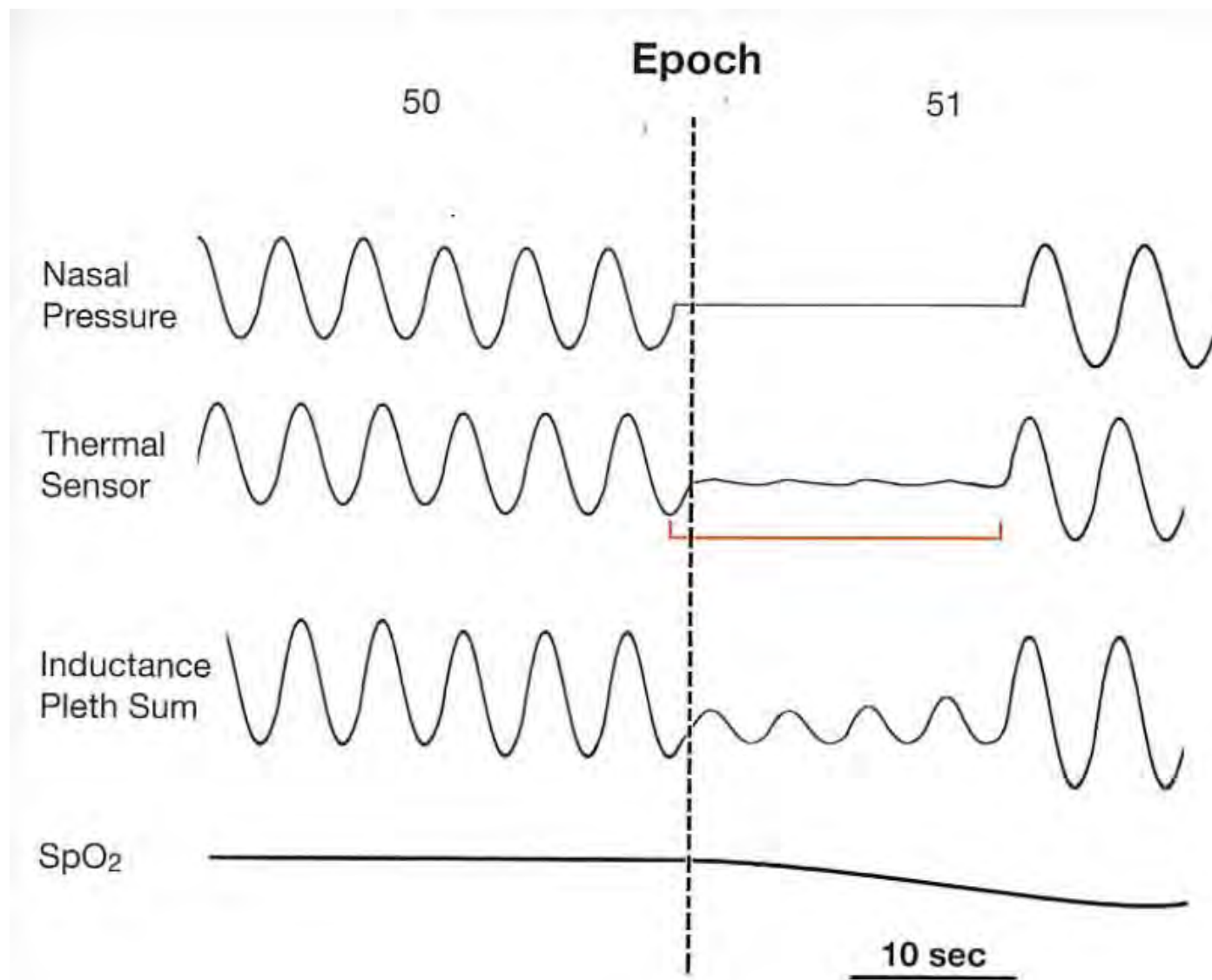




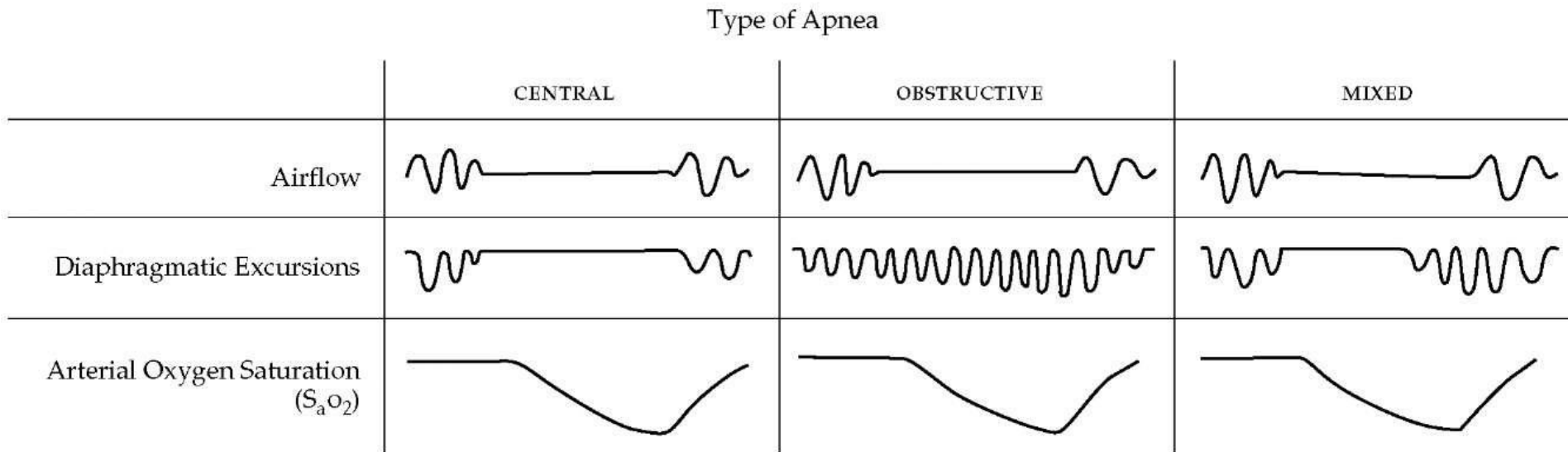
# Typical PSG montage



# Obstructive apnea



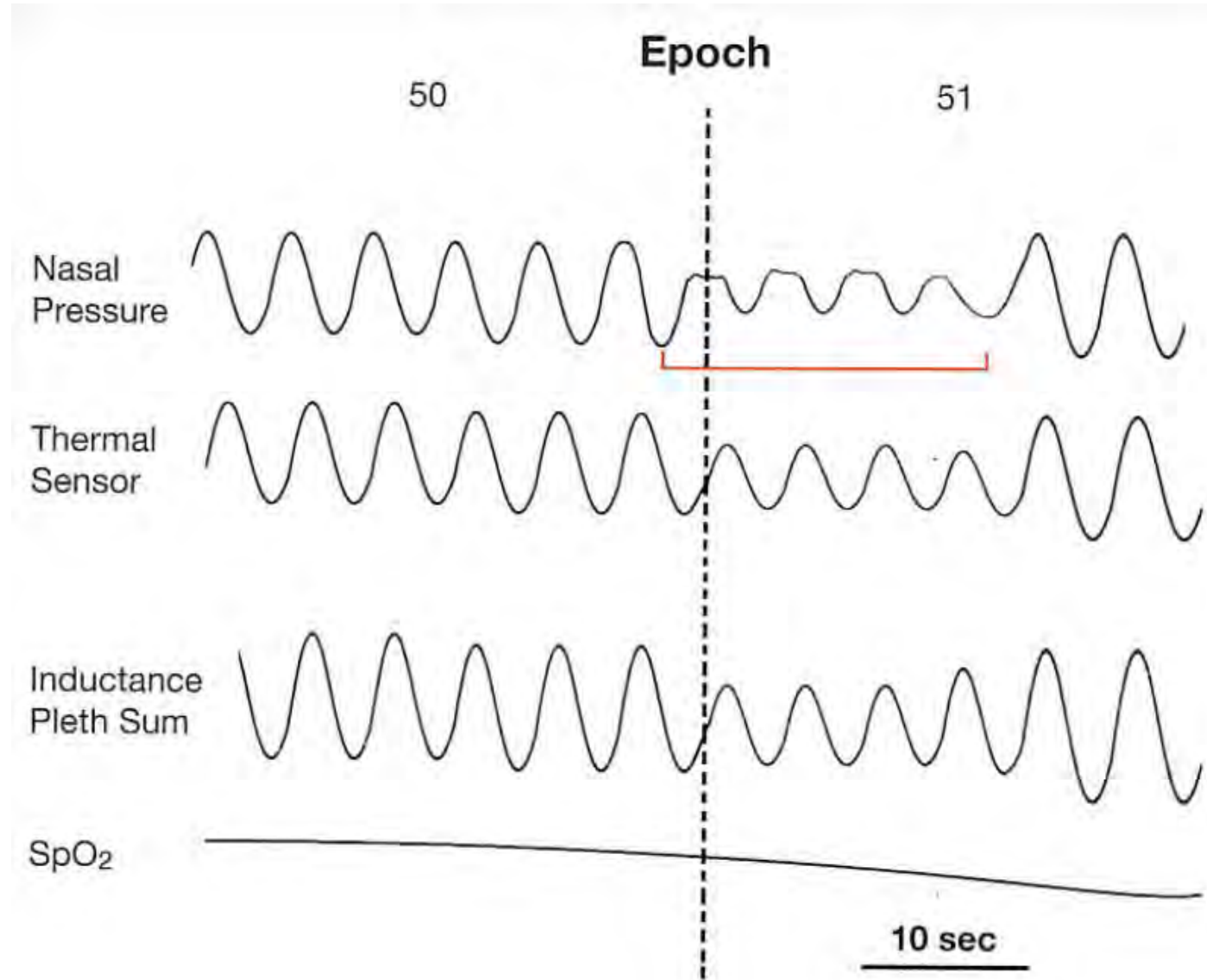
# Scoring of Apneas



## Scoring of Apneas

Event	Adult	Children
<b>Apnoea</b>	(i). Drop in peak signal excursion by <b>≥90%</b> of pre-event baseline (ii). Minimum duration of 10 seconds	(i). Drop in peak signal excursion by <b>≥90%</b> of pre-event baseline (ii). Meets duration and effort criteria for obstructive, central or mixed apnea.
<b>Obstructive</b>	Apnea criteria + Continued/increased inspiratory effort throughout the entire period.	Apnea criteria + <b>Minimum duration of 2 breaths</b> Continued inspiratory effort throughout the entire period of absent airflow.
<b>Central</b>	Apnea criteria + Absent inspiratory effort throughout the entire period of absent airflow	As in adults + <b>at least 1 of the following</b> (i). Duration ≥20 seconds (ii). Minimum duration of 2 breaths + arousal or a ≥3% desaturation (iii). HR <50bpm for at least 5 sec or <60bpm for 15 sec [For <1 year only]
<b>Mixed</b>	Apnea criteria + Absent inspiratory effort in the initial portion of the event, followed by resumption of inspiratory effort in the second portion of absent airflow.	Apnea criteria + Minimum duration of 2 breaths + absent respiratory effort during one portion of the event AND presence of inspiratory effort in another portion, <b>regardless of which portion comes first.</b>

# Hypopnea

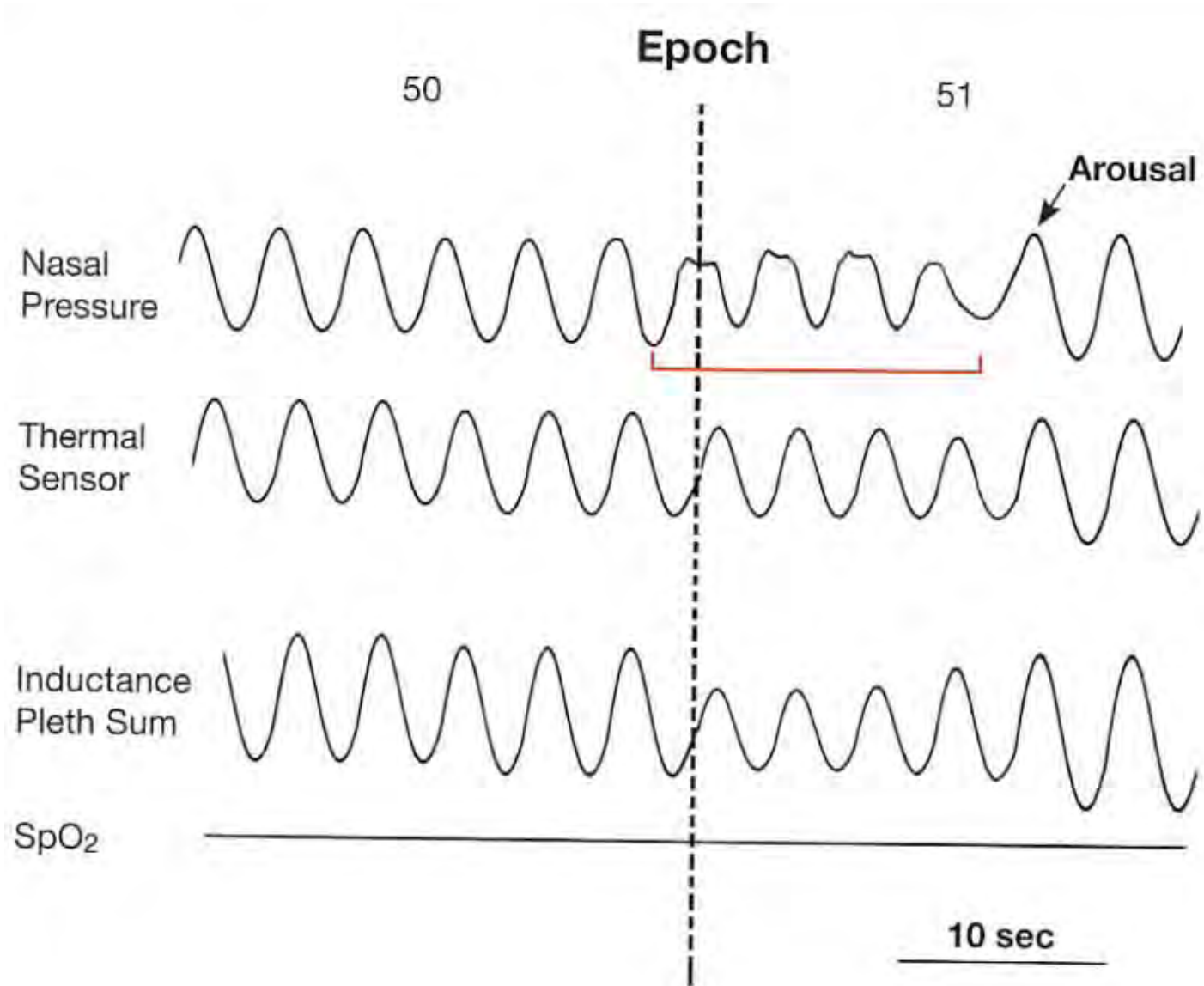




## Scoring of Hypopneas

Event	Adult	Children
Hypopnoea	(i). Drop in peak signal excursion by <b>≥30%</b> of pre-event baseline + (ii). Minimum <b>10 seconds</b> duration + (iii). <b>≥3% desaturation or arousal</b>	(i). Drop in peak signal excursion by <b>≥30%</b> of pre-event baseline + (ii). Minimum <b>duration of 2 breaths</b> + (iii). <b>≥3% desaturation or arousal</b>
Obstructive (Optional)	Hypopnea + ANY of the following (i). Snoring (ii). Increased inspiratory flattening of nasal pressure/PAP device flow (iii). Thoracoabdominal paradox during the event, but not during pre-event breathing.	Hypopnea + <b>ANY of the following</b> (i). Snoring (ii). Increased inspiratory flattening nasal pressure/PAP device flow (iii). Thoracoabdominal paradox during the event, but not during pre-event breathing.
Central (Optional)	Hypopnea + NONE of the following (i). Snoring (ii). Increased inspiratory flattening nasal pressure/PAP device flow (iii). Thoracoabdominal paradox during the event, but not during pre-event breathing.	Hypopnea + <b>NONE of the following</b> (i). Snoring (ii). Increased inspiratory flattening nasal pressure/PAP device flow (iii). Thoracoabdominal paradox during the event, but not during pre-event breathing.

# Respiratory Event Related Arousal (RERA)



Scoring of Respiratory Effort-Related Arousal (RERA)  
: Optional

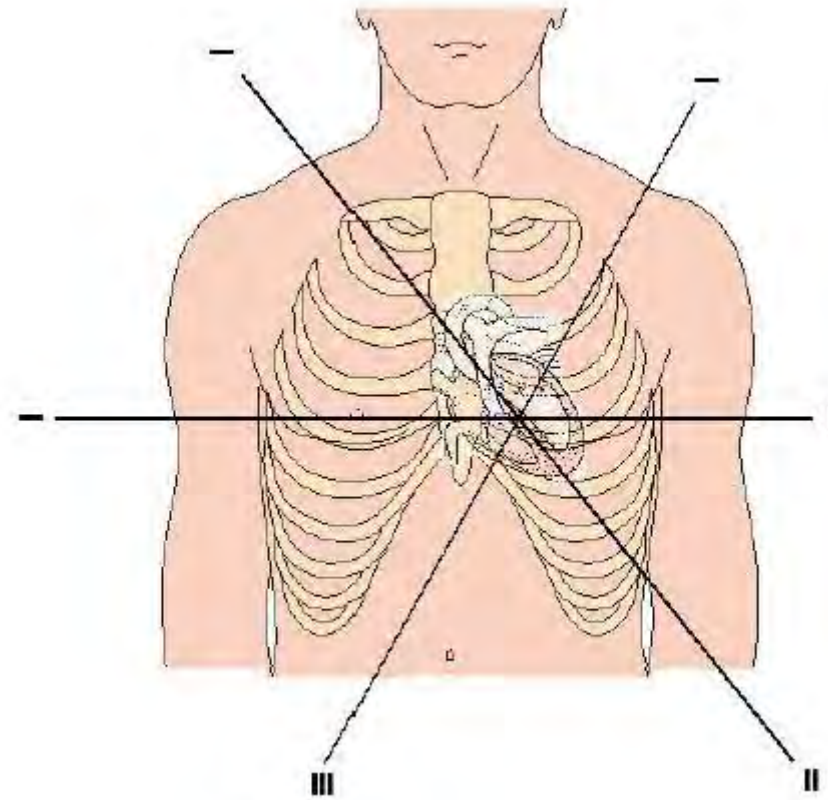
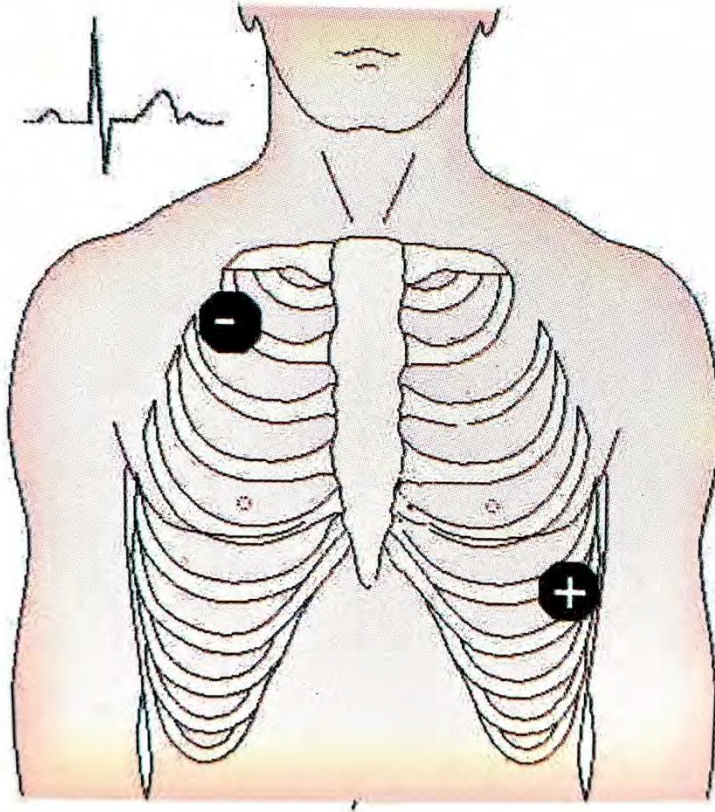
Event	Adult	Children
RERA (Optional)	<p>(i). Does not meet apnea/hyponea criteria</p> <p>(ii). Sequence of breaths lasting <math>\geq 10</math> seconds</p> <p>(iii). -Increased inspiratory effort OR -flattening of the inspiratory portion of the nasal pressure/PAP device flow waveform</p> <p>(iv). Leading to Arousal</p>	<p>(i). Does not meet apnea/hyponea criteria</p> <p>(ii). Sequence of breaths lasting <math>\geq 2</math> breaths duration</p> <p>(iii). -Increased inspiratory effort OR -flattening of the inspiratory portion of the nasal pressure/PAP device flow waveform OR -snoring OR -an elevation in the ETCO<sub>2</sub></p> <p>(iv). Leading to Arousal</p>

## Scoring of Hypoventilation

<b>Adult</b>  <b>Optional</b>	<b>Children</b>  <b>Recommended for diagnostic study</b> <b>Optional for PAP titration study</b>
<p>(i). Increase in <b>PCO<sub>2</sub> ≥55 mmHg for ≥10 minutes.</b></p> <p>OR</p> <p>(ii). <b>≥10 mmHg rise in PCO<sub>2</sub></b> during sleep (compared to awake supine value) <b>to a value &gt;50 mmHg for ≥10 minutes.</b></p> <p>PCO<sub>2</sub> = arterial/ETCO<sub>2</sub>/TcCO<sub>2</sub></p>	<p><b>&gt;25% of the TST is spent with PCO<sub>2</sub> &gt;50 mmHg.</b></p> <p>PCO<sub>2</sub> = arterial/ETCO<sub>2</sub>/TcCO<sub>2</sub></p>

1 mmHg = 0.133kPA

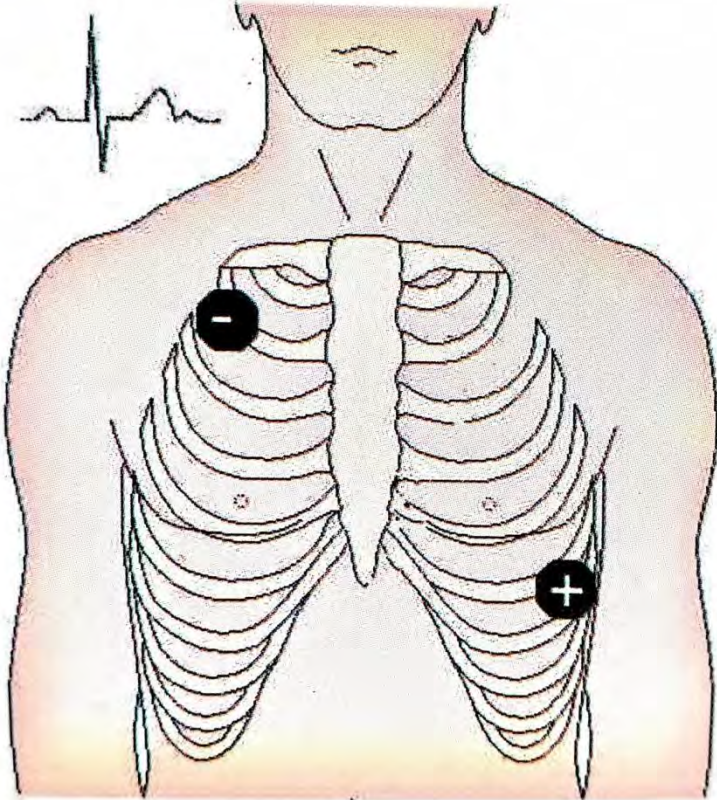
# Cardiac Rules



AASM 2017



## Cardiac Rules



- **Single modified lead II** on torso  
Aligned in parallel to the right shoulder and left hip.

- Use **standard ECG electrodes**

AASM 2017



Event	Criteria
Sinus tachycardia	Sustained, <b>&gt;90 bpm</b> (adults)
Bradycardia	Sustained, <b>&lt;40 bpm</b> ( $\geq 6$ years)
Asystole	Cardiac pause <b>&gt;3 sec</b> ( $\geq 6$ years)
Wide complex tachycardia	Minimum 3 consecutive beats Rate $>100$ bpm QRS duration <b><math>\geq 120</math> msec</b>
Narrow complex tachycardia	Minimum 3 consecutive beats Rate $>100$ bpm QRS duration <b><math>&lt;120</math> msec</b>
Atrial Fibrillation	Irregularly irregular ventricular rhythm Replacement of p waves by rapid oscillations that vary in size, shape and timing.
Sustained sinus bradycardia or tachycardia	$>30$ sec of stable rhythm (distinguish from transient responses, associated respiratory events or arousals).

# Movement Rules

SingHealth Academic Healthcare Cluster



Singapore General Hospital



KK Women's and Children's Hospital



National Cancer Centre Singapore



National Dental Centre Singapore



National Heart Centre Singapore



National Neuroscience Institute



Singapore National Eye Centre



Polyclinics SingHealth



Bright Vision Hospital

Sengkang Health

PATIENTS. AT THE HEART OF ALL WE DO.®

Partner in Academic Medicine

DUKE NUS  
TRUSTEE MEDICAL SCHOOL, SINGAPORE

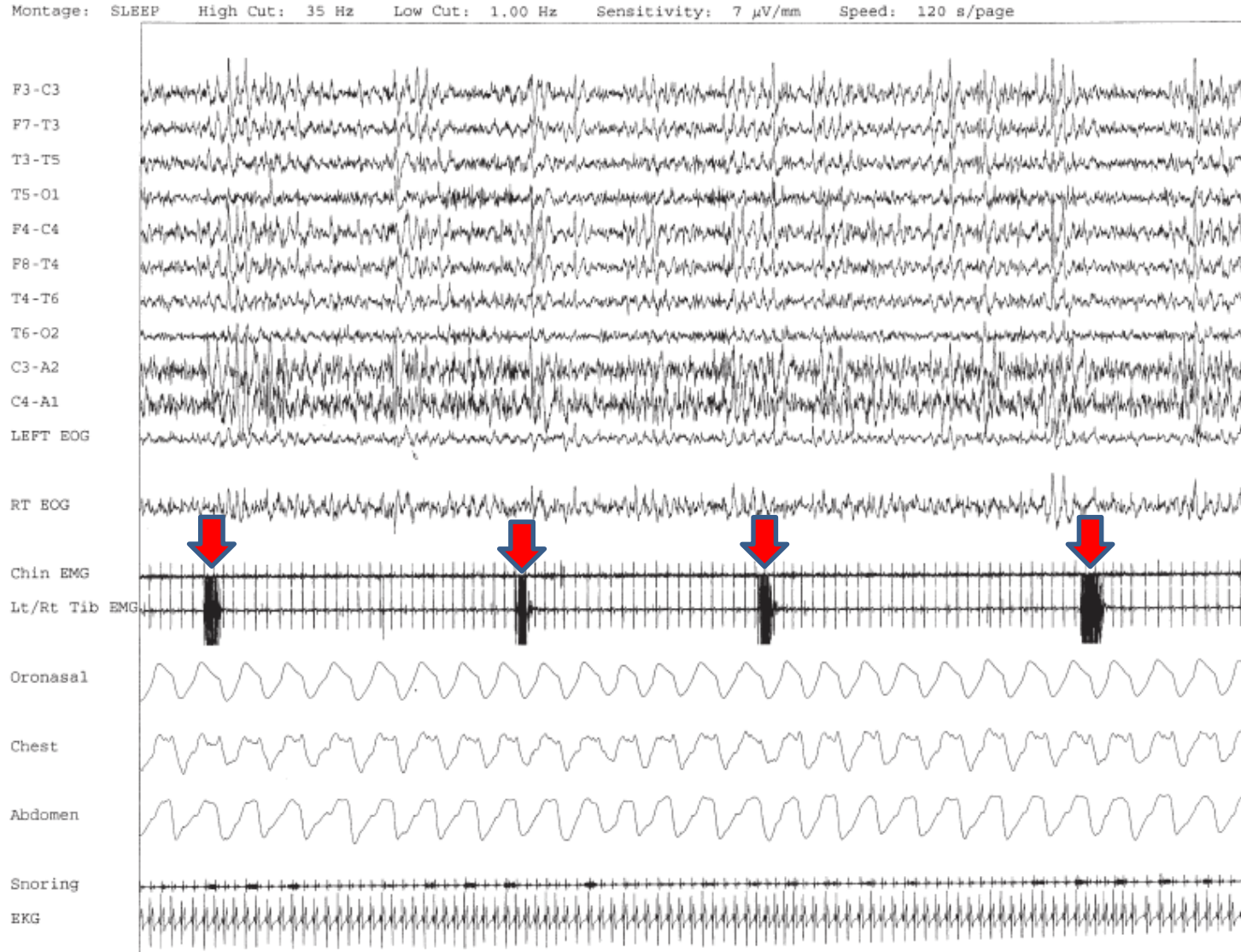
## Movement scoring

- Periodic Limb Movements in Sleep (PLMS)
- Alternating Leg Muscle Activation (ALMA)
- Hypnagogic Foot Tremor (HFT)
- Excessive Fragmentary Myoclonus (EFM)
- Bruxism
- REM Behavior Disorder (RBD)
- Rhythmic Movement Disorder (RMD)

## Significant Leg Movement (LM): Definition

- Minimum duration = 0.5 seconds
- Maximum duration = 10 seconds
- Minimum amplitude =  $8\mu\text{V}$  increase in EMG above resting EMG.
- Onset: point at which there is an  $8\mu\text{V}$  increase in EMG above resting EMG.
- End: start of period lasting at least 0.5 sec, during which the EMG does not exceed  $2\mu\text{V}$  above the resting EMG

# Periodic Limb Movements in Sleep (PLMS)



N2

PLM



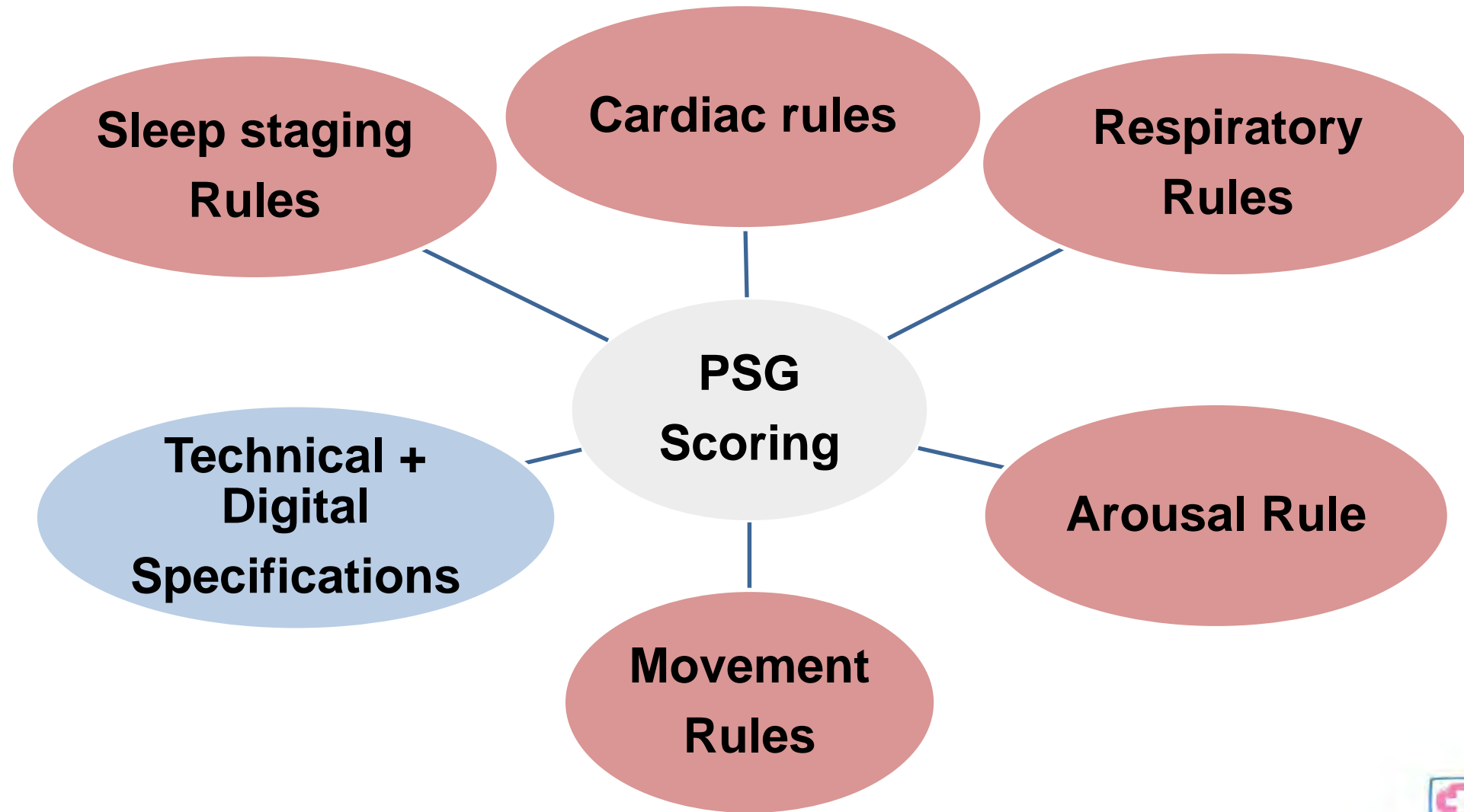
## PLM series: Definition

- Minimum number of consecutive LMs = 4
- Minimum period length between LMs = 5 seconds
- Maximum period length between LMs = 90 seconds
- Leg movements on 2 different legs separated by <5 seconds between movement onsets are counted as a single leg movement.

## PLM arousal: Definition

- An arousal and LM that occur in a PLM series should be considered associated with each other, if
  - They occur simultaneously
  - They overlap
  - There is  $<0.5$ sec between the end of one event and the onset of the other, regardless of which is first.

# AASM 2017



*Thank  
you*



[biju.thomas@singhealth.com.sg](mailto:biju.thomas@singhealth.com.sg)