Astronaut Telemetry Evaluation Form

Space Command Medical Team Report

Name(s)_____ Date _____

Overall Evaluation: Medical telemetry for **astronaut Jordan** indicates (circle one):

wakefulness NREM sleep REM sleep data inconclusive

1. Which data were useful in making your determination, and, specifically, how were they helpful?

2. Which data were *not* helpful in making your determination, and why were they not helpful?

Overall Evaluation: Medical telemetry for **astronaut Rodriguez** indicates (circle one):

wakefulness NREM sleep REM sleep data inconclusive

1. Which data were useful in making your determination, and specifically, how were they helpful?

2. Which data were *not* helpful in making your determination, and why were they not helpful?

Overall Evaluation: Medical telemetry for **astronaut Chen** indicates (circle one):

wakefulness NREM sleep REM sleep data inconclusive

1. Which data were useful in making your determination, and specifically, how were they helpful?

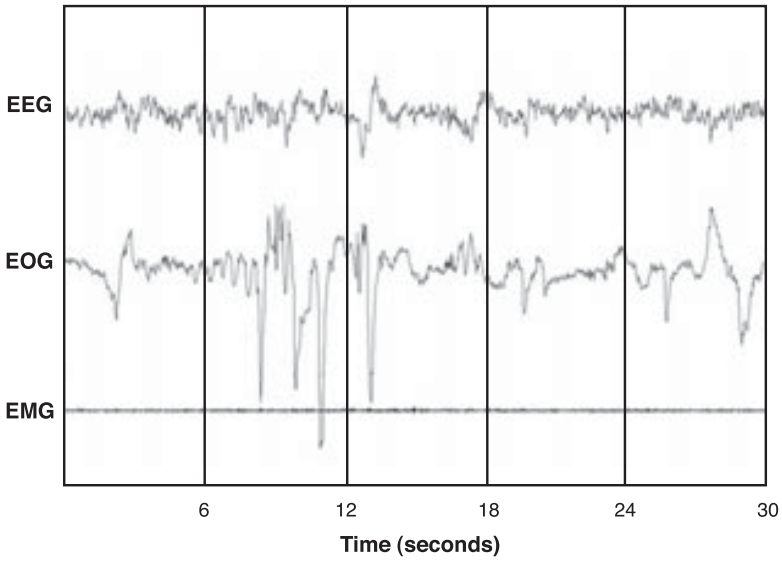
2. Which data were *not* helpful in making your determination, and why were they not helpful?

Astronaut Scenario

The scene is mission control at Space Command Central. Video and audio communications with our three astronauts in space have suddenly been lost. Communications have been out for some time, and repeated attempts by mission control technicians to fix the problem have been unsuccessful. Space Command Central would like to know if the astronauts are aware of the problem and if they are trying to fix it from their end. Unfortunately, it is supposed to be nighttime for the astronauts, and they may be asleep. What, if anything, is going on in space?

Space Command Central decides to assemble their medical team. Even though audio and video communications are out, medical telemetry (that is, data on the status of key body systems) is still being received. The engineers at Space Command Central need help interpreting all of the medical data they are receiving. Your expertise is needed to determine the state of wakefulness or sleep for each of the astronauts. If the astronauts are asleep, are they in NREM or REM sleep?

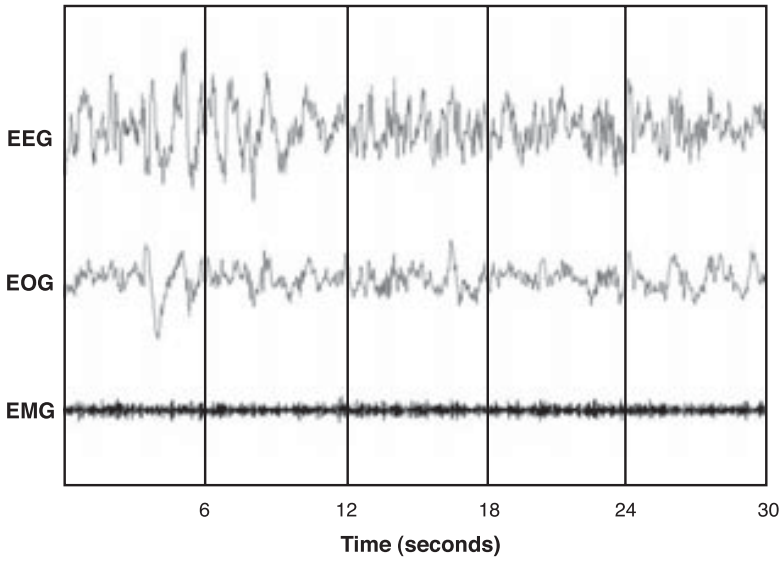
Astronaut Jordan



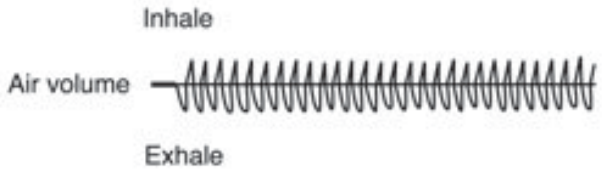
Respiration:

Body Temperature:	97.0°F 36.1°C
Heart Rate:	90 bpm
Blood Pressure:	125/85 mm Hg

Astronaut Rodriquez

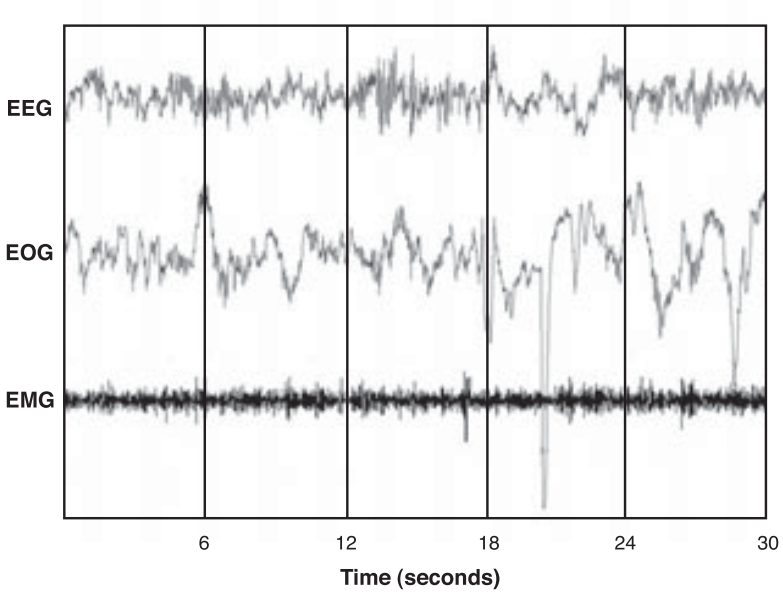


Respiration:

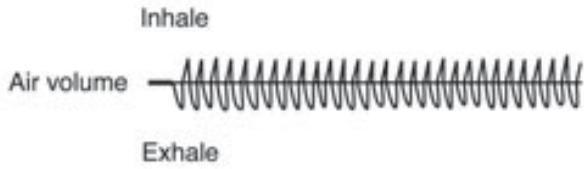


Body Temperature:	98.6°F 37.0°C
Heart Rate:	65 bpm
Blood Pressure:	115/73 mm Hg

Astronaut Chen



Respiration:



Body Temperature:	99.0°F 37.2°C
Heart Rate:	70 bpm
Blood Pressure:	110/75 mm Hg

Sleep Medicine Reference Manual

SLEEP MEDICINE REFERENCE MANUAL

Contents

Electroencephalography

Sleep is not a passive event. It is an active process involving characteristic physiological changes in the organs of the body. Scientists study sleep by measuring the electrical changes in the brain using a technique called electroencephalography (EEG). Normally, electrodes are placed on the scalp; these are usually fairly numerous and placed in a symmetrical pattern, as seen in the figure.

They measure very small voltages that are thought to be caused by synchronized activity in very large numbers of synapses (nerve connections) in the cerebral cortex. EEG data are represented by curves, which are classified according to "rhythm." The wavy lines of the EEG are what most people know as "brain waves."

Electromyography

Scientists measure the electrical activity associated with active muscles, using electromyography (EMG). This is accomplished by placing electrodes on the skin overlying a muscle. In humans, an EMG is generally recorded by placing electrodes under the chin, since muscles in this area demonstrate very dramatic changes during the various stages of sleep. Electrodes may also be placed on the lower leg.

Electrooculography

If an electrode is placed on the skin near the eye, changes in voltage are measurable as the eye rotates in its socket. This produces an electrooculogram (EOG).

Sleep Stages

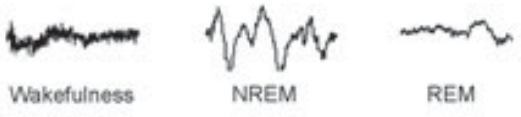
Sleep is a highly organized sequence of events that follow a regular cycle each night. For instance, the EEG, EMG, and EOG patterns change in predictable ways several times during a single sleep period. Study of these events has lead to the identification of two basic stages, or states, of sleep: non–rapid eye movement (NREM) sleep and rapid eye movement (REM) sleep. Physiologic characteristics, such as body temperature, blood pressure, heart rate, respiration, and hormone release, are also different during wakefulness, NREM sleep, and REM sleep.

NREM sleep, also known as slow wave (SW) sleep, is subdivided into four stages according to the amplitude and frequency of brain wave activity, eye movements, and voluntary muscle activity that typify each substage. Generally, these four stages differ primarily in their EEG patterns, while the general physiology of these stages is fairly similar. Therefore, in this manual, emphasis will be on NREM sleep in general, and not on its individual substages.

Sleep Stages, continued

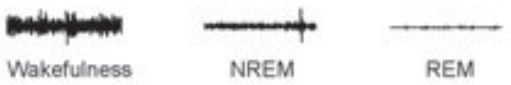
Sleep is a cyclical process. During sleep, people experience repeated cycles of NREM and REM sleep, beginning with an NREM phase. This cycle lasts approximately 90 to 110 minutes and is repeated three to six times per night. As the night progresses, however, the amount of NREM sleep decreases and the amount of REM sleep increases. The term ultradian rhythm (that is, rhythm occurring with a periodicity of less than 24 hours) is used to describe this cycling through sleep stages.

EEG



Wakefulness and REM-stage sleep are both characterized by low-amplitude, random, fast wave patterns. In contrast, NREM-stage sleep is characterized by high-amplitude, slow waves.

EMG



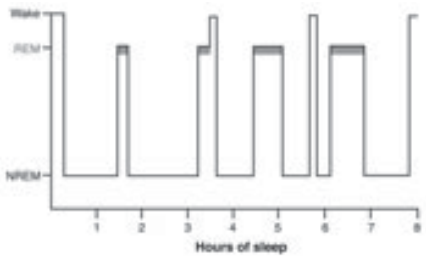
During wakefulness, the EMG may vary between moderate and high, depending on the activities in which the individual is engaged. EMGs in NREM-stage sleep are moderate to low. In REM-stage sleep, voluntary muscle activity is inhibited and the EMG is virtually absent.

EOG

During wakefulness, rapid eye movements may be very frequent or scarce, depending on the extent to which vision is being used. Eye movement is absent during NREM, although some brain activity may be picked up by the testing equipment and be recorded incorrectly as eye activity. During REM-stage sleep, there are bursts of rapid eye movements, in between which there are periods of no eye movements.

Hypnograms

Hypnograms were developed to summarize the voluminous chart recordings (EEG, EMG, and EOG) that are made when recording electrical activities occurring during a night's sleep. As a simple graphic, they provide a simple way to evaluate data that would originally have been collected on many feet of chart paper or stored as a large digital file on a computer. This hypnogram summarizes how a typical night's sleep for a young, healthy adult is organized into stages.



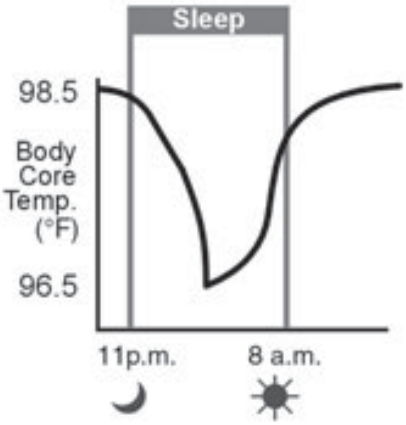
Heart Rate

During wakefulness, heart rate (in beats per minute, or bpm) can vary considerably depending on the level of activity in which the individual is engaged. During NREM-stage sleep, the heart rate exhibits less variability and may be slightly lower than what is observed during resting or less active wakefulness. Heart rate during REM-stage sleep exhibits pronounced changes and may rise to levels seen during moderate to strenuous exercise.

Body Temperature

Body temperature is relatively constant during wakefulness. However, it is maintained at a lower set point during NREM-stage sleep, thus resulting in a lower body temperature during NREM as compared with wakefulness. Body temperature is not regulated during REM-stage sleep, and it will drift toward the environmental temperature.

There also is a biological clock–related component to body temperature. This means that the body temperature will vary in a regular way with the time of day. For instance, body temperatures will be higher at midafternoon and reach their low point in the early morning hours before awakening, as seen below.



Blood Pressure

During wakefulness, blood pressure can vary considerably, for instance, with activity and stress levels. Blood pressure tends to decrease slightly during NREM-stage sleep and exhibits less variability. During REM-stage sleep, blood pressure is highly variable and may occasionally increase up to 30 percent over the resting level. During REM sleep, the diameter of blood vessels decreases (that is, they undergo vasoconstriction), which may be the cause of the rise in blood pressure.

Respiration

During wakefulness, respiration may vary with activity, stress, and emotional levels. During NREM-stage sleep, breathing slows, and the inhalation and exhalation of air decrease in magnitude compared with those of wakefulness. Breathing during NREM sleep is generally very regular. In REM-stage sleep, breathing can be very irregular.