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 respiratorymonitoring

Respiratory Parameter	Sensor
Airflow (use both	 Oronasal thermal airflow sensor*
oronasal thermal flow	(to score apnea in diagnostic study) Nasal pressure transducer**
sensor and nasal	(to score hypopnea in diagnostic study) PAP device flow signal
pressure transducer	(to score apneas and hypopneas in PAP
during diagnostic study)	titration study)
Respiratory Effort	 Esophageal manometry Dual thoracoabdominal RIP belts*** Dual thoracoabdominal PVDF belts
(select one)	[Acceptable] in adults
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 duringdiagnostic study

Respiratory Event	Sensor
Apnea (select one)	 Nasal pressure transducer* RIPsum** RIPflow** PVDFsum [Acceptable] in adults End-tidal PCO₂ [Acceptable] in children
Hypopnea (select one)	 Oronasal thermal airflow sensor*** RIPsum** RIPflow** Dual thoracoabdominal RIP belts** PVDFsum [Acceptable] in adults

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)
 - u dual thoracoabdominal PVDF belts

For detection of hypoventilation during a diagnostic study, use arterial PCO₂, transcutaneous PCO₂ or end-tidal PCO₂

 For detection of hypoventilation during PAP titration, use arterial PCO₂, or use transcutaneous PCO₂

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 ≥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 ≥90% drop in sensor signal is ≥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)





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

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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.

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- 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 ≥30% of preevent baseline using nasal pressure (diagnostic study), PAP device flow (titration study), or an alternative hypopnea sensor (diagnostic study)
 - b. The duration of the ≥30% drop in signal excursion is ≥10 seconds
 - c. There is a ≥3% oxygen desaturation from pre-event baseline or the event is associated with an arousal



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- 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



SpO₂ 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 ≥3 consecutive central apneas and/or central hypopneas separated by a crescendo and decrescendo change in breathing amplitude with a cycle length of ≥40 seconds.
- There are ≥5 central apneas and/or central hypopneas per hour of sleep associated with the crescendo/decrescendo breathing pattern recorded over ≥2 hours of monitoring



 Cycle length is the time from the beginning of a central apnea to the end of the next crescendodecrescendo 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.



(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.





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?

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Hypoventilation Rule

- Either of the following are present
 - a. Increase in arterial PCO2 (or surrogate) to a value more than 55 mmHg for more than 10 min
 - b. There is a ≥10 mmHg increase in arterial PCO2(or surrogate) during sleep (in comparison to awake supine value) to a value exceeding >50 mmHg for ≥ 10 min