

# **NEW RESPIRATION RULES - ADULTS**

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# Respiratory Events

- Apnea- Obstructive, Central, Mixed
- Hypopnea- Obstructive vs Central
- Cheyne Stokes Respiration

# **SENSORS**

**Table 1: Recommended sensors for routine respiratory monitoring**

Respiratory Parameter	Sensor
Airflow (use both oronasal thermal flow sensor and nasal pressure transducer during diagnostic study)	<ul style="list-style-type: none"> <li>• Oronasal thermal airflow sensor* (to score apnea in diagnostic study)</li> <li>• Nasal pressure transducer** (to score hypopnea in diagnostic study)</li> <li>• PAP device flow signal (to score apneas and hypopneas in PAP titration study)</li> </ul>
Respiratory Effort (select one)	<ul style="list-style-type: none"> <li>• Esophageal manometry</li> <li>• Dual thoracoabdominal RIP belts***</li> <li>• Dual thoracoabdominal PVDF belts [Acceptable] in adults</li> </ul>
Oxygen Saturation	Pulse oximetry

Level of recommendation = [Recommended] in adults and children unless otherwise noted. \*Including PVDF airflow sensor; \*\*with or without square root transformation; \*\*\*calibrated or uncalibrated; RIP, respiratory inductance plethysmography; PVDF, polyvinylidene fluoride.

**Table 2: Alternative sensors for scoring respiratory events during diagnostic study**

Respiratory Event	Sensor
Apnea (select one)	<ul style="list-style-type: none"> <li>• Nasal pressure transducer*</li> <li>• RIPsum**</li> <li>• RIPflow**</li> <li>• PVDFsum [Acceptable] in adults</li> <li>• End-tidal PCO<sub>2</sub> [Acceptable] in children</li> </ul>
Hypopnea (select one)	<ul style="list-style-type: none"> <li>• Oronasal thermal airflow sensor***</li> <li>• RIPsum**</li> <li>• RIPflow**</li> <li>• Dual thoracoabdominal RIP belts**</li> <li>• PVDFsum [Acceptable] in adults</li> </ul>

*Alternative* sensors are used for scoring events if the *recommended* sensor fails or the signal is not reliable. Level of recommendation = [Recommended] in adults and children unless otherwise noted. \*With or without square root transformation; \*\*calibrated or uncalibrated; \*\*\*including PVDF airflow sensors; RIP, respiratory inductance plethysmography; PVDF, polyvinylidene fluoride.

- During positive airway pressure (PAP) titration, use the PAP device flow signal to identify apneas or hypopneas
- For monitoring respiratory effort, use one of the following –
  - oesophageal manometry
  - dual thoracoabdominal RIP belts (calibrated or uncalibrated)
  - dual thoracoabdominal PVDF belts

- For detection of hypoventilation during a diagnostic study, use arterial  $\text{PCO}_2$ , transcutaneous  $\text{PCO}_2$  or end-tidal  $\text{PCO}_2$
- For detection of hypoventilation during PAP titration, use arterial  $\text{PCO}_2$ , or use transcutaneous  $\text{PCO}_2$

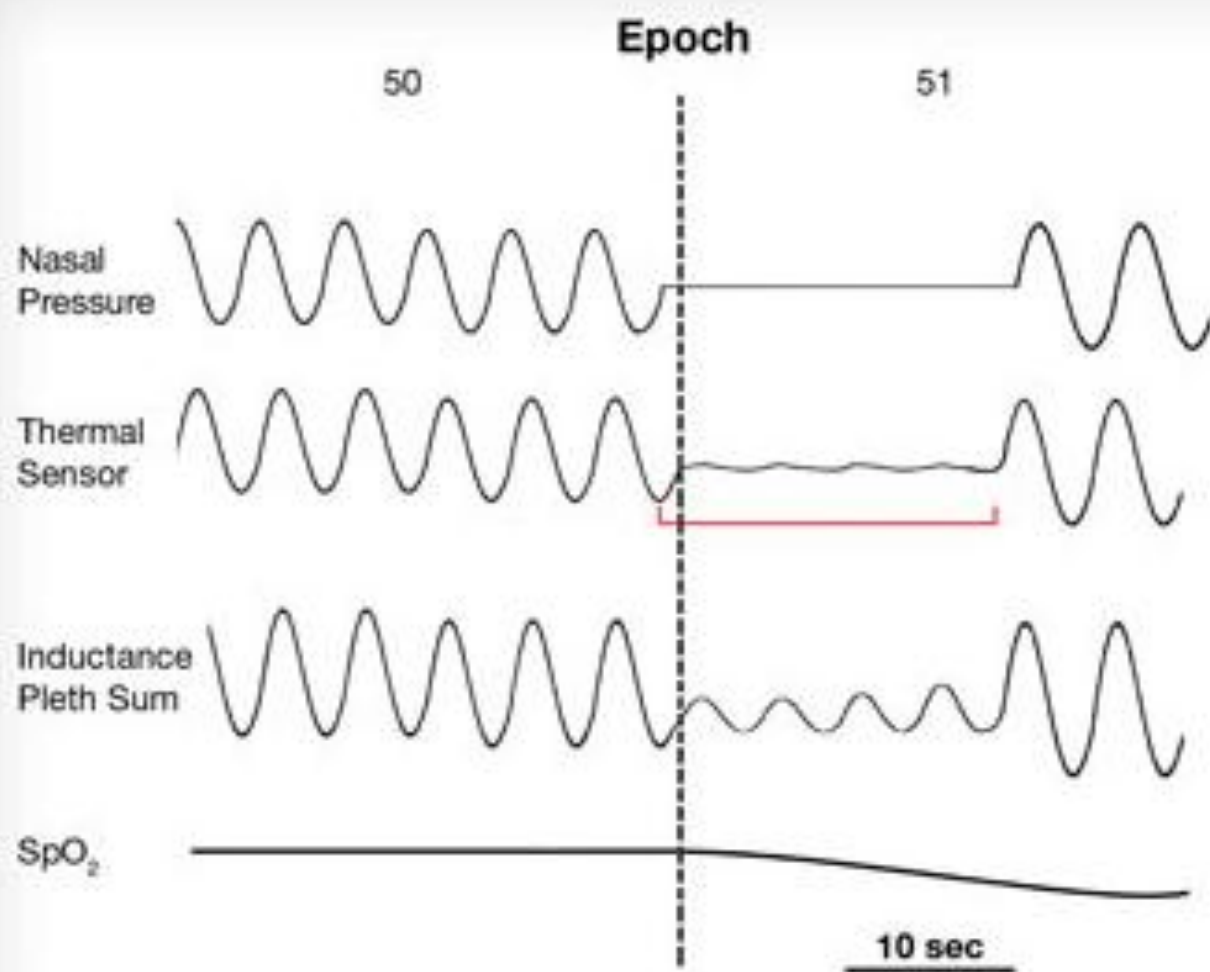
# **APNEA DEFINITION**



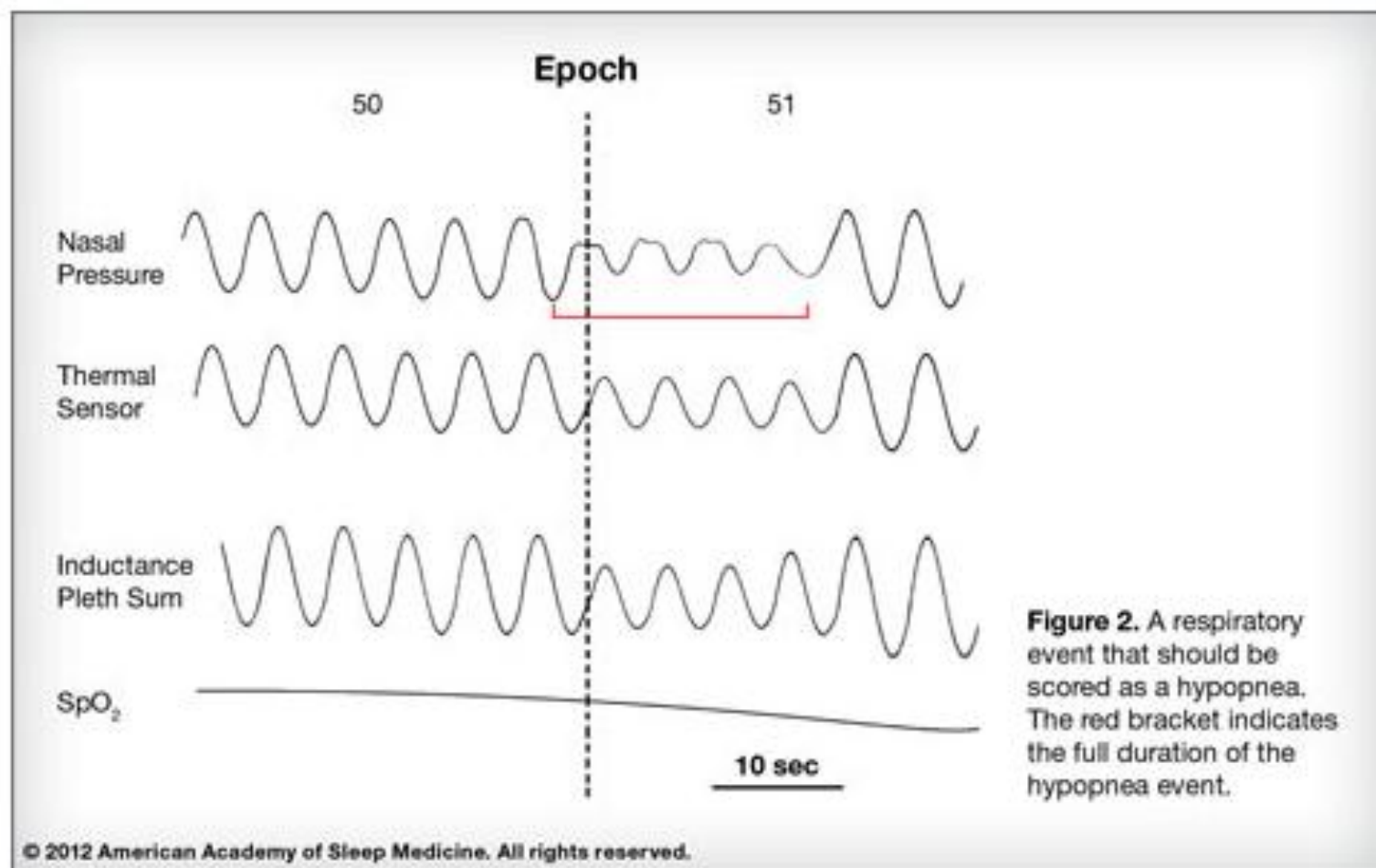
# Scoring of Apneas

- Score a respiratory event as an apnea when **BOTH** of the following criteria are met (see Figure 1)
- There is a drop in the peak signal excursion by  $\geq 90\%$  of pre-event baseline using an oronasal thermal sensor (diagnostic study), PAP device flow (titration study) or an alternative apnea sensor (diagnostic study).
- The duration of the  $\geq 90\%$  drop in sensor signal is  $\geq 10$  seconds

- **For scoring either an apnea or a hypopnea, the event duration is measured from the nadir preceding the first breath that is clearly reduced to the beginning of the first breath that approximates the baseline breathing amplitude. (see red bracket, Figures 1 and 2)**



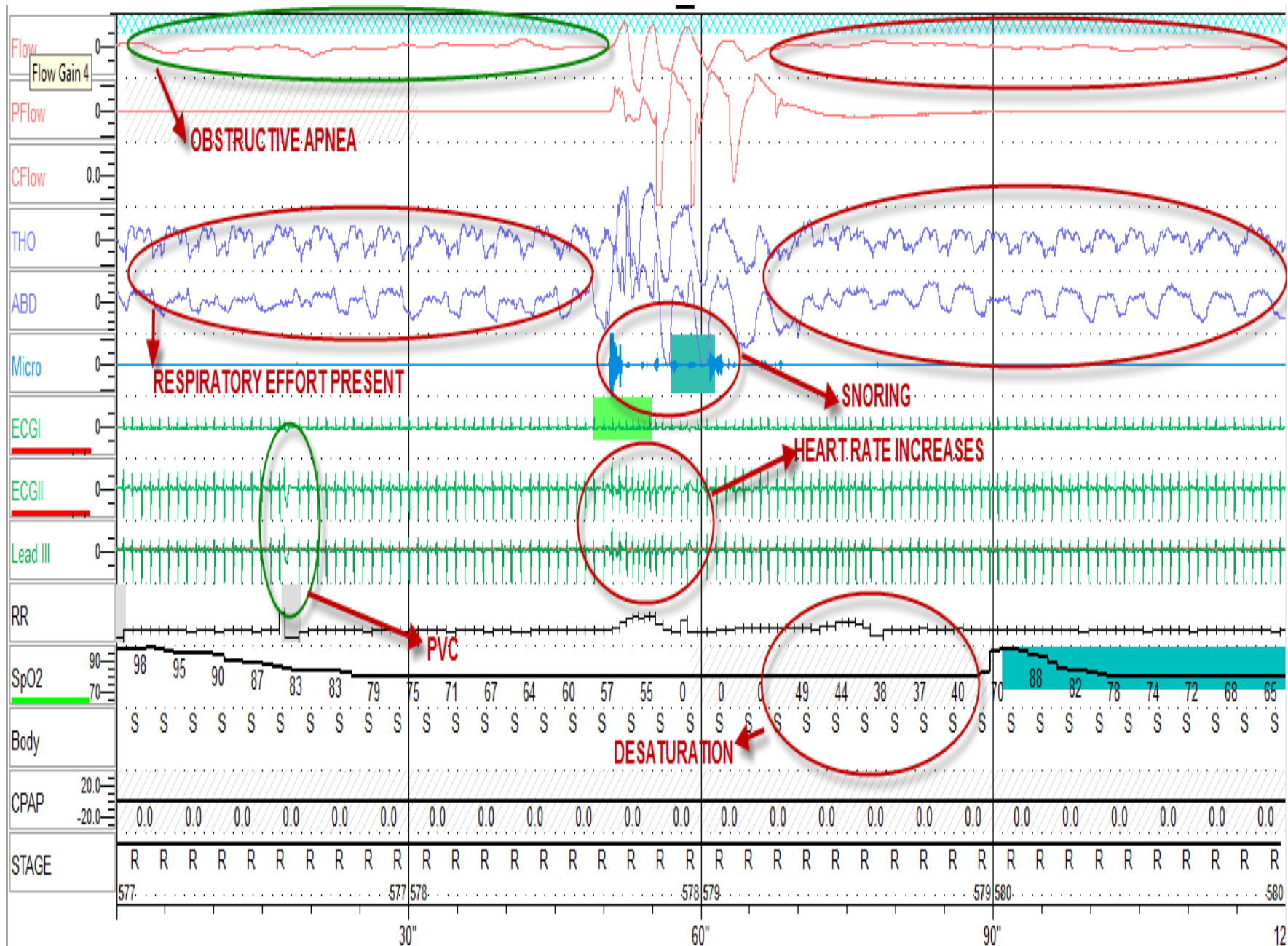
**Figure 1.** A respiratory event that should be scored as an apnea. The red bracket indicates the full duration of the apnea event.



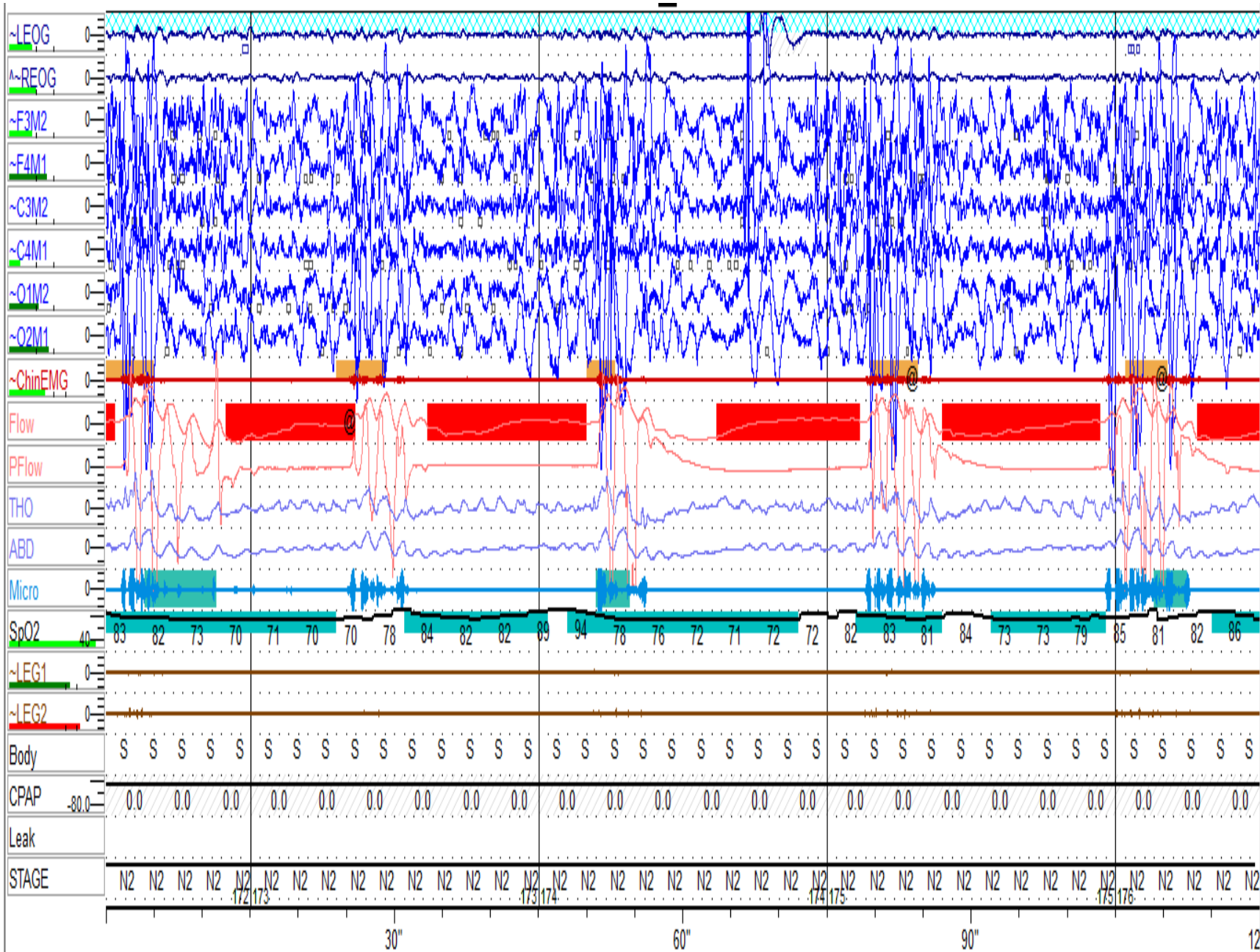
- Score an apnea as central if it meets apnea criteria and is associated with absent inspiratory effort throughout the entire period of absent airflow.

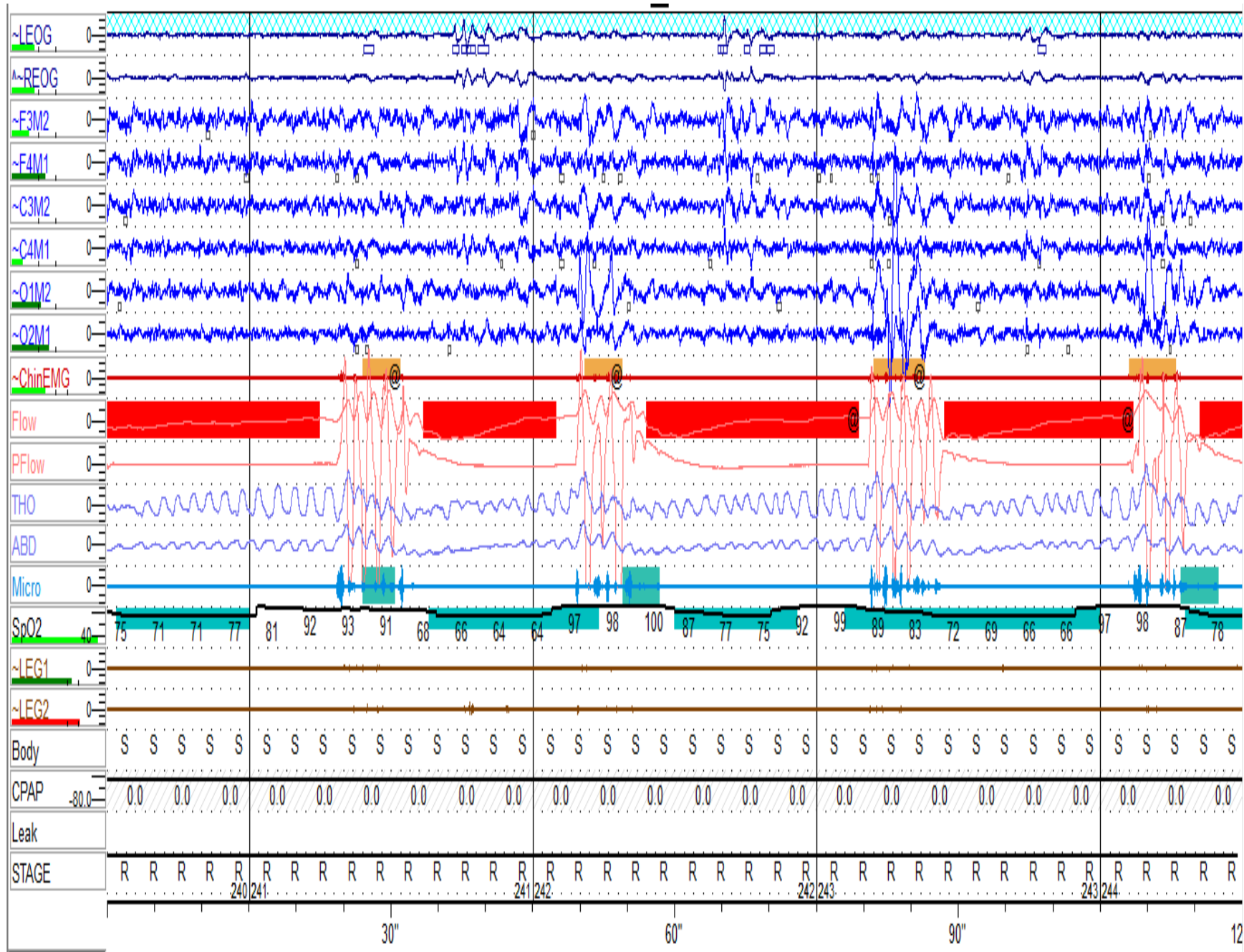


- Score an apnea as obstructive if it meets apnea criteria and is associated with continued or increased inspiratory effort throughout the entire period of absent airflow.





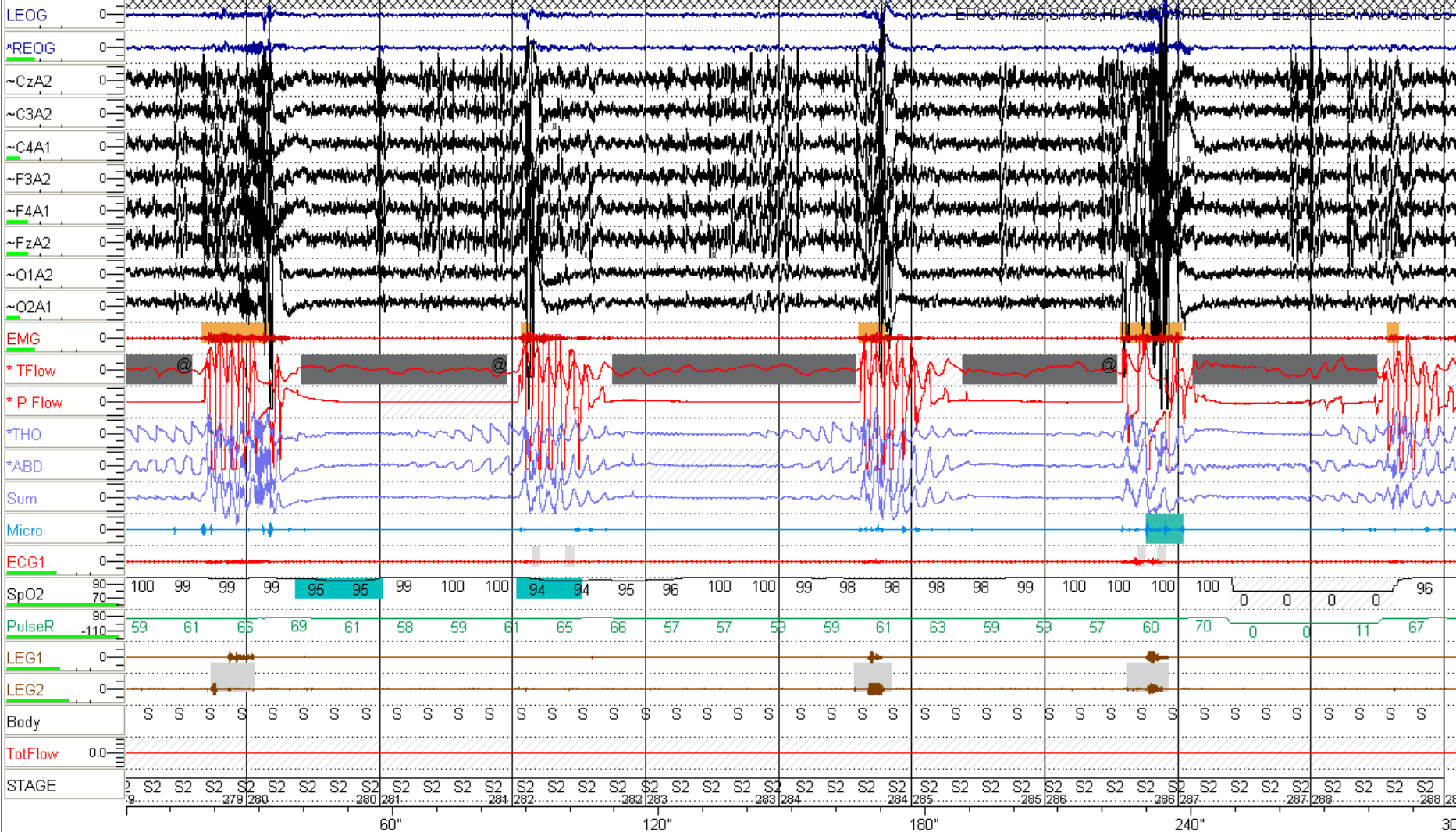






- Score an apnea as mixed if it meets apnea criteria and is associated with absent inspiratory effort in the initial portion of the event, followed by resumption of inspiratory effort in the second portion of the event.

WK  
MVT  
REM  
S1  
S2  
S3  
S4

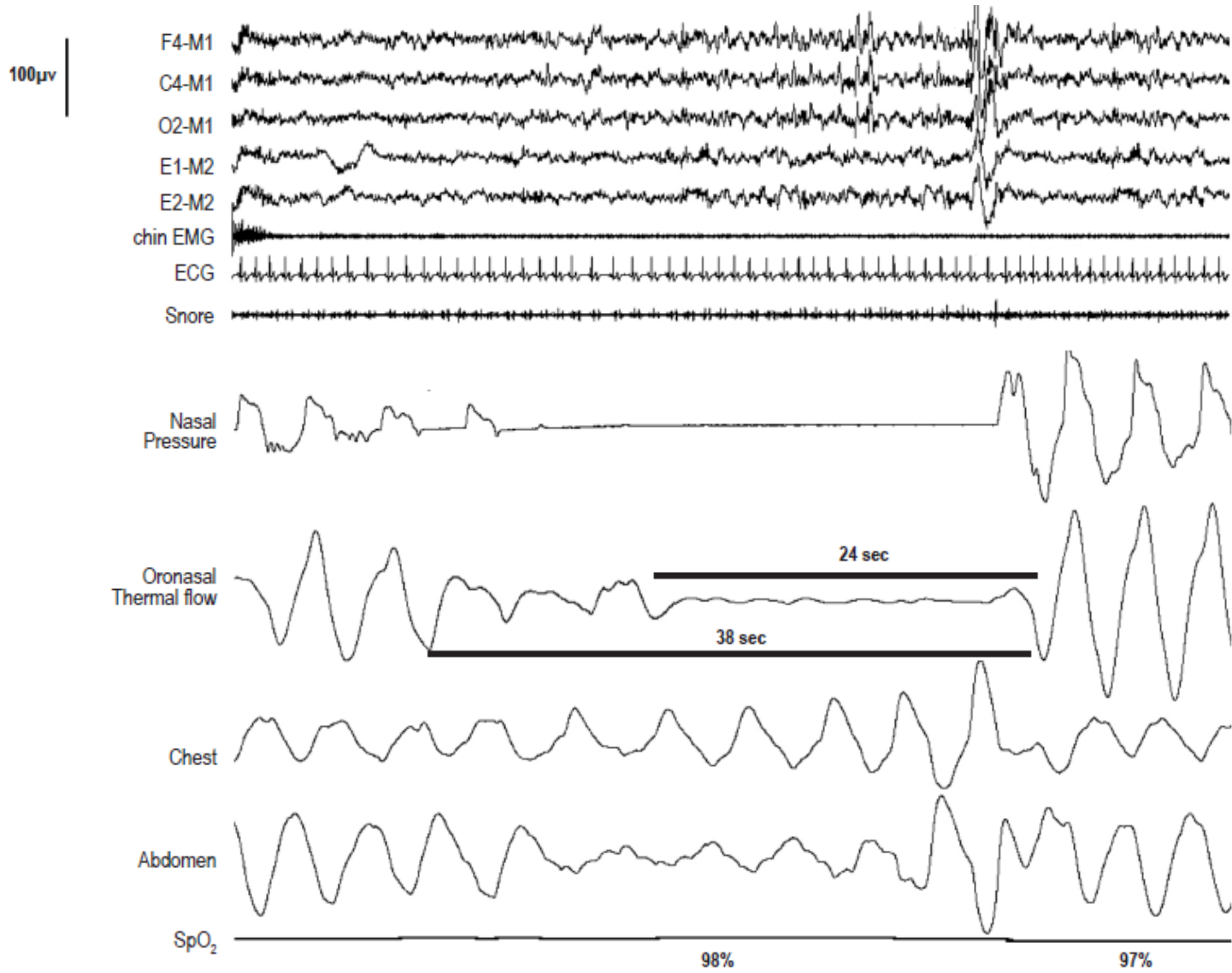


5 min.

- Identification of an apnea does not require a minimum desaturation criterion
- If a portion of a respiratory event that would otherwise meet criteria for a hypopnea meets criteria for apnea, the entire event should be scored as an apnea.



**Figure 5 – The event duration (based on drop in oronasal thermal flow) is 38 seconds as defined by the event duration rule**



An apnea cannot be scored using the apnea rule in the 2007 scoring manual as 24 seconds (the duration of the  $\geq 90\%$  drop in oronasal flow) is not 90% of the event duration. A hypopnea cannot be scored based on the drop in nasal pressure, as there is no associated desaturation or arousal. Using the proposed revised apnea definition this event would be scored as an apnea as there is a  $\geq 90\%$  reduction in the peak excursions of the oronasal thermal signal compared to baseline that lasts  $\geq 10$  seconds. The respiratory effort (thoracoabdominal excursions) during the entire apnea indicates that this is an obstructive apnea.

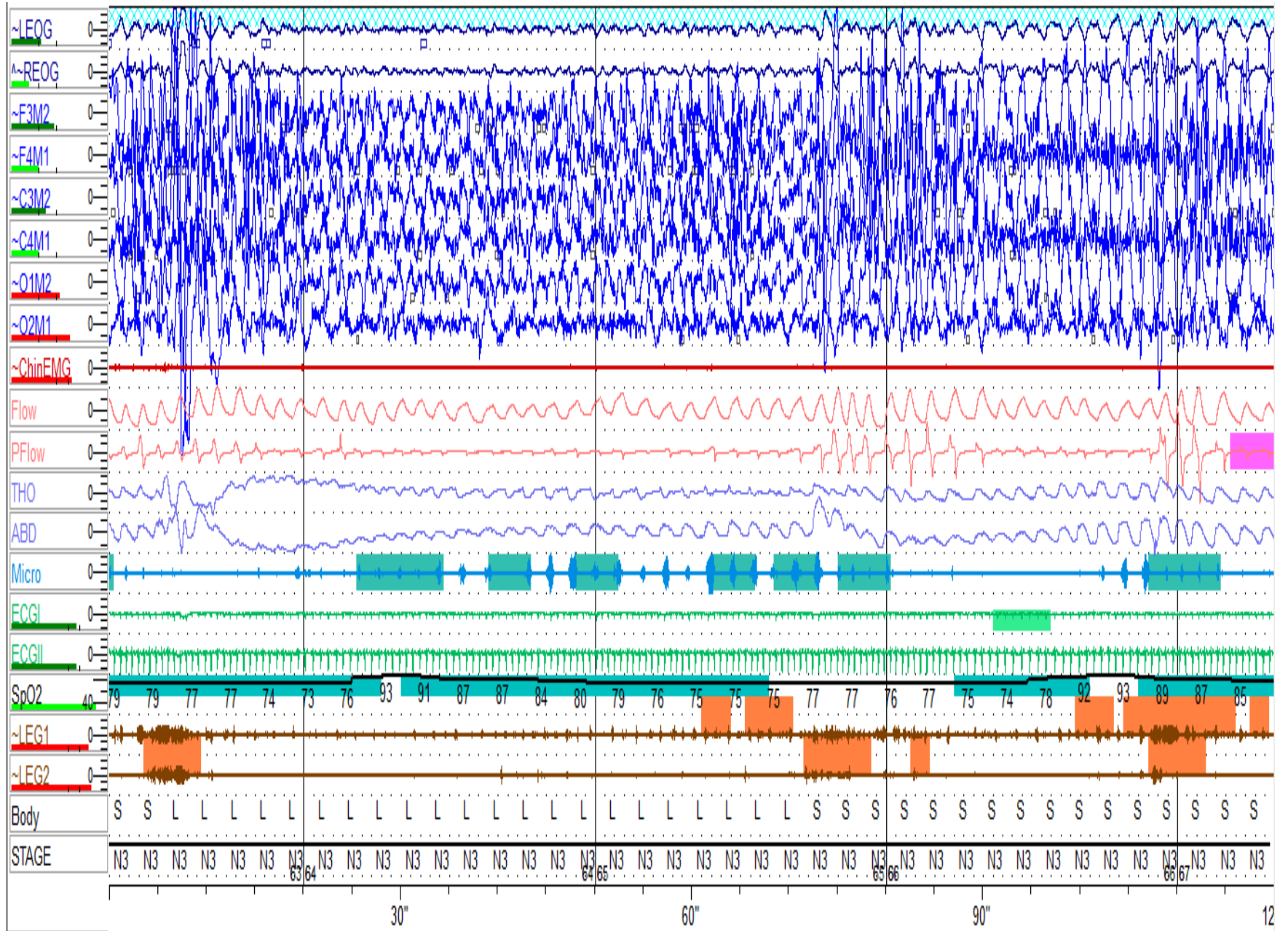
- If the apnea or hypopnea event begins or ends during an epoch that is scored as sleep, then the corresponding respiratory event can be scored and included in the computation of the apnea hypopnea index (AHI).
- This situation usually occurs when an individual has a high AHI with events occurring so frequently that sleep is severely disrupted and epochs may end up being scored as wake even though <15 seconds of sleep is present during the epoch containing that portion of the respiratory event.



# **HYPOPNEA DEFINITION**

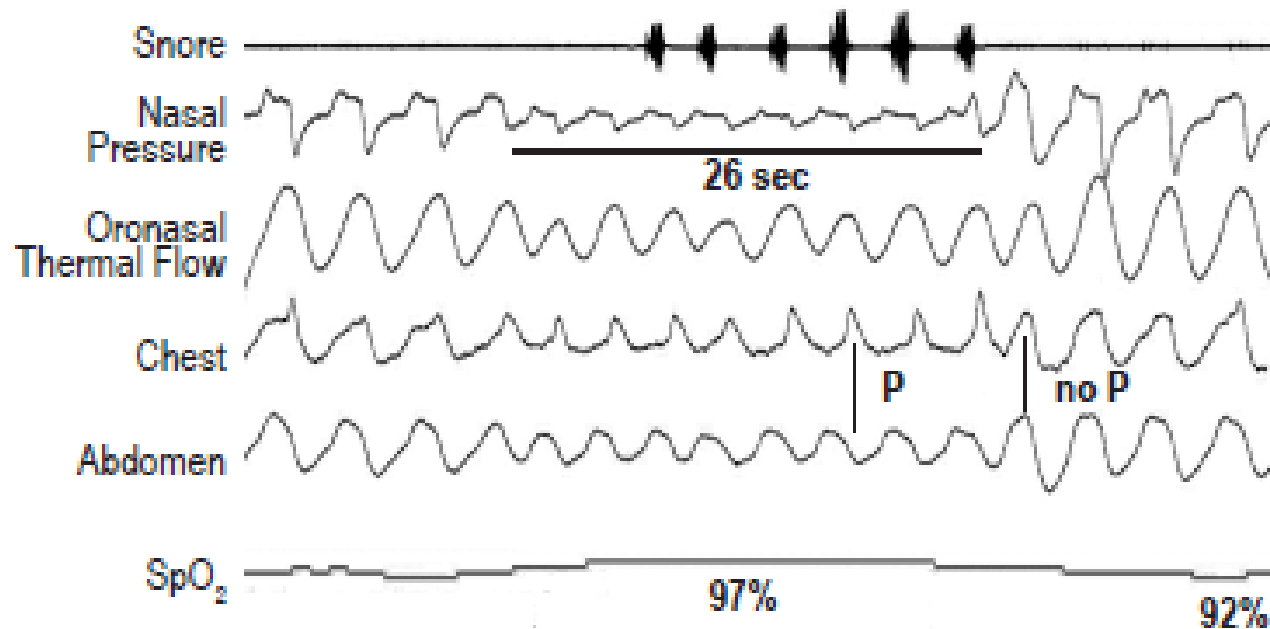
- Score a respiratory event as a hypopnea if ALL of the following criteria are met –
  - a. The peak signal excursions drop by  $\geq 30\%$  of pre-event baseline using nasal pressure (diagnostic study), PAP device flow (titration study), or an alternative hypopnea sensor (diagnostic study)
  - b. The duration of the  $\geq 30\%$  drop in signal excursion is  $\geq 10$  seconds
  - c. There is a  $\geq 3\%$  oxygen desaturation from pre-event baseline or the event is associated with an arousal





- If electing to score obstructive hypopneas, score a hypopnea as obstructive if ANY of the following criteria are met –
  - a. Snoring during the event
  - b. Increased inspiratory flattening of the nasal pressure or PAP device flow signal compared to baseline breathing
  - c. Associated thoracoabdominal paradox occurs during the event but not during pre-event breathing

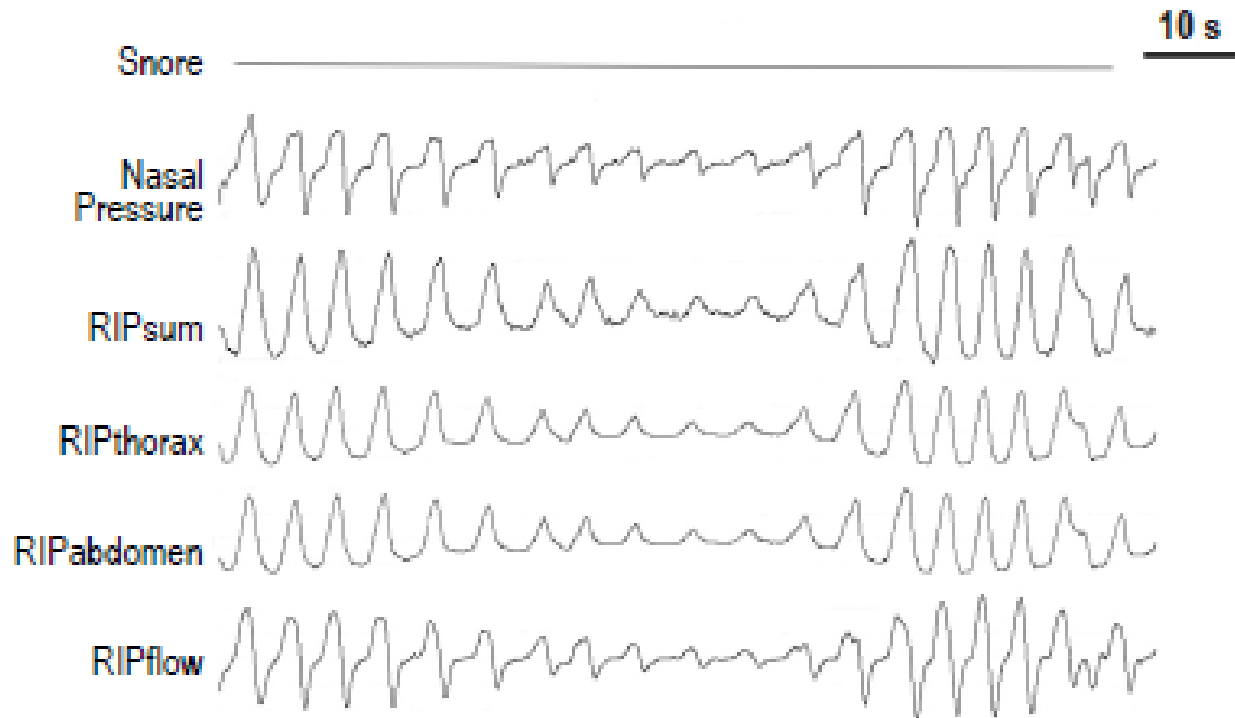
**Figure 6**—An example of an obstructive hypopnea with snoring, flattening of the nasal pressure (NP) waveform, and paradoxical motion of the chest and abdominal (ABD) respiratory inductance plethysmography excursions



SpO<sub>2</sub> is the pulse oximetry. Inspiration is upward in the figure. P denotes paradox during the hypopnea and no P the absence of paradox during unobstructed breathing.

- If electing to score central hypopneas, score a hypopnea as central if **NONE** of the following criteria are met –
  - a. Snoring during the event
  - b. Increased inspiratory flattening of the nasal pressure or PAP device flow signal compared to baseline breathing
  - c. Associated thoracoabdominal paradox occurs during the event but not during pre-event breathing

**Figure 7**—A central hypopnea in a patient with Cheyne-Stokes breathing is illustrated



NP is the nasal pressure signal. There is no evidence of snoring or thoracoabdominal paradox in the RIP bands (RIPthorax and RIPabdomen). There is no evidence of airflow limitation (flattening of the nasal pressure signal). The direction of inspiration is upward in this figure.



- Supplemental oxygen may blunt desaturation. There are currently no scoring guidelines for when a patient is on supplemental oxygen and no desaturation is noted.
- If the diagnostic study is performed while the subject is on supplemental oxygen, its presence should be mentioned in the narrative summary of the study.

# CSR

- Score a respiratory event as Cheyne-Stokes breathing if BOTH of the following are met. (see Figure 10)
- There are episodes of  $\geq 3$  consecutive central apneas and/or central hypopneas separated by a crescendo and decrescendo change in breathing amplitude with a cycle length of  $\geq 40$  seconds.
- There are  $\geq 5$  central apneas and/or central hypopneas per hour of sleep associated with the crescendo/decrecendo breathing pattern recorded over  $\geq 2$  hours of monitoring

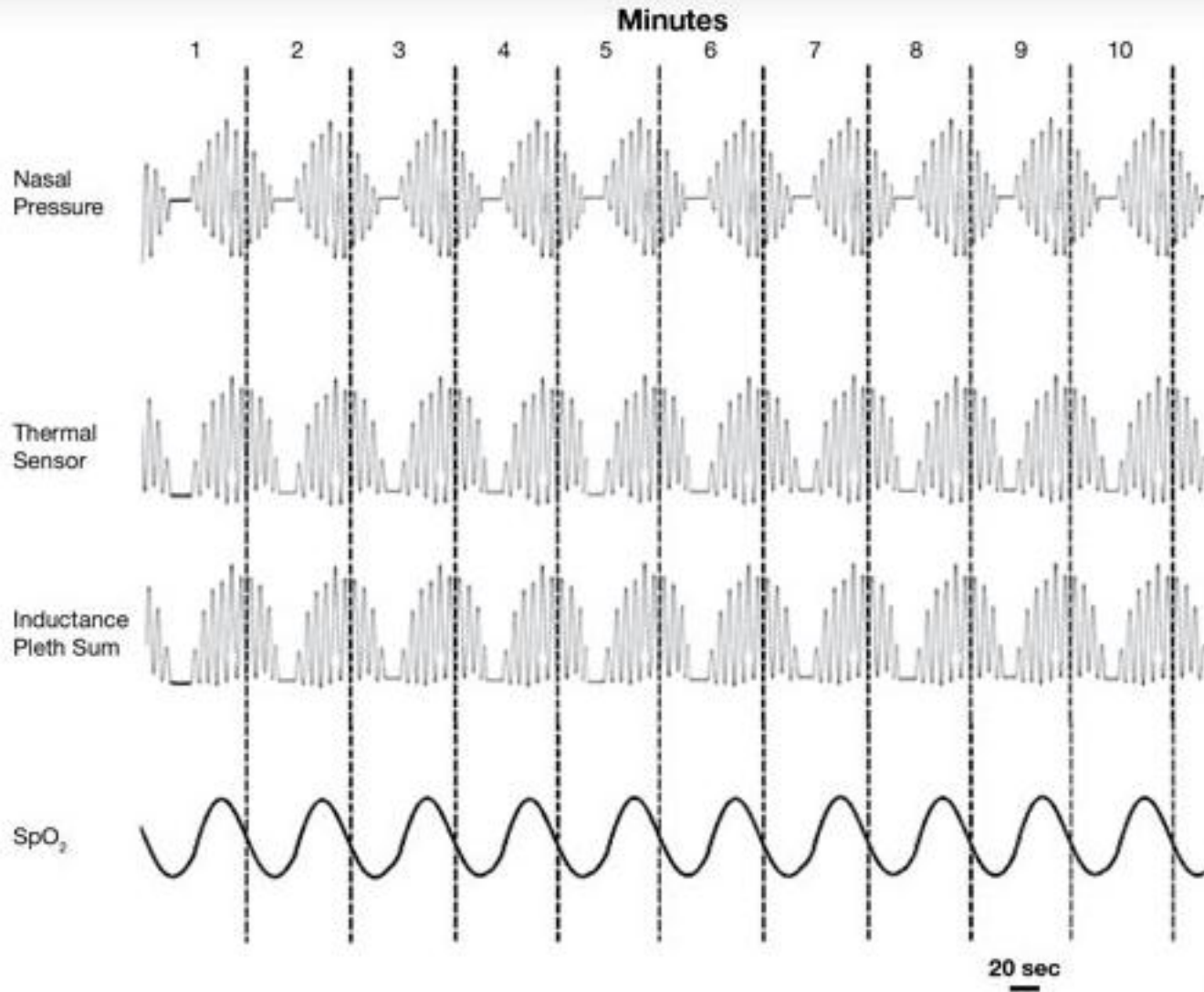
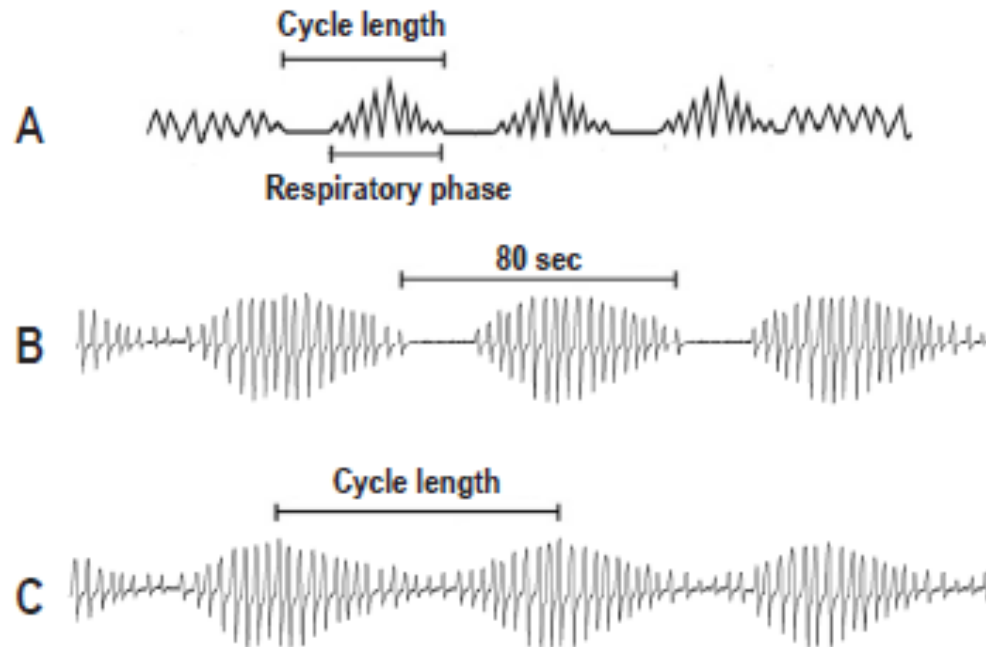


Figure 10: A respiratory event that should be scored as Cheyne-Stokes breathing due  $\geq 3$  consecutive apneas with crescendo and decrescendo breathing in between.

- Cycle length is the time from the beginning of a central apnea to the end of the next crescendo-decrescendo respiratory phase (start of the next apnea).

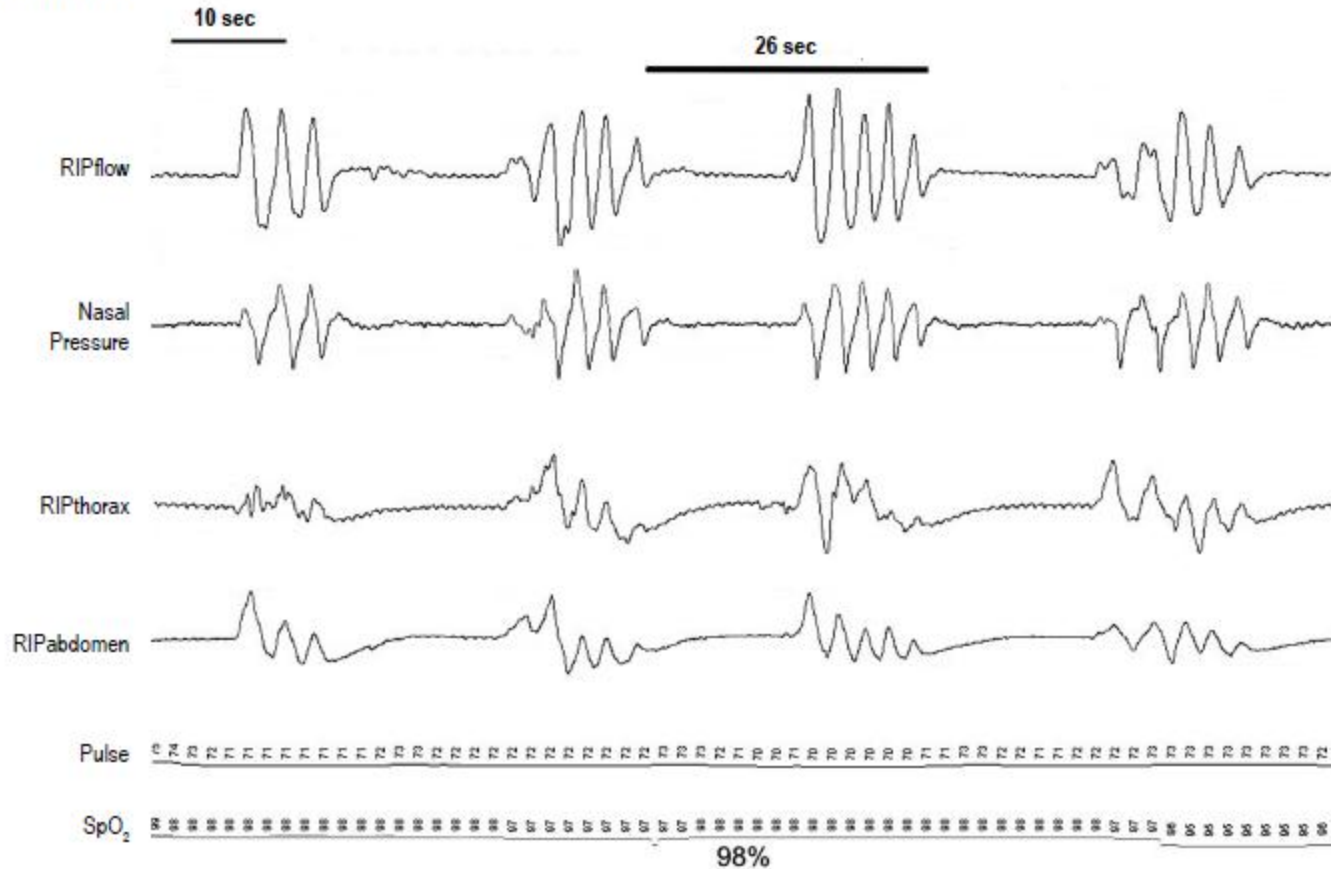
*Note 2: Central apneas that occur within a run of Cheyne-Stokes breathing should be scored as individual apneas as well.*

**Figure 11**



**(A)** Schematic of Cheyne-Stokes breathing (airflow shown) with a minimum of 3 consecutive central apneas (effort not shown) separated by a crescendo-decrescendo pattern of breathing. **(B)** Cheyne-Stokes breathing with central apneas (only airflow shown) with a long cycle time of 80 seconds. **(C)** Cheyne-Stokes breathing with central hypopneas (airflow shown). Although respiratory effort is not shown, these are central hypopneas with no evidence of airflow limitation (no flattening). As it is difficult to identify a beginning or end of the hypopnea, cycle time is defined as the time from one zenith in airflow during the respiratory phase to the next zenith in airflow.

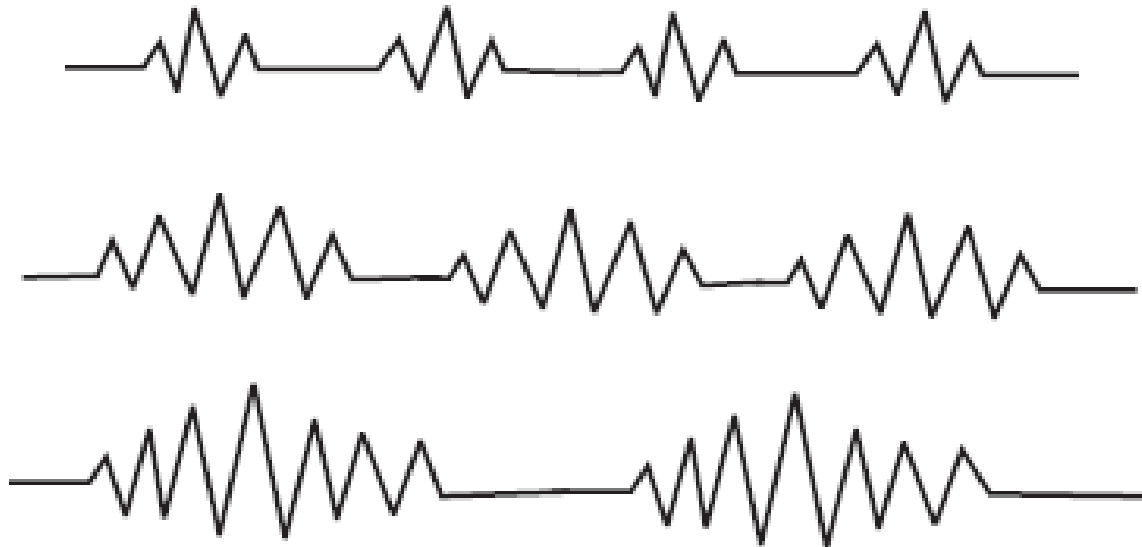
**Figure 12 – The tracings illustrate periodic breathing in a 35-year old male with no evidence of cardiac disease who is not taking narcotic medication**



Central apneas are separated by respiration that sometimes shows a crescendo-decrescendo pattern. However, three consecutive ventilatory periods with a crescendo-decrescendo pattern are not present. In addition, the cycle length is only about 26 seconds. The cycle length is defined as the time from the beginning of a central apnea to the end of the subsequent crescendo-decrescendo respiratory phase.

**Figure 13 – Various possibilities of periodic breathing with a crescendo – decrescendo pattern**

Are these all Cheyne-Stokes Breathing?







# Hypoventilation Rule

- Either of the following are present –
  - a. Increase in arterial PCO<sub>2</sub> (or surrogate) to a value more than 55 mmHg for more than 10 min
  - b. There is a  $\geq 10$  mmHg increase in arterial PCO<sub>2</sub>(or surrogate) during sleep (in comparison to awake supine value) to a value exceeding  $>50$  mmHg for  $\geq 10$  min