The Polysomnogram

Robertson Chapter 9

Introduction

- Patient-centered care is at the forefront
  - Several constructs:
    - Dignity and respect
    - Collaboration
    - Participation
    - Information sharing
- IOM definition of quality health care = Degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge

Introduction

6 quality parameters for care:

- Safe
- Effective
- Patient-centered
- Timely
- Efficient
- Equitable

Critical thinking skills are essential as a sleep technologist

- Must be able to analyze, evaluate, infer, and utilize inductive and deductive reasoning in order to adequately perform your role

Patient Communication

- Establish rapport with your patient
- Advocate for your patient
  - Ensure that the patient's rights and welfare are maintained
- Communication should be patient-centered
  - Ask the patient the reason for their study
  - Allow patient to acclimate to testing room
  - Gauge the patient's support system by communicating with family or friends accompanying them and educating them about the sleep disorder and treatment

Medical Record Review

- A written order from physician required to perform study
- Review sleep diaries and questionnaires
- Thorough history and physical should be available
  - Imperative for quality of care
- Patient acuity = Clinical intensity or severity of patient's condition
- Must document well and capture clinical data
- Tech can play big role in educating, comforting, and being a resource for patients

Health Care Provider Orders

- May be electronic or handwritten
- Most are EMRs today
  - Order should be dated and electronically signed by ordering physician
- Order should have pertinent patient info
  - Minimum of name, DOB, age, diagnosis, procedure code, and contact info
  - Order forms should include ICD-10 codes
- Tech responsible for identifying discrepancies in the order

Medications

- Must have complete list of medications the patient is taking
- Document whether the patient took the medications prior to the study or during the study

Patient Assessment

- Physical assessment begins at 1st encounter
- Practicing and learning patient assessment skills enables tech to gain improved knowledge of the patient
  - Take into account patient's age, culture, cognitive level, literacy, and current state of health
  - Start "head to toe"
  - Tech assessment does not need to be comprehensive
- Some labs have techs take vital signs

Vital Signs

Adult Vital Signs	Normal Ranges
Blood pressure	90/60 mm Hg to 120/80 mm Hg
Respiratory rate	12-18 breaths per minute
Heart rate	60-100 beats per minute
Temperature	97.8° to 99.1° F
Pulse oximetry	95% to 100%

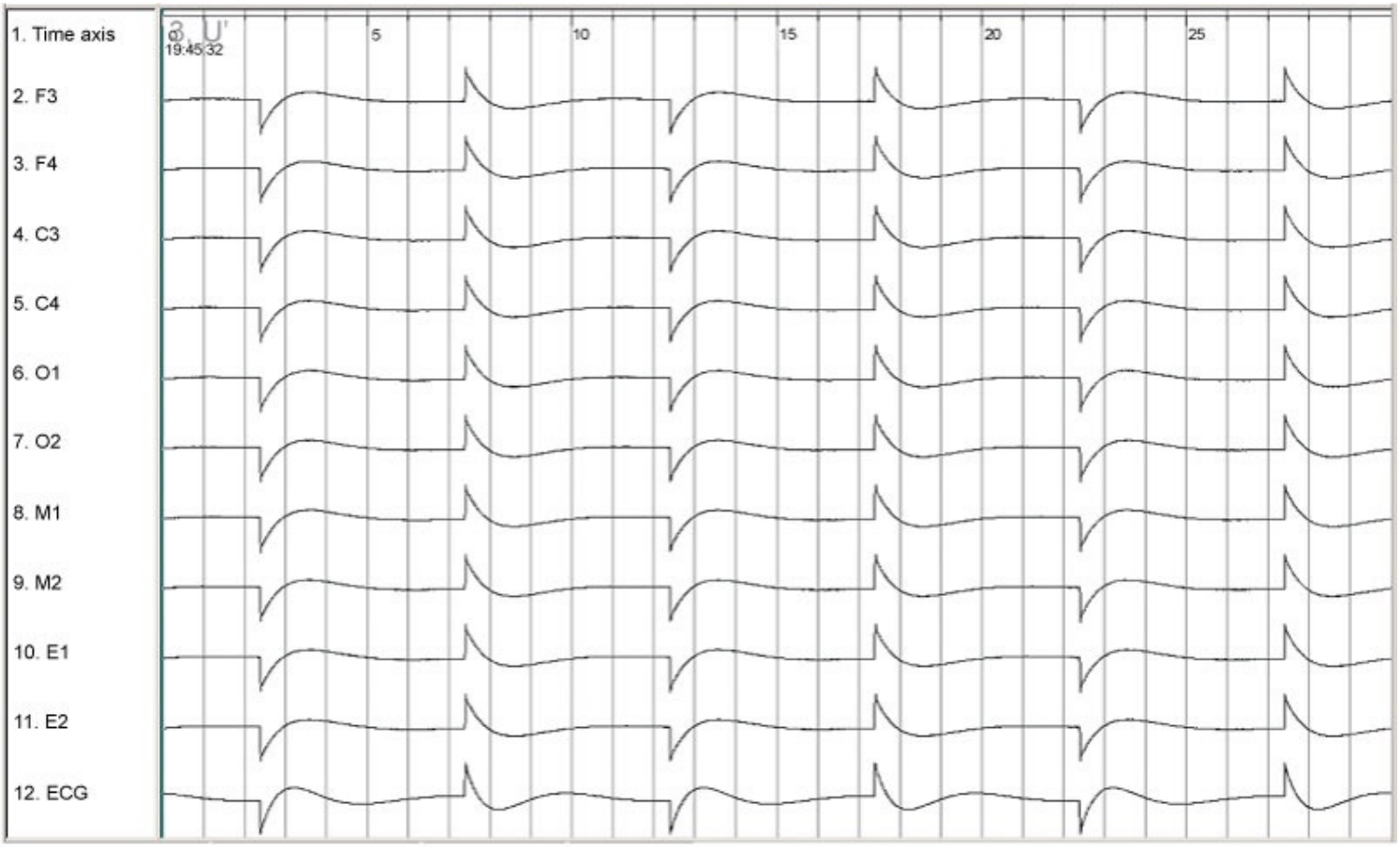
Recording Montage

- Map of the physiologic signals collected from electrodes and sensors
- Sometimes vary depending on study type
- Made up of individual channels that display various signals
- Differential amplifiers are used that record from 2 different electrodes: input 1 and 2
- AASM recommends 3 referential derivations for EEG
  - F4-M1, C4-M1, and O2-M1

Equipment Calibrations

- Foundation that provides knowledge of veracity and validity of data being collected
- Calibrations include assessment of amplitude, decay, and morphology of each signal based on known input voltage
- 1st step = Enter same inputs (voltage and filter settings) to all channels (all-channel calibration)
- 2nd step = Calibrate montage
  - Most data systems provide ability to enter and store the montage and settings for specific study types
- Sometimes specialized equipment is needed

All-Channel Calibration



AASM Recommended Amplifier Settings

Signal	Desirable Sampling Rate	Minimum Sampling Rate	LFF	HFF
EEG	500	200	0.3	35
EOG	500	200	0.3	35
EMG	500	200	10	100
ECG	500	200	0.3	70
Breathing sensors	100	25	0.1	15
Oximetry	25	10	NA	NA
Snoring	500	200	10	100
Body Positions	1	1	NA	NA

EEG and EOG Electrode Application

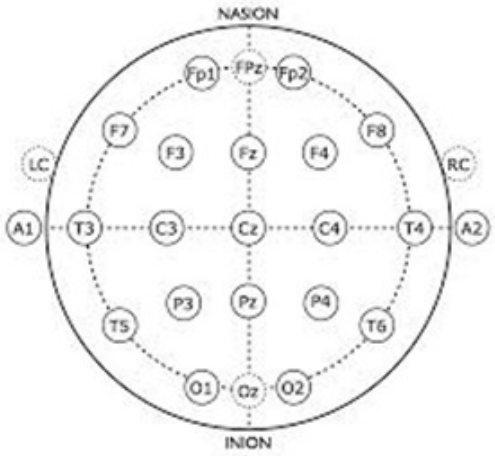
International 10-20 system provides standardized and consistent approach to collecting brain wave activity

Head measurement performed prior to EEG electrode placement

- 3 primary measurements:
  - Head circumference
  - Nasion to inion
  - Preauricular to preauricular

EOG electrode placement = 1 cm below LOC and 1 cm above ROC

- Both referenced to M2 electrode



EMG and Non-Cephalic Sensor Application

- Chin EMG placement:
  - One in midline 1 cm above inferior edge of mandible
  - One placed 2 cm below inferior edge of mandible and 2 cm to right of midline
  - One placed 2 cm below inferior edge of mandible and 2 cm to left of midline
- PSG used modified lead II ECG
- Recommended leg EMG placement:
  - Place on anterior tibialis muscle 2-3 cm apart on each leg

Respiratory Monitoring Sensors

- Recommended:
  - Thermal oral-nasal sensors for apneas
  - Nasal pressure transducer for hypopneas and RERAs
  - RIP for chest and abdominal effort
  - Pulse oximetry
- Proper placement must be a priority
  - Make sure belts fit securely and are in the right place
  - Make sure cannula and thermal sensor are picking up both nasal and oral breathing

Skin Preparation

- Skin must be adequately prepped
  - First clean with alcohol wipe
  - Apply a slightly abrasive, gritty type solution to the skin using a cotton-tipped applicator
- Improper skin prep leads to high impedances

Electrode Metal Recording Properties

- Must use electrodes that all have the same type of metal
  - Using differing metals can lead to artifact
- Electrodes can be affixed to the head with collodion, paste or tape
- Artifacts may be encountered
  - These include:
    - Sweat artifact
    - Muscle artifact
    - Respiratory artifact
    - ECG artifact

Pre-Bedtime Activities

Medscape www.medscape.com

Name:
Today's date: _____Your age: _____Your gender (M/F): ___
a). My ideal amount of sleep is ____ hours (number of hours sleep you need each night in order to feel and function your best)
1. During the *weekdays* I usually:2. During the *weekends* I:
Go to bed at _____ AM or PM (time)Go to bed at _____ AM or PM (time)
Get up at _____ AM or PM (time)Get up at _____ AM or PM (time)
Sleep _____ (total hours)Sleep _____ (total hours)
b). I awaken from sleep with headache: daily ___ sometimes ___ rarely ___ never ___
c). Sleep helps my headache: daily ___ sometimes ___ rarely ___ never ___
d). Oversleeping produces headache: daily ___ sometimes ___ rarely ___ never ___
e). I snore:nightly ___sometimes ___rarely ___never ___
f). After a typical night's sleep, I feel:
refreshed ___ fairly rested ___somewhat tired ___very drowsy ___

Source: Headache © 2006 Blackwell Publishing

- Questionnaire
  - Helps with interpretation of data
  - Provides overview of patient's day before sleep study
  - Has questions related to medications, caffeine use, and sleep info

Physiologic Calibrations

- Aids in interpretation of data
- Helps determine accuracy of signal response
- Allows for comparison between wake and sleep
- Proper channel polarity must be determined
- Important to assess the physiologic signal of each channel and adjust settings as needed
- After completion, patient is ready for “lights out”
- Calibrations should be done before and after every study

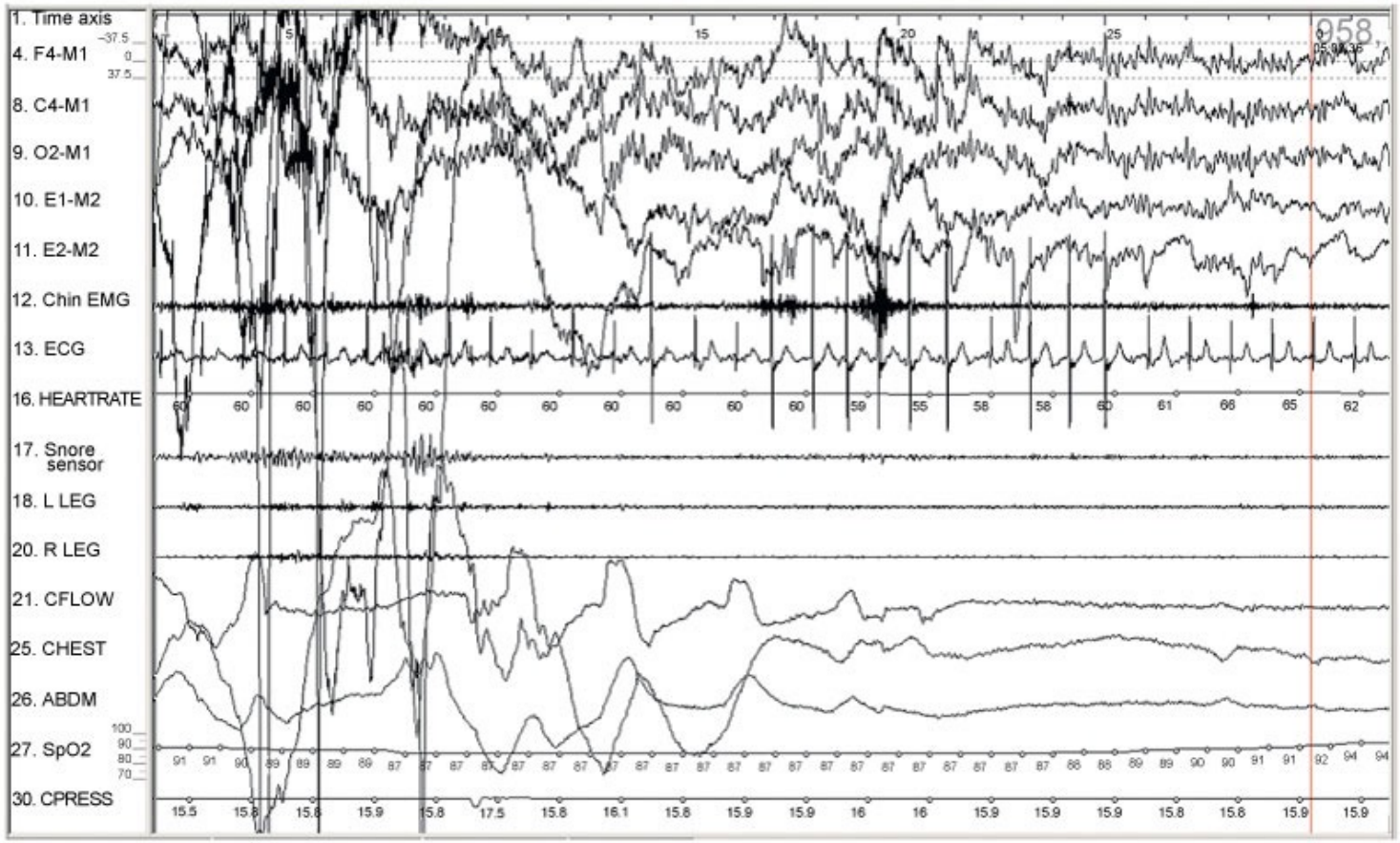
Physiologic Calibrations

- Typical physiologic calibrations:
  - Eyes open for 30 seconds
  - Eyes closed for 30 seconds
  - Move eyes left and right
  - Move eyes up and down
  - Blink eyes 5 times
  - Grind teeth
  - Simulate a snore
  - Flex feet
  - Normal breathing
  - Hold breath for 10 seconds
  - Paradoxical breathing

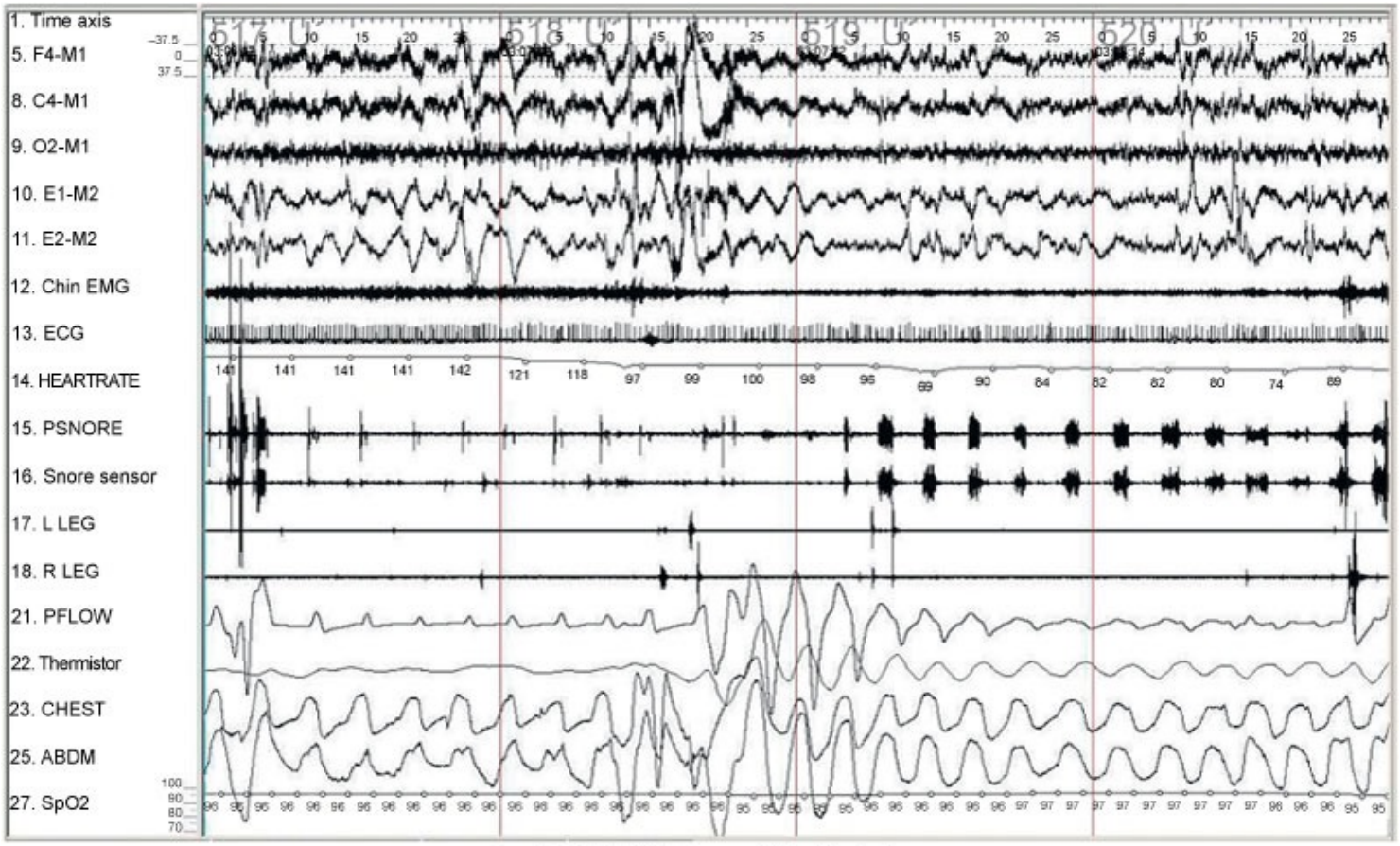
Monitoring and Documenting

- Audio and visual monitoring should occur from moment patient enters room to the moment patient leaves room
- Technologist needs to be vigilant to maintain safety of patient and quality of study
  - Failure to do so may be a liability for patient, sleep center, and sleep tech

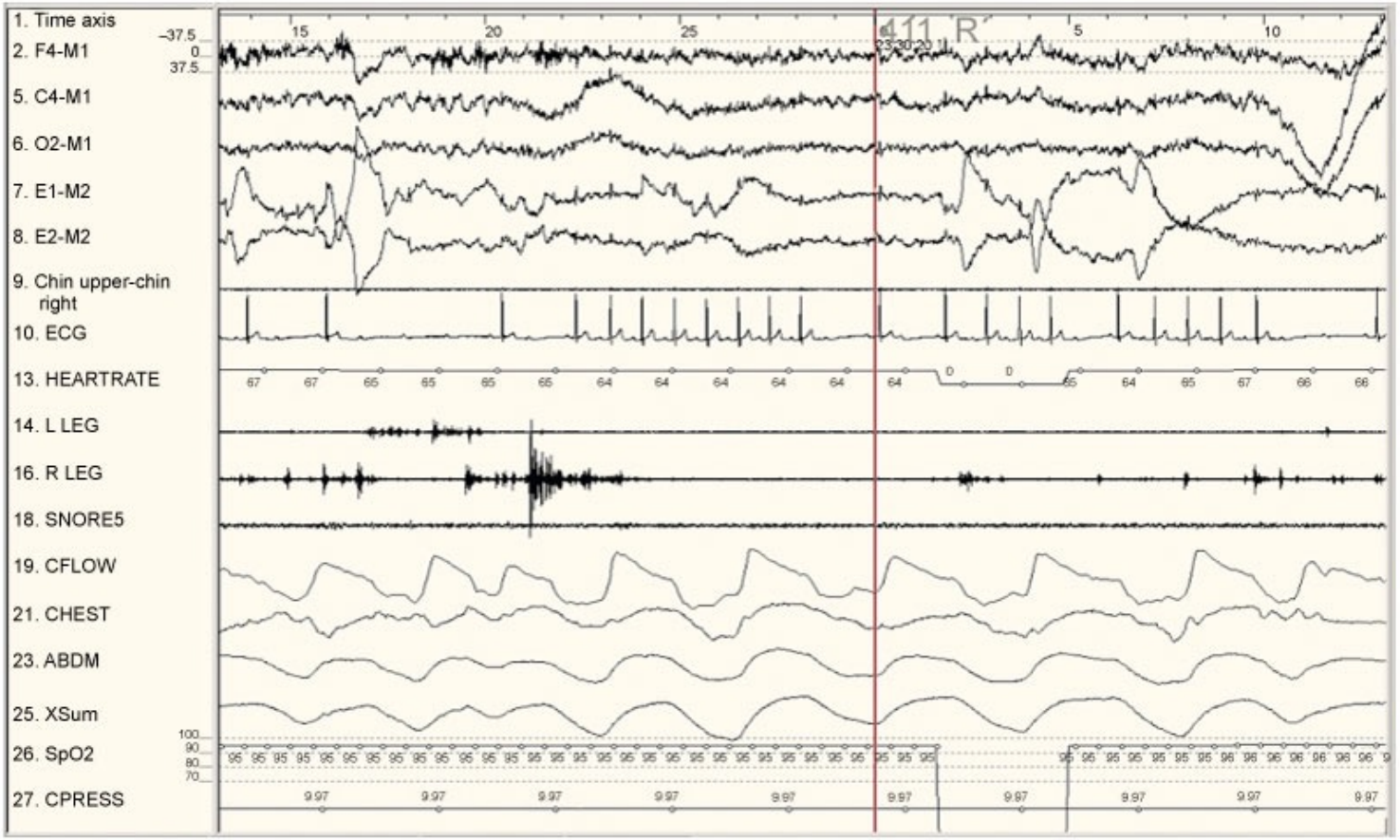
Unstable M2 and ECG Variance



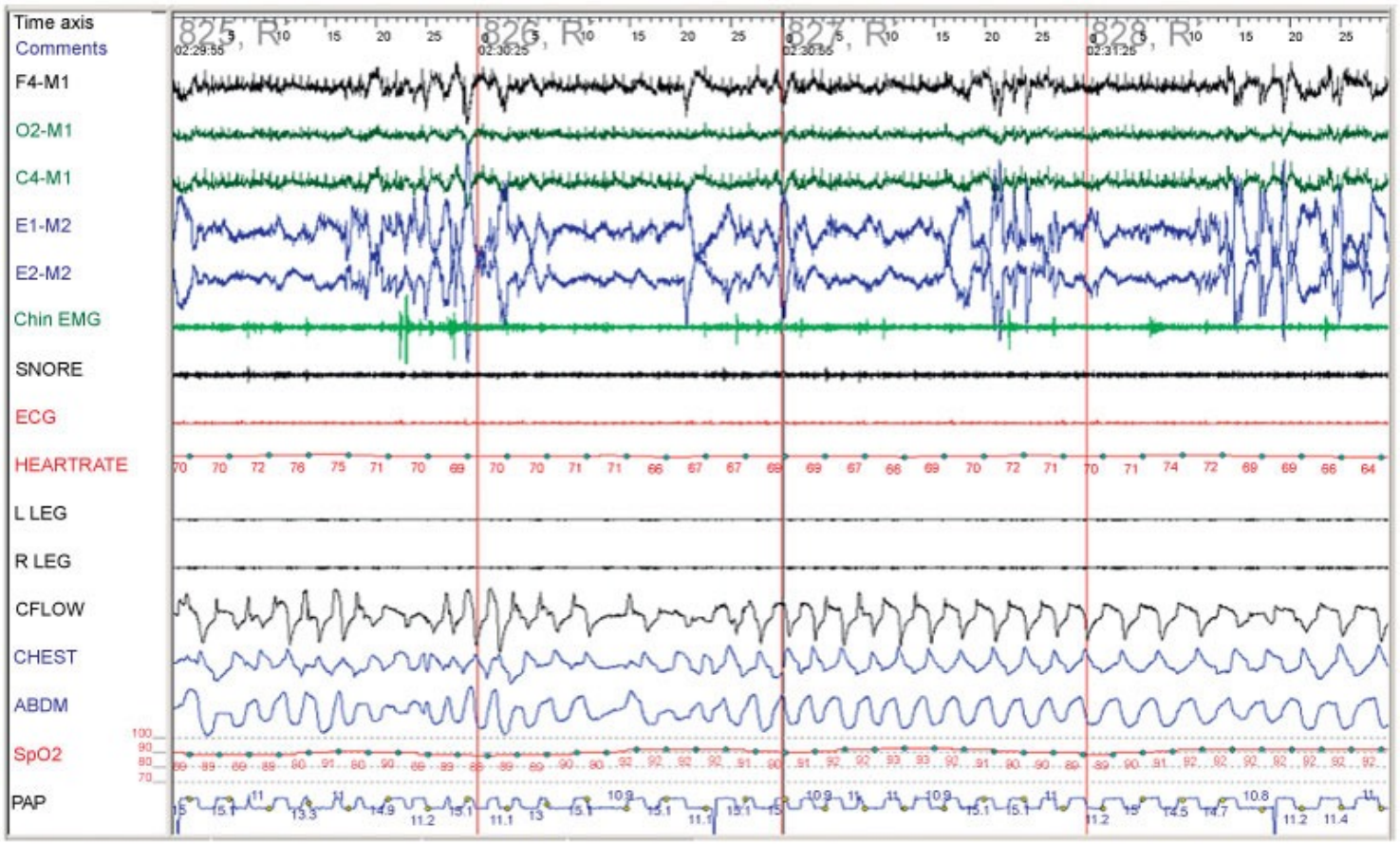
Extreme Heart Rate Variability



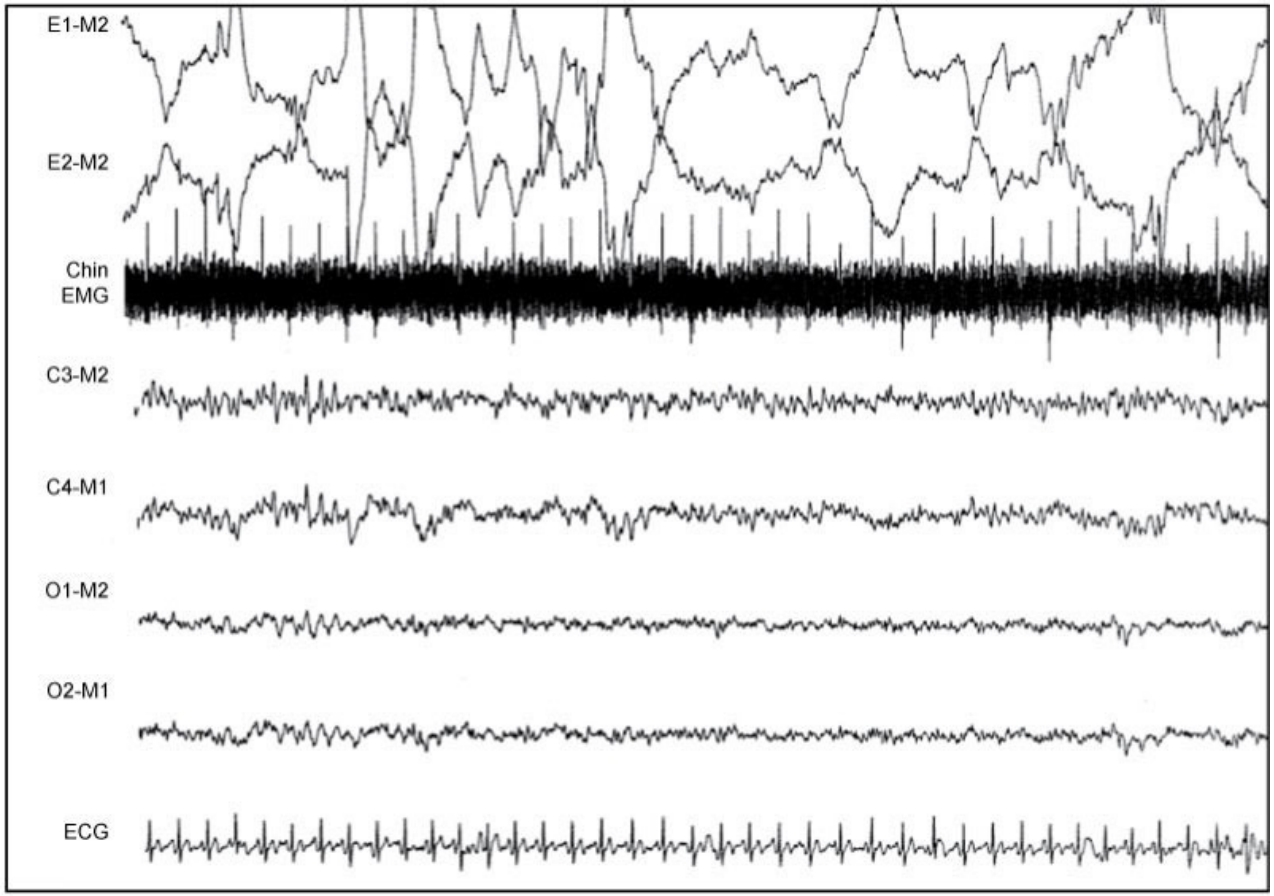
2nd Degree AV Block, Type II



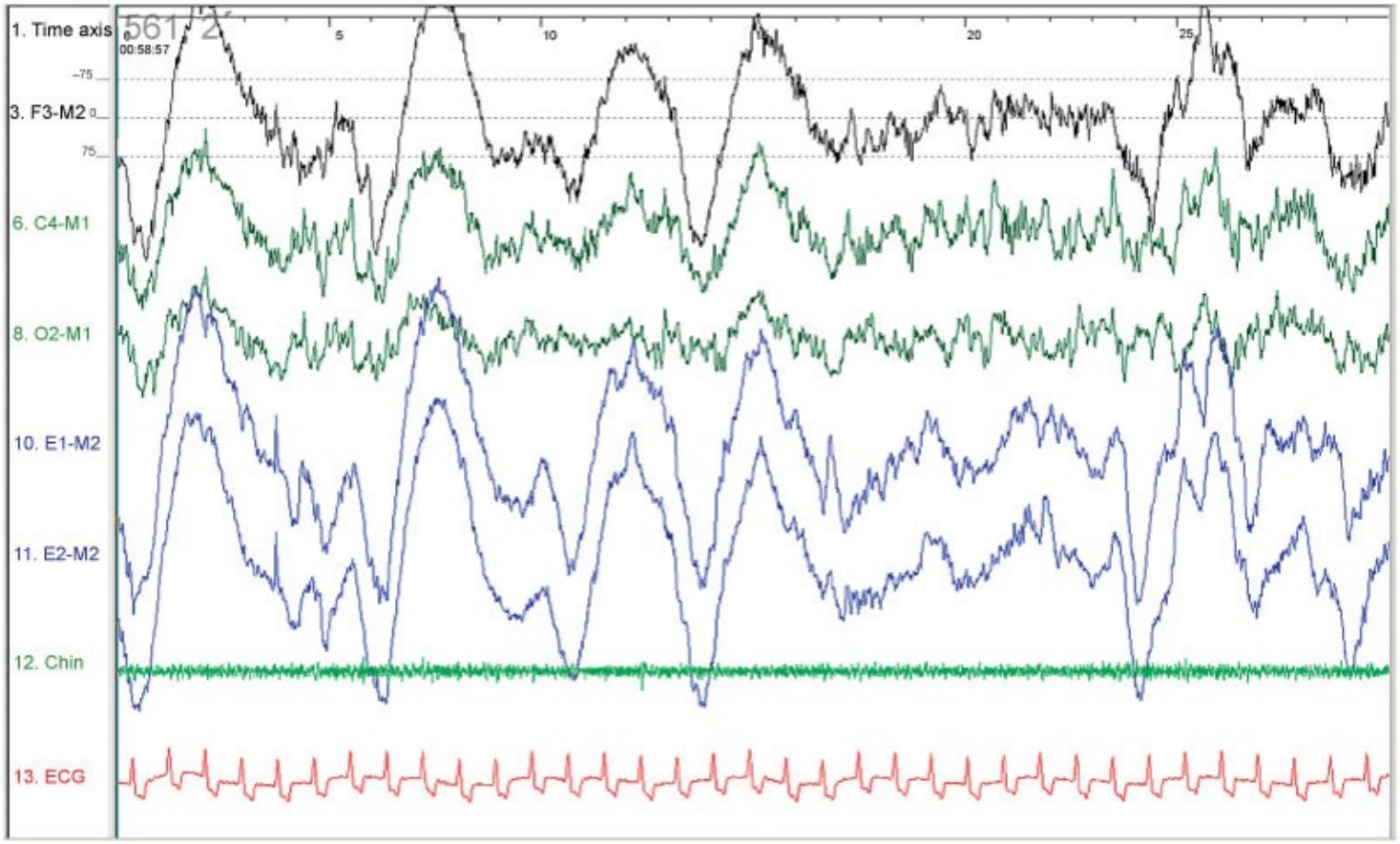
No ECG Signal



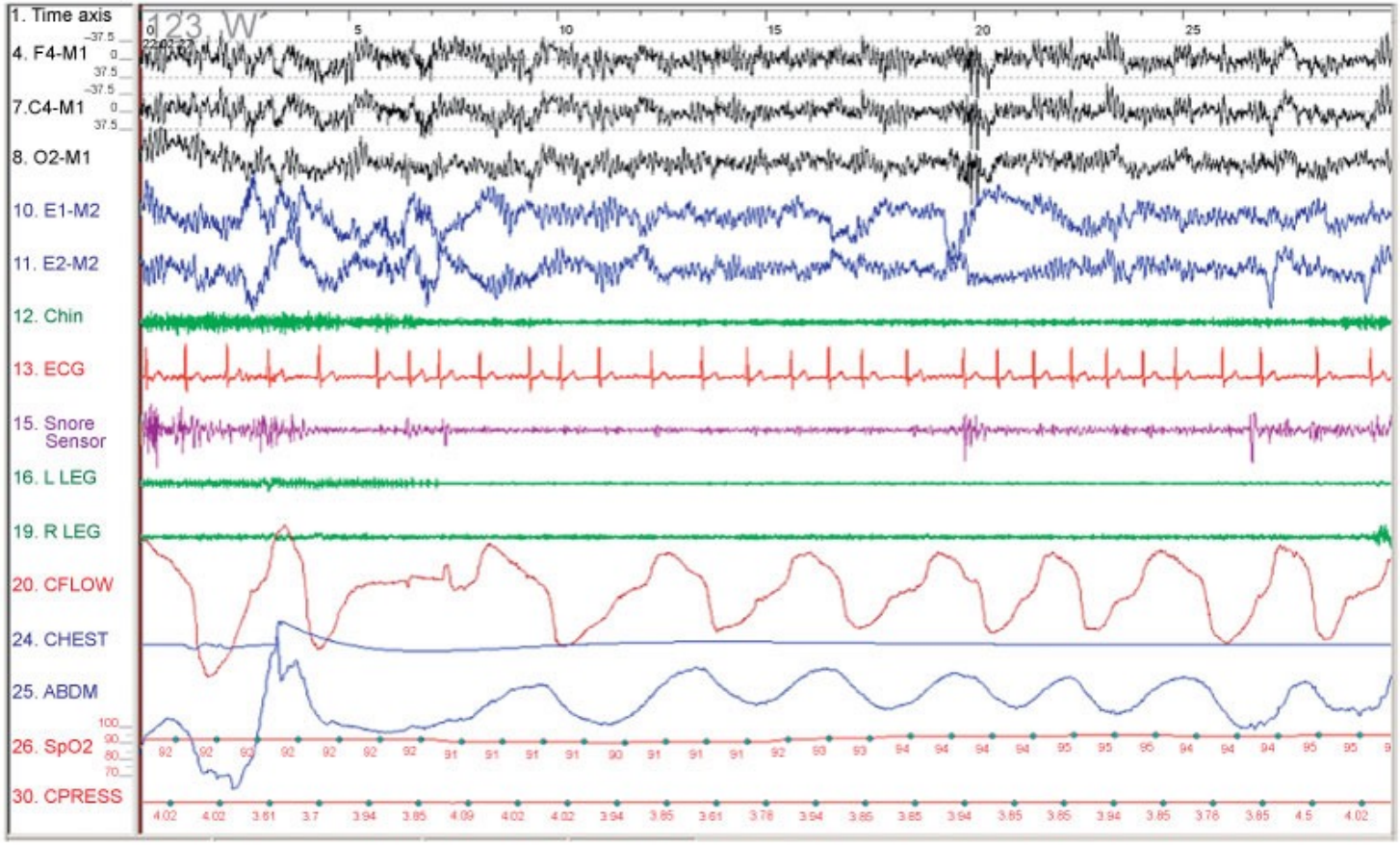
60 Hz Artifact in Chin EMG



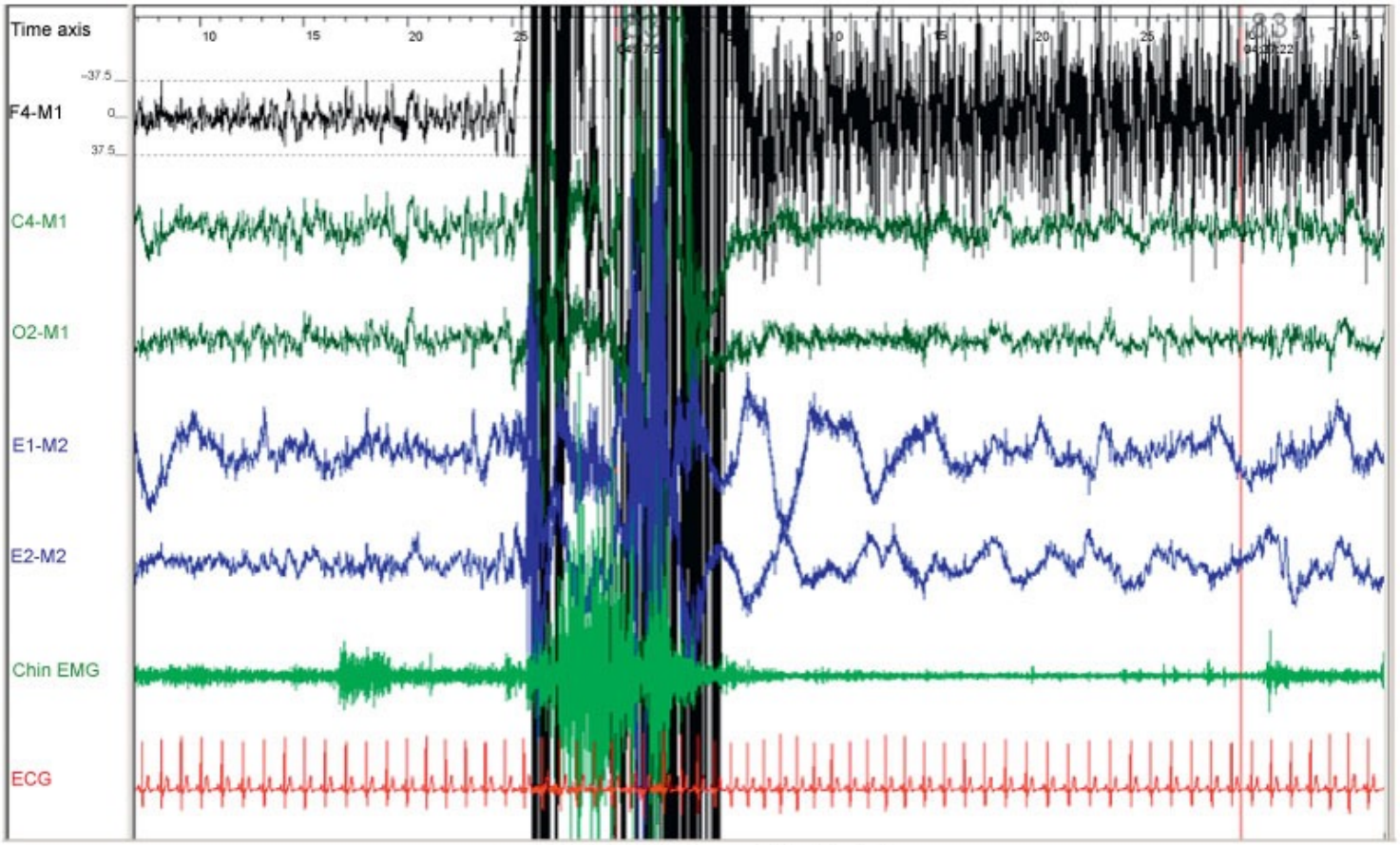
Sweat Artifact in M2 Channel



Chest Belt Not Functioning



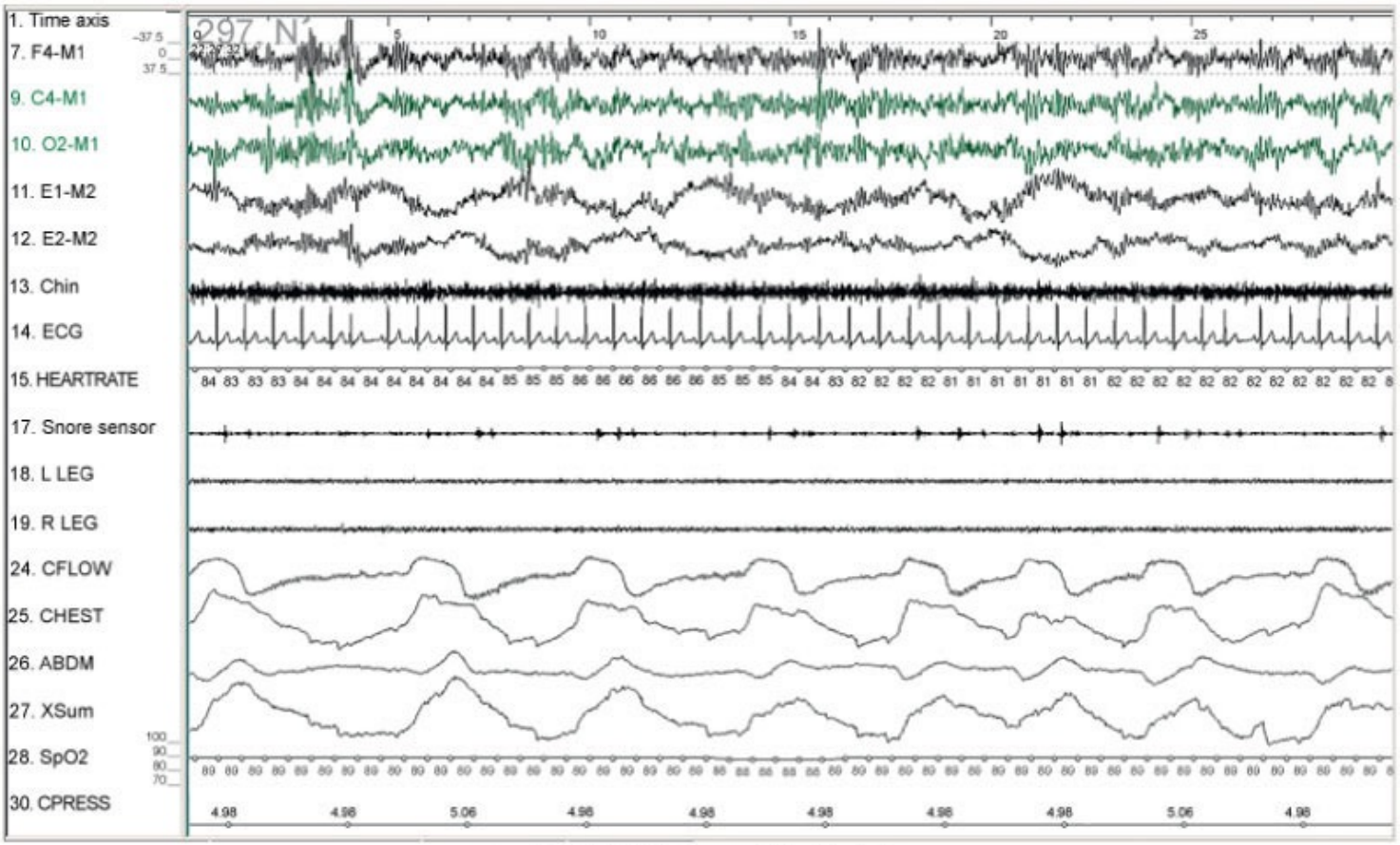
F4 Disconnected



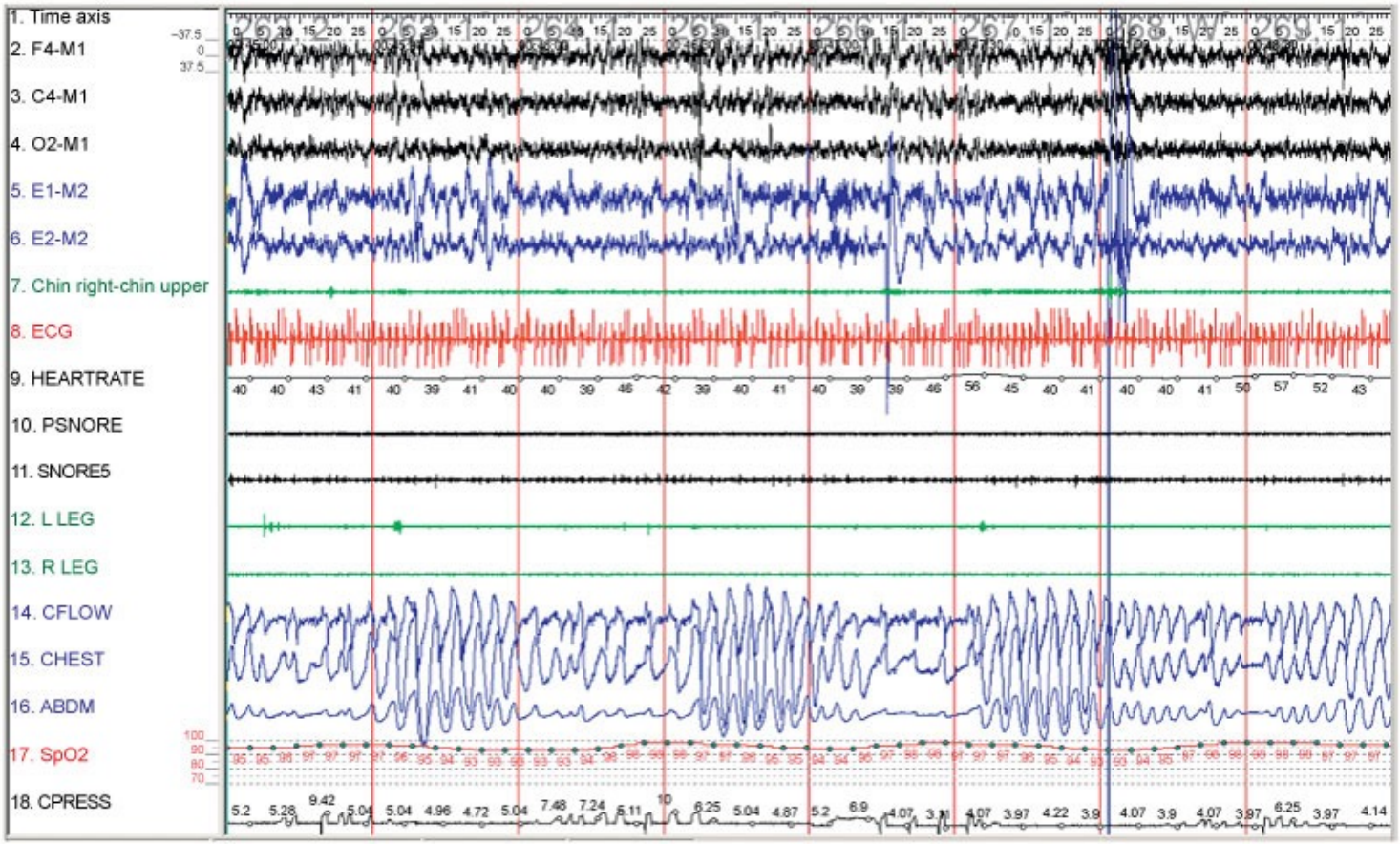
Record Keeping

- Keep track of normal and abnormal vital signs
- Record body positions
- Note any variances from normal recording parameters
- Digital systems time stamp changes to settings and tech notes
- Must do “30-minute” or “hourly” checks on studies

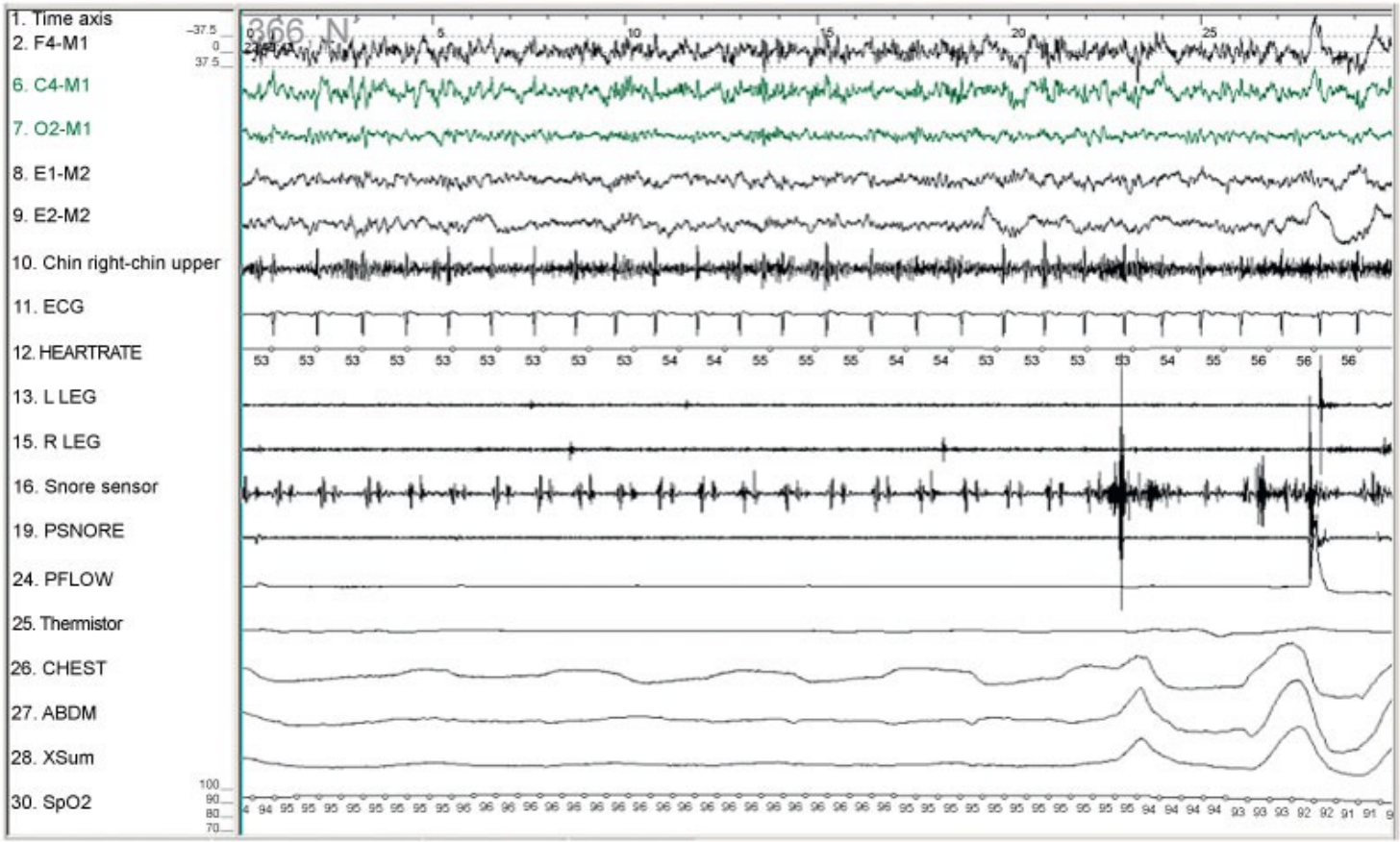
Alpha Intrusion



Atrial Fibrillation Affecting HR



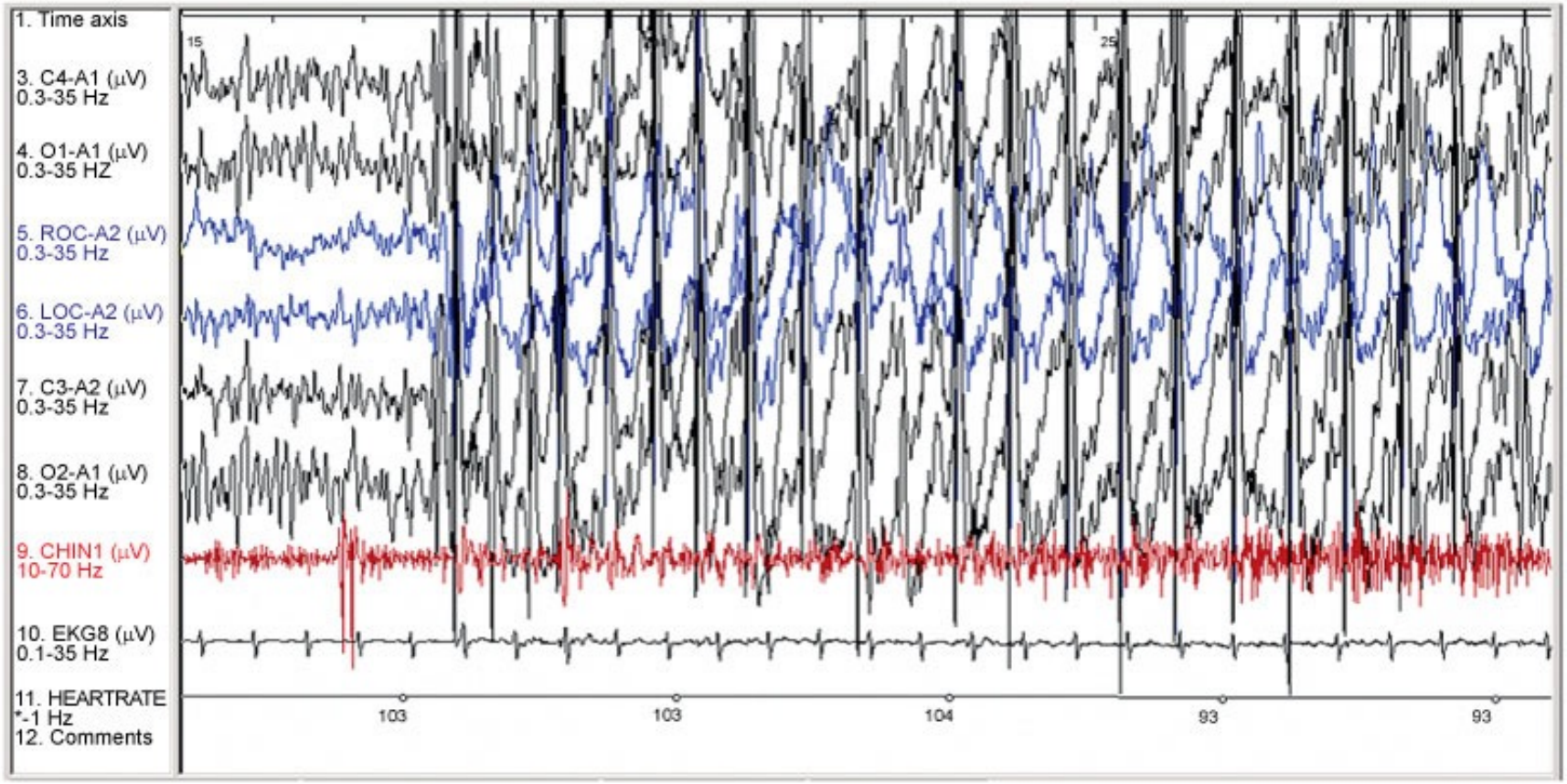
What's Wrong?



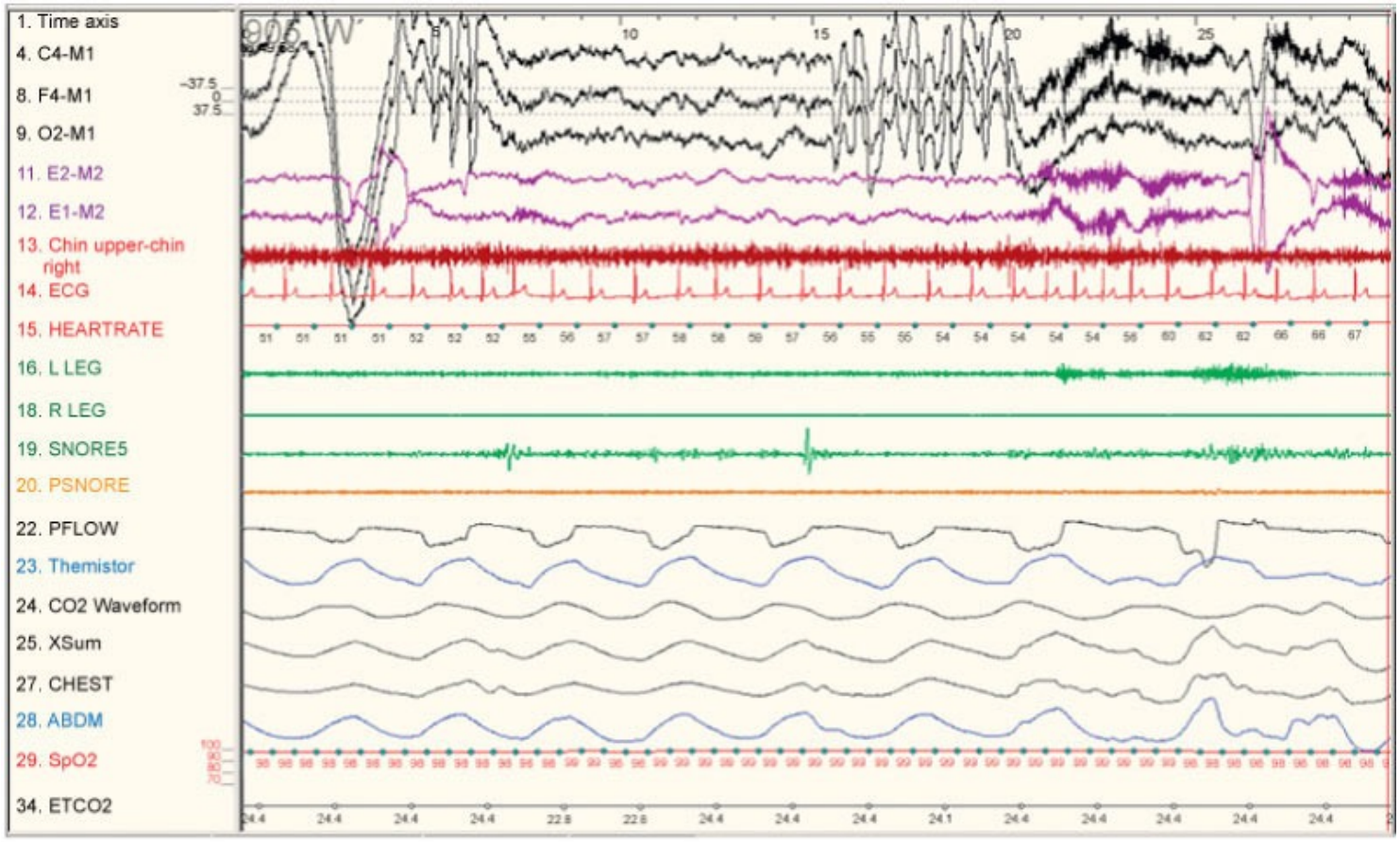
Response to Clinical Events

- Instruct patient to call for tech if they have to get out of bed or need assistance
- Tech must be prepared to respond to unexpected or life-threatening events
- Tech should be trained to recognize and respond to cardiac events, seizures, parasomnias, and respiratory events
- Must have detailed protocols for emergencies, such as fire, weather events, internal/external disasters, and violence

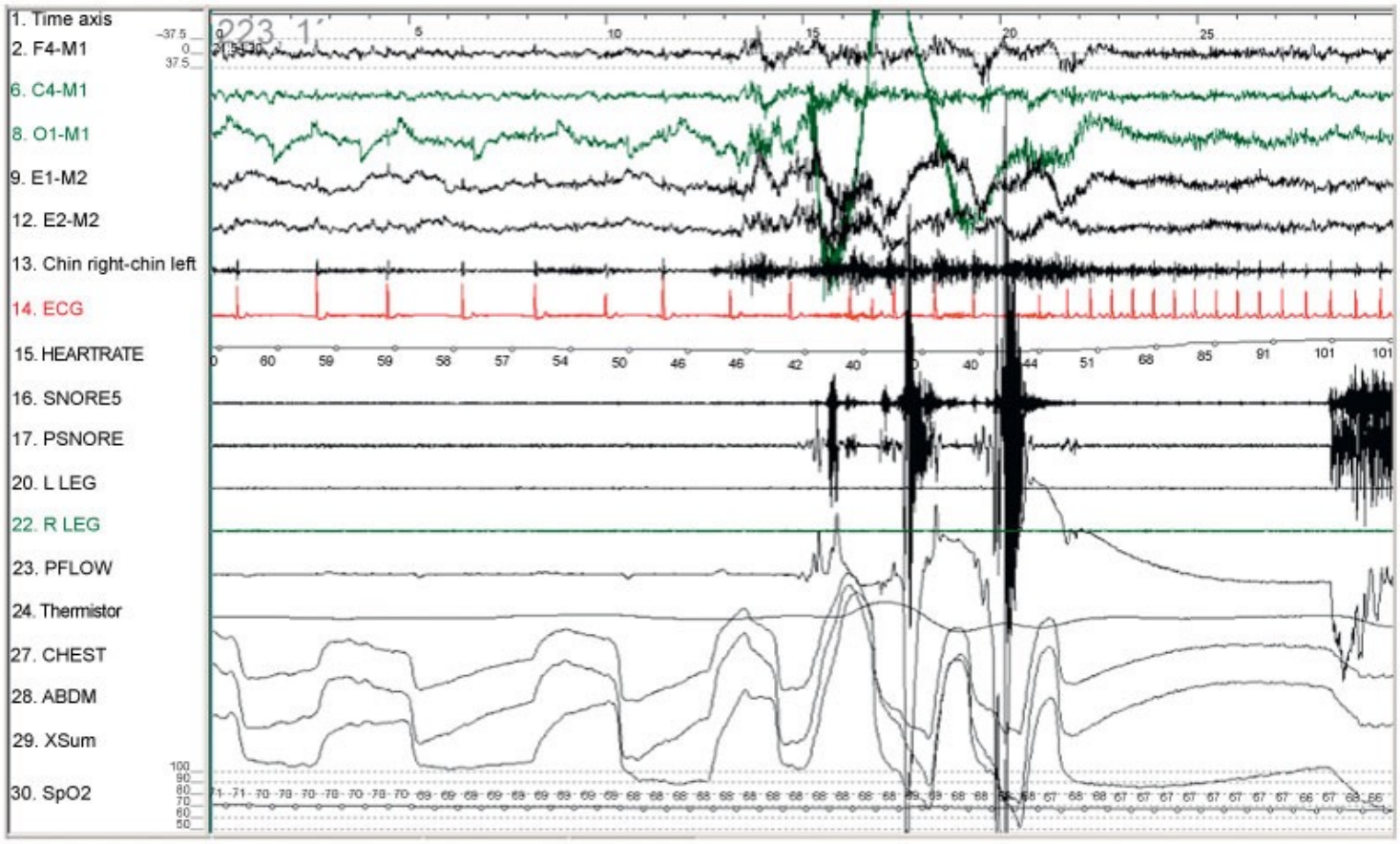
Seizure or Artifact?



EEG: Physiologic Abnormality or Artifact?



Severe Apnea



Conclusion of the Sleep Study

- Completion time depends on numerous factors and tech must determine if study requirements have been met prior to “wake up”
- Perform post-study physiologic, montage, and all-channel calibrations
- Gently and completely remove all electrodes and sensors
- Give the patient and family verbal and written instructions for next steps

Conclusion of the Sleep Study

- Answer patient questions or if unable to answer, give timeline for physician reply
- Make sure patient has collected all their belongings and discharge patient
- Some labs have post-study questionnaires to be completed and tech has to create a summary report of the study

Scoring

- Term for epoch-by-epoch examination and classification of sleep data
- All techs should know how to score, whether required by job or not, and participate in an interscorer reliability program
- Study tracking methodology should be used to monitor sleep study status
- Study should be scored and ready for physician interpretation within 24 hours of end of study

Data Tabulation and Report Elements

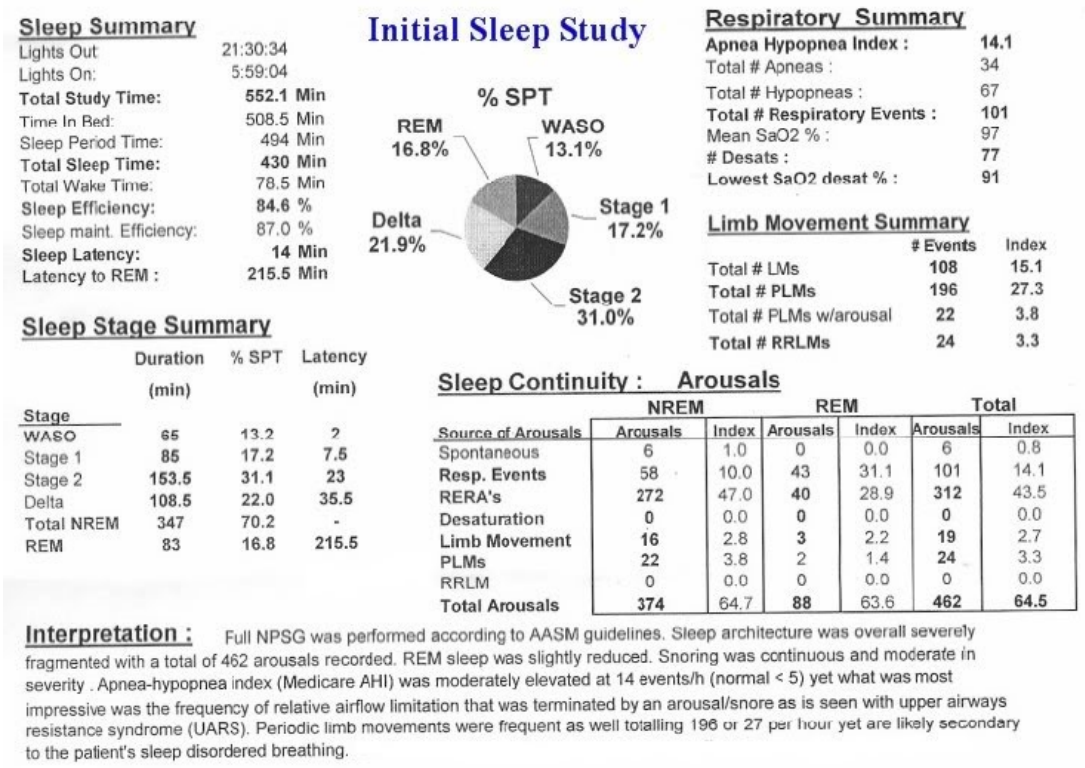
- Report must be accurate
- Sleep architecture components to be confirmed:
  - Lights out
  - Lights on
  - TST
  - Sleep onset latency
  - Sleep period
  - REM sleep onset latency
  - WASO
  - Each stage by total minutes and % of TST
  - Sleep efficiency

Data Tabulation and Report Elements

- Report components for respiratory events:
  - AHI
  - Body position
  - Indices for NREM, REM, and Wake
  - RDI
  - Recording time with SpO2 < 90%
  - Recording time with SpO2 < 88%
- Other report components:
  - Limb movements
  - Body movements
  - Seizure activity
  - Parasomnia activity
  - ECG abnormalities

Data Tabulation and Report Elements

- Report should include patient medication dosage and frequency data
  - Note whether the patient took the medications the day of study, immediately prior to “lights out” or upon awakening from the study
  - Urine drug screen may be indicated for MSLT and MWT



Initial Sleep Study

Sleep Summary

Lights Out	21:30:34
Lights On:	5:59:04
Total Study Time:	**552.1 Min**
Time In Bed:	508.5 Min
Sleep Period Time:	494 Min
Total Sleep Time:	**430 Min**
Total Wake Time:	78.5 Min
Sleep Efficiency:	**84.6 %**
Sleep maint. Efficiency:	87.0 %
Sleep Latency:	**14 Min**
Latency to REM :	215.5 Min

% SPT

Respiratory Summary

Apnea Hypopnea Index :	**14.1**
Total # Apneas :	34
Total # Hypopneas :	67
Total # Respiratory Events :	**101**
Mean SaO2 % :	97
# Desats :	**77**
Lowest SaO2 desat % :	91

Limb Movement Summary

	# Events	Index
Total # LMs	108	15.1
Total # PLMs	196	27.3
Total # PLMs w/arousal	22	3.8
Total # RRLMs	24	3.3

Sleep Stage Summary

Stage	Duration (min)	% SPT	Latency (min)
WASO	65	13.2	2
Stage 1	85	17.2	7.5
Stage 2	153.5	31.1	23
Delta	108.5	22.0	35.5
Total NREM	347	70.2	-
REM	83	16.8	215.5

Sleep Continuity : Arousals

	NREM		REM		Total	
Source of Arousals	Arousals	Index	Arousals	Index	Arousals	Index
Spontaneous	6	1.0	0	0.0	6	0.8
Resp. Events	58	10.0	43	31.1	101	14.1
RERA's	272	47.0	40	28.9	312	43.5
Desaturation	0	0.0	0	0.0	0	0.0
Limb Movement	16	2.8	3	2.2	19	2.7
PLMs	22	3.8	2	1.4	24	3.3
RRLM	0	0.0	0	0.0	0	0.0
Total Arousals	374	64.7	88	63.6	462	64.5

Interpretation : Full NPSG was performed according to AASM guidelines. Sleep architecture was overall severely fragmented with a total of 462 arousals recorded. REM sleep was slightly reduced. Snoring was continuous and moderate in severity . Apnea-hypopnea index (Medicare AHI) was moderately elevated at 14 events/h (normal < 5) yet what was most impressive was the frequency of relative airflow limitation that was terminated by an arousal/snore as is seen with upper airways resistance syndrome (UARS). Periodic limb movements were frequent as well totalling 196 or 27 per hour yet are likely secondary to the patient's sleep disordered breathing.

Interpretation

- Should be timely and diagnostically significant
  - Helps to build rapport with referring physicians and patients
- Interpreting physician must be board registered or board eligible in sleep medicine
- Data should be reviewed epoch by epoch for accuracy
- Diagnosis and diagnostic ICD code should be clearly outlined on the report
- Recommendations should outline course of treatment

Patient Follow-Up

- Patient should be tracked from initial referral to follow-up
  - Can be done through EHR systems
    - These systems can also help with the billing component
    - EHR systems allow immediate access on need-to-know basis for all members of the health care team to patient info

Interscorer Reliability

- Must be used as a measurement of scoring correlation between each tech
- One of the sleep lab's quality improvement markers
- Scorers are compared to a "gold standard" scorer
  - Can be sleep lab physician or through an outside service like the AASM's Interscorer Reliability Program

Therapy Compliance Monitoring

- Important quality measurement
- Cloud-based technology now helps with PAP therapy adherence
- Helps labs to work with patients to adjust to therapy and address therapy barriers in timely manner
- Over time, patients need new PAP supplies, and DME companies can help with this