出國報告（出國類別：進修）

# 美國高年身心醫學進修

**服務機關：衛生福利部嘉南療養院**
**姓名職稱：蕭暉獻醫師**
**派赴國家：美國國家衛生研究院**
**出國期間：一百零六年十月一日至一百零六年十二月二十八日**
**報告日期：一百零七年三月**

**摘 要**

人口老化在已開發國家已是十分重要的課題，它造成的老年問題之影響是多層面的，從個人生理疾病、心理障礙、精神疾病、到造成家庭困擾及龐大社會負擔等。以美國為例，在 1984 年即已有 11%老人人口（大於 65 歲），他們花掉了全國 1/4 的藥費（只有 5%以下的老人沒有服任何藥物），估計到了 2030 年，老人人口將達 17%。研究顯示住院老人中，78%至少有四種重要疾病。以有名的阿滋海默病來看，65 歲以上的老人有 5~7%罹病，80 歲以上有 20%，光是老年痴呆病人就占據了半數安養院的床位。即使較不嚴重的精神疾病在老人中也很普遍，如焦慮、憂鬱、睡眠疾病等，一項研究顯示在 50 歲以上的人約 40%有失眠問題。

台灣西化的現象十分明顯，美國發生的問題許多都會在台灣陸續發生，我們的人口老化之速度同樣十分快速，老年問題也日益明顯，報章雜誌常報導老人失智失蹤、無依受虐、多重疾病、喪偶自殺等醫療家庭社會問題。之前一項台中市社區的研究便發現每五位老年人就有一位有憂鬱症的症狀，可見老年精神疾病是多麼普遍而值得重視並應及早因應。

而在老年精神醫學領域，由於台灣邁入老年社會是目前現在進行式，也有多個學術單位及協會在這個項目耕耘，諸如台灣老年精神醫學會、臨床失智症學會及多個民間協會等等，但諸多力量尚未有效整合，而彼此著重的重點也不盡相同，但是漸漸也有個脈絡出來，比如期待家醫科或社區診所能夠深入鄰里，將醫院外的潛在個案篩檢出來，在疾病的初始則可以預防或介入，在醫療的方面，更是往整合且跨團隊的模式邁進，例如神經科及精神科和相關內外科的協助，期待提供民眾更優質的醫療。即便如此，但整體醫療的進步追根究柢還是源自於基礎研究的生根，任何源頭的理論突破或者現實上的新發現才能在之後的進展中慢慢轉變為第一線臨床實做上的突破，而此次前往美國國家研究院的將近三個月過程中，有幸參予在華盛頓舉辦的 2017 society for neuroscience 大型國際研討會，會議中除了有基礎研究比如阿茲海默症致病機轉中B-amyloid 及 tau protein在細胞層次的深度探討，在廣度上也邀請了 alphago 創辦元老 deepmind 團隊的 Demis Hassabis 來演講。試著從 AI 人工智慧的進展如何架橋延伸到神經生物醫學的領域來協助人類在醫療上的突破，而在 NIAAA 實驗室的所見所聞則是聚焦在腦影像科技如 MRI/PET 在精神醫學的應用及神經心理測驗軟體在做研究上的協助以及完整的研究設計與進行流程，在NIAAA除了使用腦影像在學術上著墨的學者，亦有不少博士後的專家則是聚焦在穿戴型裝置在研究發表中的使用，例如穿戴式的睡眠多功能儀器及其他紀錄生理數據類似手表之穿戴型裝置。

**目次：**

**目的：**

參訪及進修美國國家衛生研究院神經影像研究室，學習老年及物質成癮患者的腦影像及身心健康之研究。

**過程：**

進修機構簡介：

一、 美國國家衛生研究院

國立衛生研究院（英語：National Institutes of Health，縮寫為 NIH），隸屬於美國衛生及人類服務部，是美國聯邦政府中首要的生物醫學研究機構。

2006 年的資料顯示，此機構花費美國全國 28%的年度生物醫學研究經費，約 280 億美元，其中多數來自產業界的支援。NIH 主要可分兩大部分，一部分負責支援研究院之外的生物醫學研究，另一部分則負責直接由研究院指導的內部研究，大多是在位於馬里蘭州貝塞斯達的部門進行。美國衛研院位於馬里蘭州畢思達市(Bethesda)，四十棟建築座落在三百二十英畝綠茵裡，擁有一萬三千位研究人員，其中三千五百位具博士學位，是美國支援並進行生物醫學研究最大的機構，每年經費約佔美國生物醫學研究發展總支出的 40%。

「揭開生物醫學知識的奧祕，以科學態度，探研致病因子，明瞭維繫人類健康的基本過程，發展預防、檢驗與治療疾病的最佳方法，厚惠美國人民健康」是美國衛生研究院的使命。

這個美國科學家引以為傲的「研究寶庫」，隸屬於美國聯邦政府衛生教育福利部的公共衛生服務司，其主要職責有四：(一)在院內進行精深研究；(二)評審並財務支援美國聯邦政府外的生物醫學研究機構；(三)培訓有發展潛力的研究新血及(四)促進生物醫學資訊之便捷交換。

美國國立衛生研究院由 27 個不同的生物醫學學科和研究中心組成，負責許多科學成就，包括發現防止蛀牙的氟化物，使用鋰來治療雙相情感障礙，以及創建針對肝炎，流感嗜血桿菌（HIB）和人乳頭瘤病毒（HPV）的疫苗。

圖一 位於馬里蘭州貝塞斯達之美國國立衛生研究院 (NIH)

進修單位簡介：

美國「國家防治酒精濫用與酒精中毒研究所」為隸屬於美國國家衛生研究院之下的二十七個研究機構之一。該研究所的主要進行關於酒癮和酒精關聯疾患的成因、後果、治療及預防的相關研究。美國「國家防治酒精濫用與酒精中毒研究所」同時也贊助及執行許多院外單位專注於酒精對於人類健康影響的許多研究計畫。

透過在 NIAAA 內部執行的研究計劃，及全球各地的研究計劃贊助，NIAAA 致力於關於酒精為何造成人體成癮以及關於使用酒精對於健康的益處及風險，同時揭露生物學及社交文化等因素來解釋為何人們對於酒精的反應存在不同的差異，再來是移除社會大眾對酒癮的標籤，並努力發展預防及治療的策略來處理過度使用酒精的問題。

## NIAAA3 個月過程心得

第一 雖然 NIH 是美國國家政府單位，理論上開放美國公民可以進入參訪，但對於外籍人士則有一定程度上的要求，若是抵美入境是持觀光簽證則是被拒絕參訪，至少是需 VWB 或者是 B1/B2 簽證，才可進入 NIH。

再者，NIH 門禁森嚴，若是一般訪客持 VWB/B1/B2 簽證每天進入 NIH，都需經過訪客中心的安檢閘口才可進入，在訪客中心會有安檢人員要求脫下外套，訪客及其隨身通品排隊依序進入安檢 X 光機器，之後再由內頭工作人員核對護照簽證，再製作識別證才可進入園區參訪。


NIH 訪客中心

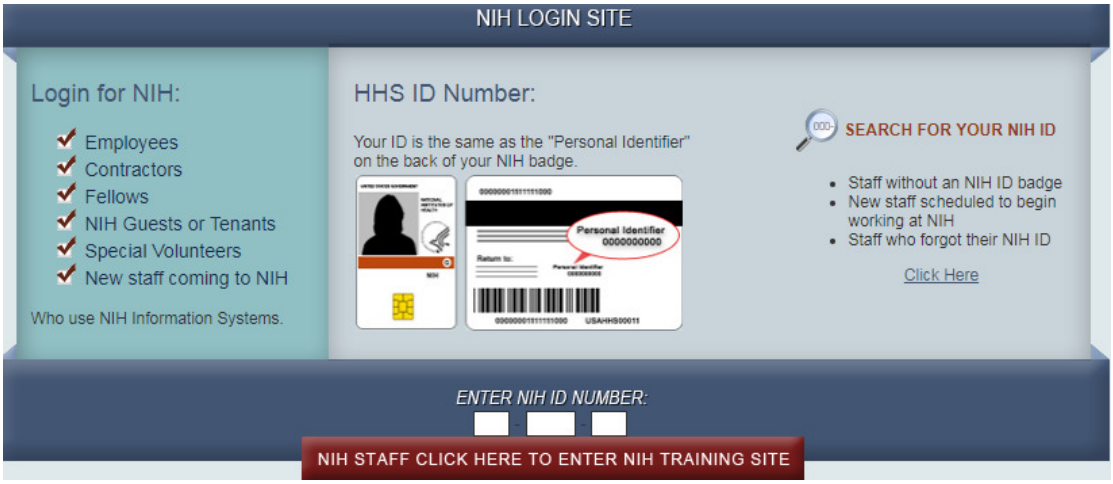
入至 NIH 後，由於幅地廣大，是故院區中會有接駁 shuttle 可至不同大樓。

NIH 此次參訪主要之臨床中心大樓( building 10)

首先一般 NIH 新進員工，倘若要直接進入臨床或研究工作是不可能的，龐大而複雜的職前訓練是必經的過程，依照你所在的單位及之後的業務執行內容會有不同要求的職前訓練及實操會被考核。在取得一連串的認證前，則無法取得員工證，代表你無法進入 NIH 電腦系統，同時一些臨床或研究工作也無法擔任。

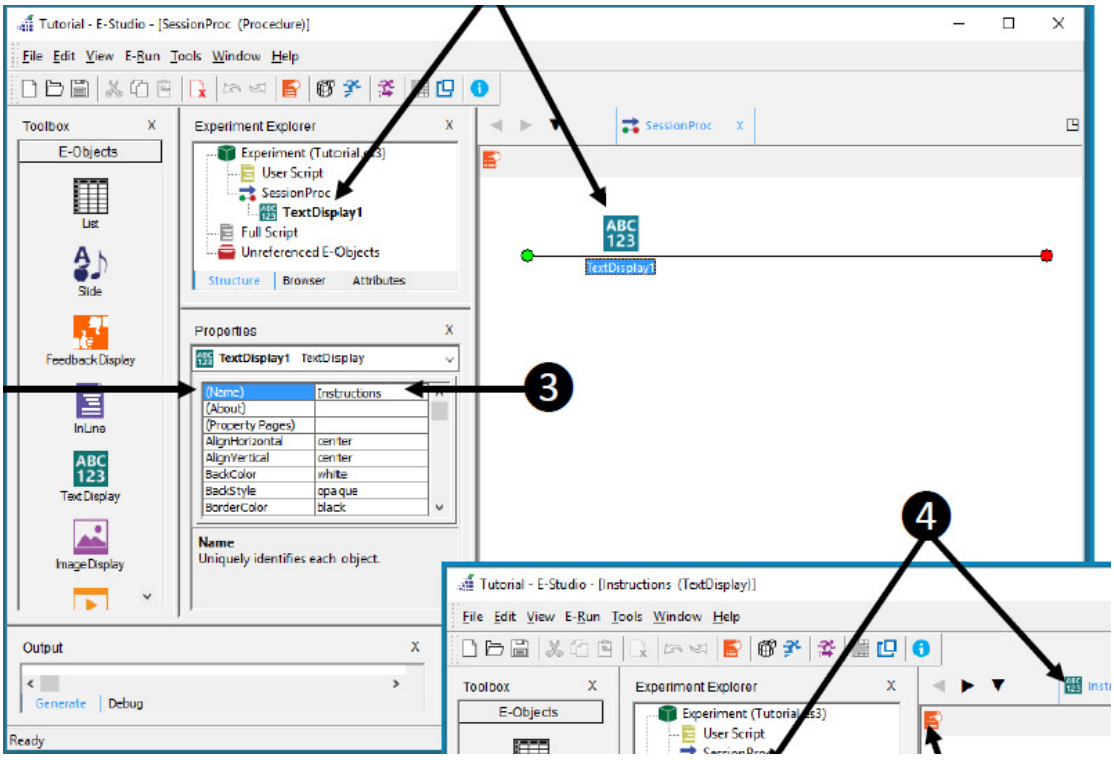
以下如圖示


另外 NIH 內部資安亦做的相當紮實，每一台電腦的使用都需使用帳密及晶片卡插入才可作業。




通過一連串繁瑣的作業，才能取得員工卡片避開每日進入的安檢流程。

在 NIAAA 學習的主要是 e-prime 的神經心理測驗操作軟體。

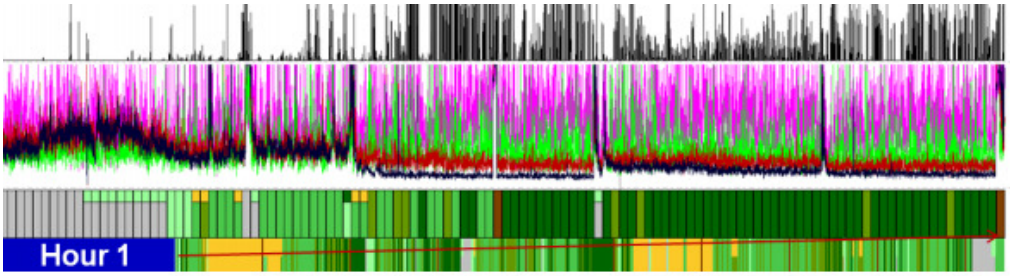



E-prime 是專門執行神經心理測驗的軟體，結合影像的輸出，紀載受試者的反應時間，延遲等情形，再搭配腦功能影像的搭配，成為發表學術研究的強力助手，目前許多熱門的精神領域相關研究都是可以使用 E-prime 操作軟體來給予輔助，比如酒癮患者，對於酒精物質的環境線索較一般民眾更為強烈，而透過 E-prime

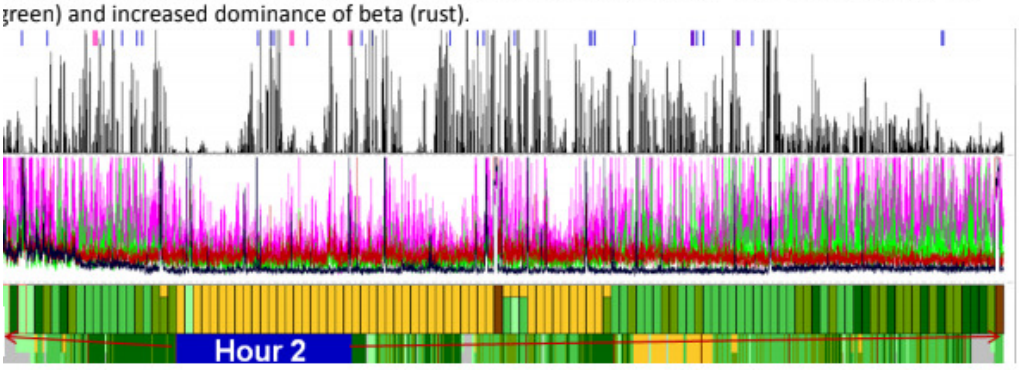
軟體讓酒癮患者接受圖片的訊號刺激，再搭配軟體中提供的相關神經心理測驗，而在這同時軟體亦紀錄個案的多項實驗數據並予以搭配同樣在進行中的同步腦影像檢查比如核磁共振或正子照影，如此完整的資訊收集實驗執行者將得到豐富的資料可做論文的研究進而發表。

在 NIAAA 另一個參訪重點是，攜帶式睡眠檢查儀器的了解，該儀器不用讓受試者在醫院躺一天，身上也較傳統式的 PSG 儀器少了很多綁線，在回家睡覺的同時紀錄多項生理數據，同樣的此利器一樣是發表學術論文的好幫手，比如說在做研究上，可將病房內病患服用安眠鎮靜藥物後的變化，透過頭部穿戴式 PSG 所蒐集之各項生理數據做服用前及服用後的對照，得到的資料將是之後直行研究可以整理分析的素材。

( 請看下圖)




..2 highlights the transition from NREM to REM and then back to NREM. Note the suppression of
green) and increased dominance of beta (rust).




..3 shows that the pattern changes are readily interpretable using a 10-minute screen.

在NIAAA閒暇之餘，當然不可錯過難得的大型國際學術研討會，以下為參加證明，五個整天的研討會，參加者需負擔美金 US830。

NEUROSCIENCE 2017 | WASHINGTON, DC NOVEMBER 11–15 | SfN Society for Neuroscience

**Registration Confirmation:**
Confirmation #: 226929
Hui-Hsien Hsiao
National Institute Health
10 Center Drive, Rm B2L124

**Registration ID #:** 226929

Bethesda, MD 20892

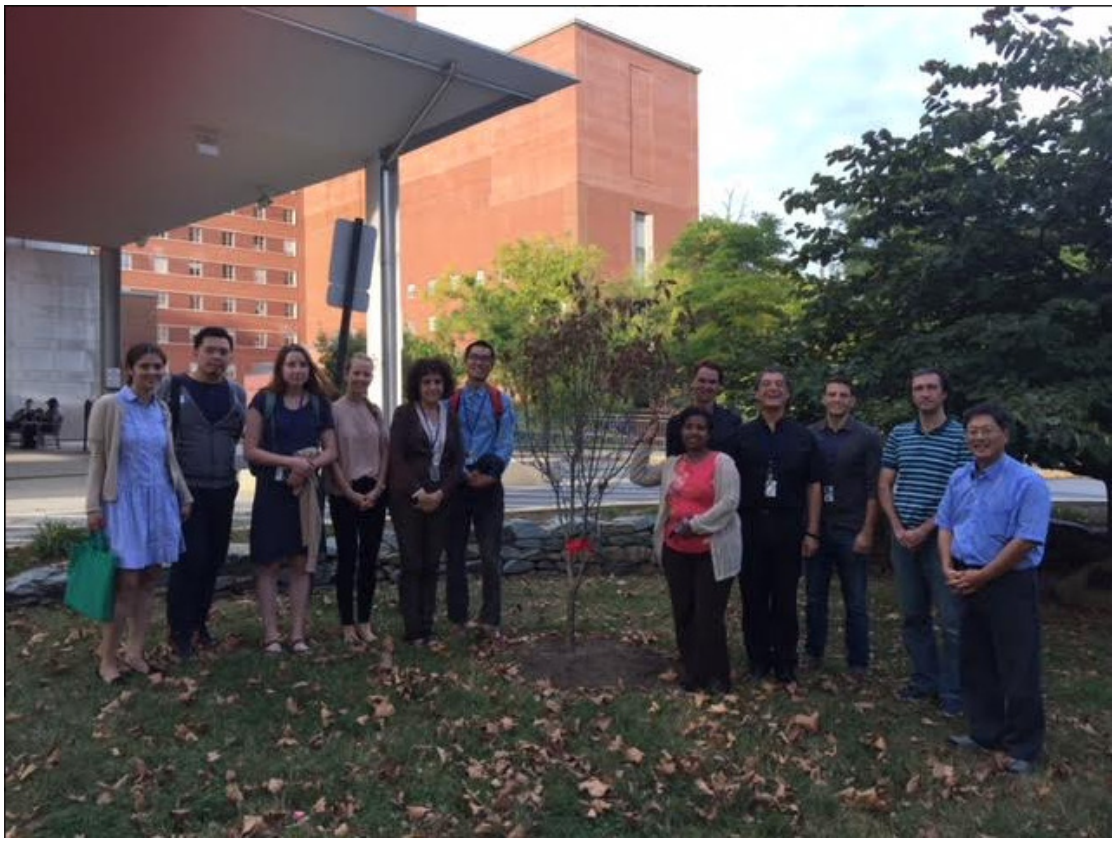
**RECEIPT OF PAYMENT** - Please **PRINT** and **SAVE**

You have successfully registered for Neuroscience 2017 to be held November 11-15 at the Walter E. Washington Convention Center, Washington, DC. You have registered with the following contact information. If any of this information is incorrect, please contact us at (888) 736-6690 or (508) 743-8563.

## 心得及建議

1. 歐美生活水平較高，是故日常花費較多，建議可妥善規劃後再擬定出國行程，在出國前建議先確認參訪機構對於簽證的要求，另外同樣建議需事先了解符合參訪當地的醫療保險契約，避免網路投保之醫療險與當地醫療院所所搭配之保險業者有不符合狀況。
2. 在 NIAAA lab 遇到最菜的同仁，也是美國一流大學的學士後，更遑論 7-8 位以上的博士後，大家戮力研究，而研究所的收入足以匹敵臨床收入，是故所發表論文量大質精。另外一流期刊的論文某方面陷入裝備競賽，論文執行有時需搭配強大完整之實驗室做後盾，這樣才能與其他國家強者並駕齊驅。
3. 在美台灣人逐漸稀少，目前待在 NIH 之台灣人數目相當稀少，取而代之的為對岸學術人士，可見兩岸在經濟發展及學術資源挹注間的此消彼長。
4. 精神醫學領域的論文研究，倘若可以結合完善的神經心理測驗軟體及完整高階的腦影像檢查，將可得到大量豐富的素材做為論文發表基層的分析資料庫。
5. 穿戴式設備做為研究工具的風潮在近幾年正在崛起，倘若無昂貴高階設備亦可考慮簡單方便的穿戴式裝置作為多項生理資料的收集器，同樣可為研究發表幫助良多。

最後感謝實驗室同仁 3 個月的陪伴，讓我開啟人生新的扉頁。



左 2 為本人

附錄：



Sleep Profiler™

# Scoring Manual

## Signal Pattern Definition and Application of Sleep Staging Rules



This manual was created using software features released on May 28, 2015. Studies processed prior to this date may not apply improvements made to the software. To apply new software features to previously acquired data, please contact Advanced Brain Monitoring Client Services to arrange for reprocessing of studies.

**Contact Information:**
Advanced Brain Monitoring, Inc.
2237 Faraday Avenue, Suite 100
Carlsbad, CA, USA 92008
Phone: (760) 720-0099 x6032
Email: SleepProfiler@Advanced-Sleep.com

## Section 1: Auto-Staging Rules

The auto-scoring algorithms are based on deconstruction of the power spectral densities of the EEG activity and assessment of patterns across contiguous epochs. The first two hours of a sleep study are presented below to highlight the changes in alpha, sigma, beta and EMG power. Figure 1.1 shows the transition from sleep onset to stage N3. Note the decrease in EMG power (black) and increase in sigma power (green) as the depth of NREM sleep increases

Figure 1.1

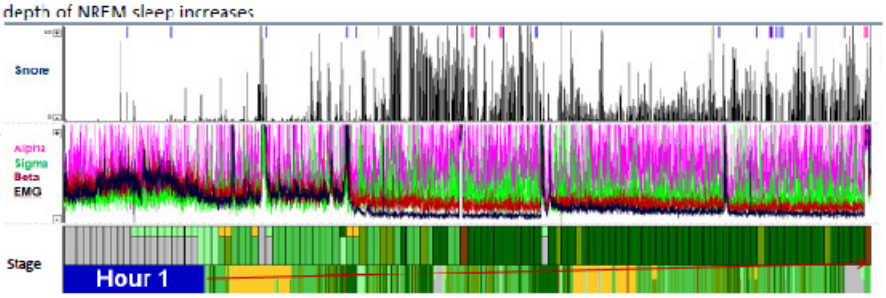



Figure 1.2 highlights the transition from NREM to REM and then back to NREM. Note the suppression of sigma (green) and increased dominance of beta (rust).

Figure 1.2

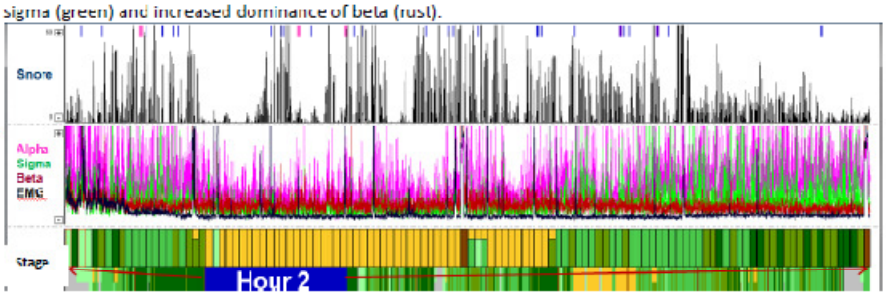
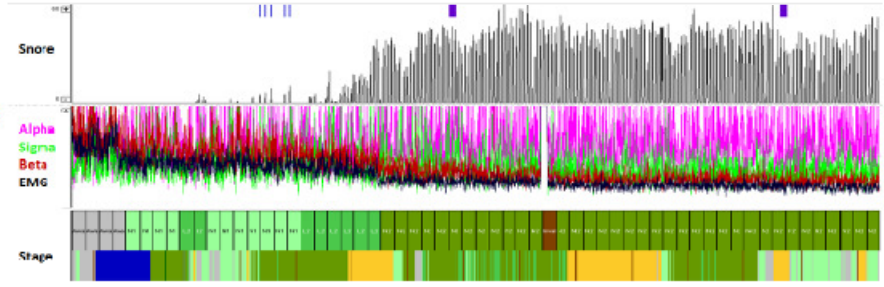


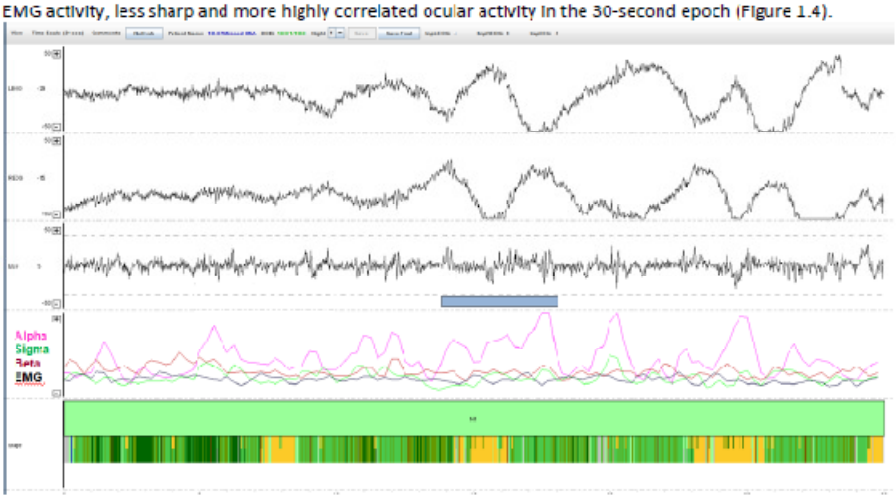

Figure 1.3 shows that the pattern changes are readily interpretable using a 10-minute screen.

Figure 1.3



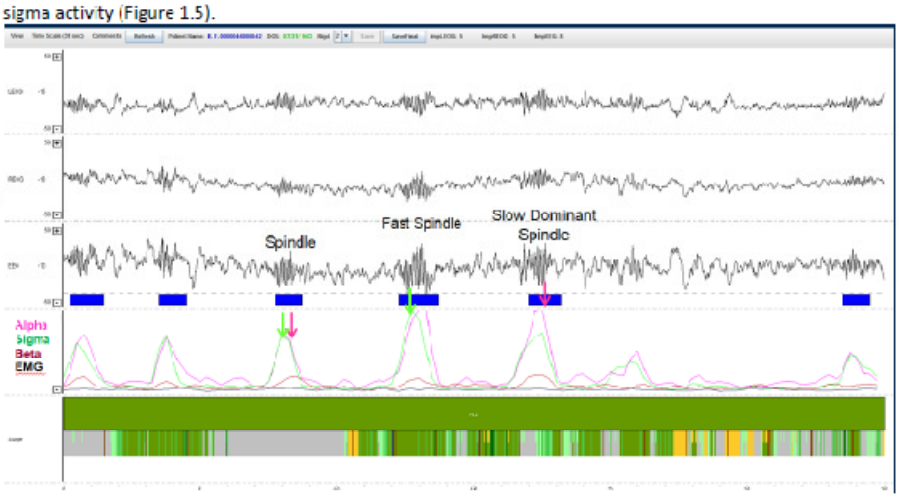
To differentiate N1 from REM, the algorithm expects increased relative alpha activity, potentially increased EMG activity, less sharp and more highly correlated ocular activity in the 30-second epoch (Figure 1.4).

Figure 1.4




Stage N2 is detected when delta power increases relative to alpha and EMG activity, in the absence of ocular activity and/or presence of sleep spindles. Spindle detection requires concurrent bursts of both alpha and sigma activity (Figure 1.5).

Figure 1.5



Stage N2 and N3 are differentiated based on delta activity equivalent to +/- 35 microvolt change, a magnitude equivalent to the 75 uV observed from the central region during conventional PSG. Similar to PSG 20% of the epoch or 6 seconds must include high amplitude delta activity to be called stage N3 (Figure 1.6).

Figure 1.6

Figure 1.7 displays an epoch staged REM and characterized with dense REM based on the amplitude of the negatively correlated LEOG and REOG activity.

Figure 1.7

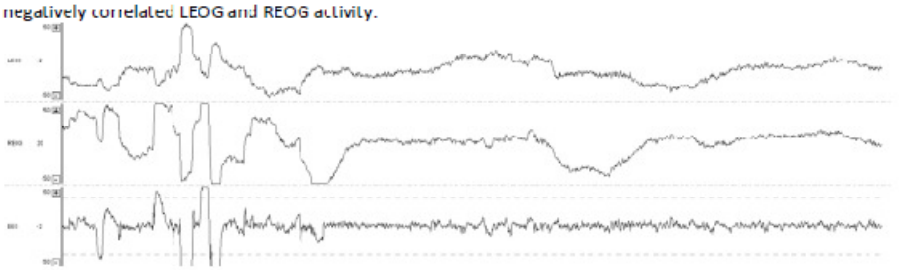
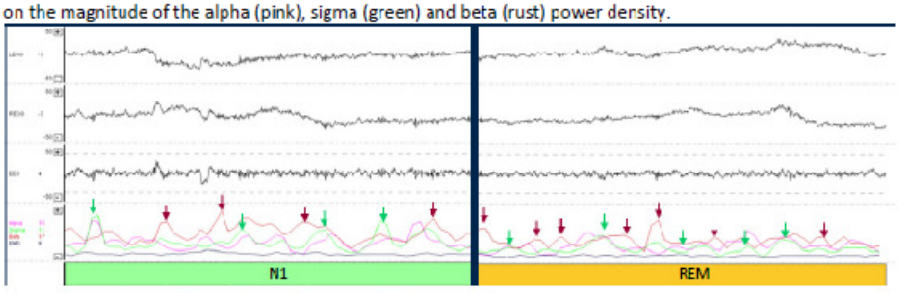


Figure 1.8 presents signal patterns that appear to be similar but are differentially staged N1 and REM based on the magnitude of the alpha (pink), sigma (green) and beta (rust) power density.

Figure 1.8

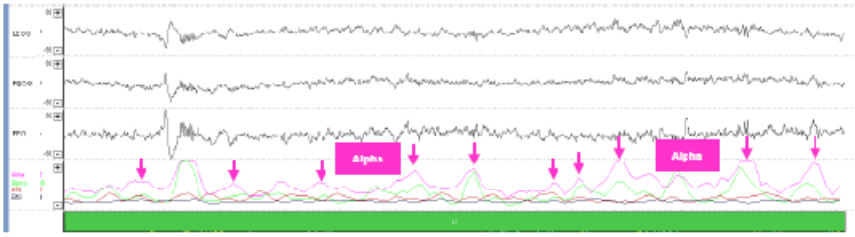


The rules were designed to emulate the American Academy of Sleep Medicine scoring rules with a few exceptions:

1. Four consecutive non-wake epochs are required for sleep onset to occur in the first five-minutes.
2. The first epoch following a wake period in a block of REM epochs will be staged N1.
3. Epochs will be assigned the lighter stage (i.e., REM to N1, N2 to N1, etc.) when a significant arousal (EMG) event occurs, violating the majority of the epoch rule for assigning a stage.
4. Epochs staged as N2 will be marked Light N2 (or L2) based on three rules indicating light or transitions to lighter sleep as shown in Figures 1.9, 1.10 and 1.11.

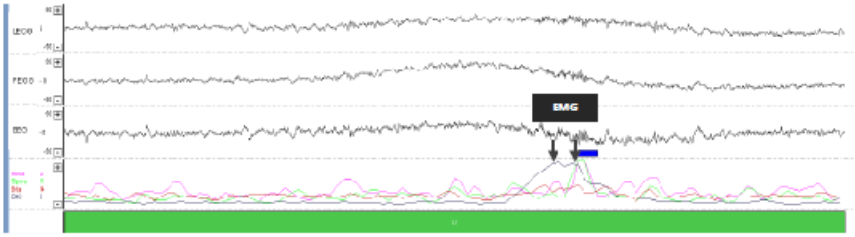
Light N2 rule #1: Elevated alpha activity across entire epoch

Figure 1.9



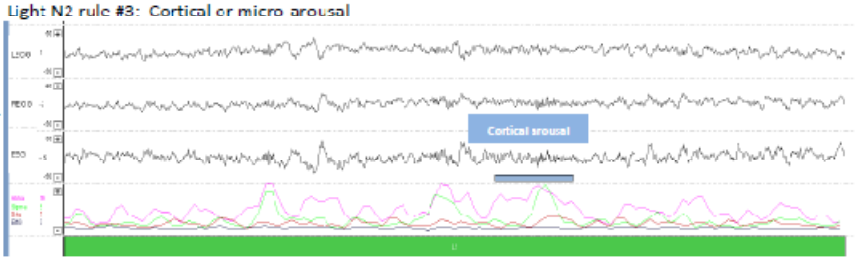

Light N2 rule #2: Elevated baseline EMG or EMG excursion

Figure 1.10




Light N2 rule #3: Cortical or micro arousal

Figure 1.11

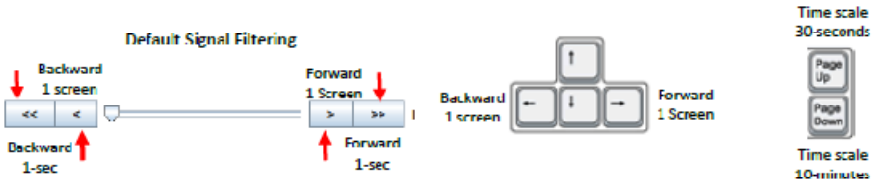


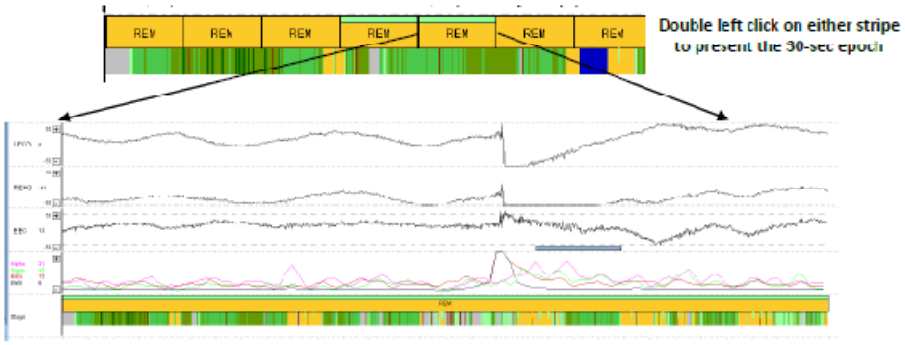

 

# Section 2: Sleep Profiler Presentation and Navigation

## 2.1: Presentation and Navigation

Figure 2 1 1

## 2.2: Arousal Events

| Event | Channel | Color | Description |
|---|---|---|---|
| Autonomic activation | Pulse | Orange stripe | 6 beat per minute increase (decrease) compared to the previous (subsequent) 10th beat |
| Movement arousal | Hmov | Pink stripe | Initiation of movement with stepped ranges from 1 to 5 |
| Spindle | EEG | Dark blue stripe | Short burst of alpha/sigma activity |
| Cortical arousal | | Light Blue stripe | 3-second sustained increase in alpha activity |
| Microarousal-other | | | 3-second sustained increase in EMG activity |

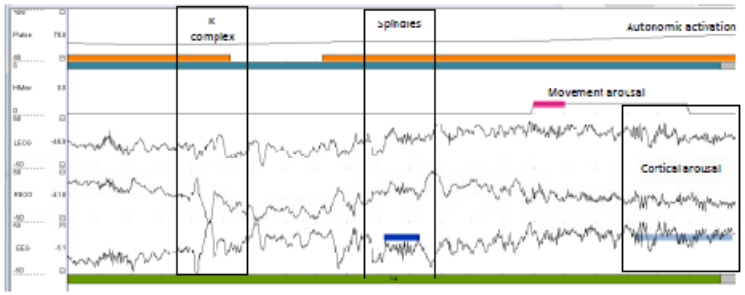



Figure 2.2.1

## 2.3: Artifact

Sleep Profiler signals identified with artifact are marked in red. When artifact is detected in more than 15 seconds of the differential signal, sleep staging is alternatively applied to LEOG, and if LEOG is contaminated then sleep staging is applied to REOG. If the signal is marked red across all three channels it is staged invalid. Impedance testing, which occurs every 30 minutes, has a unique pattern that is also marked as red. If the impedance test covers more than 15-seconds of an epoch, it is staged as invalid.

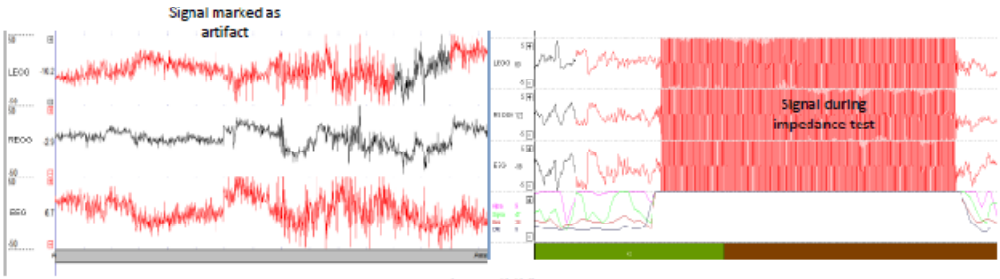


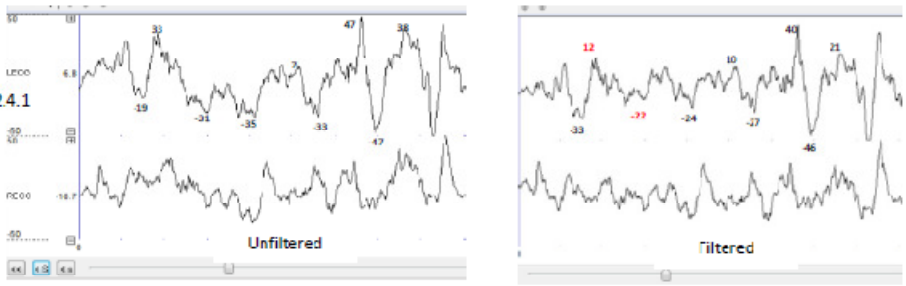

Figure 2.3.1

## 2.4: Filtering

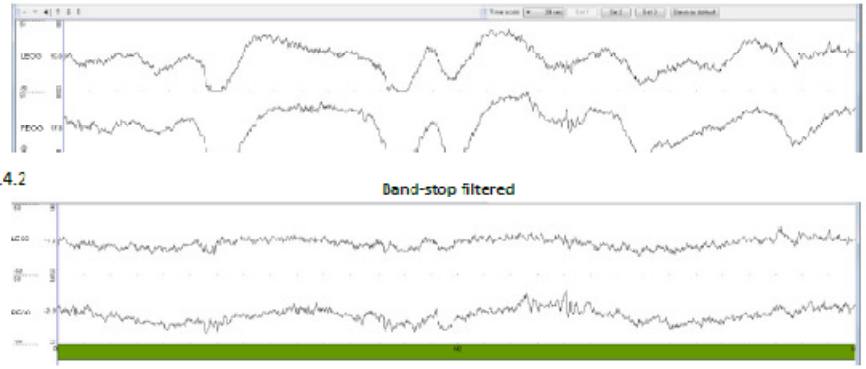
A narrow band-stop filter (0.1 to 0.6 Hz) is automatically applied to the presented signal during stages N2 and N3 to remove respiration/sweat artifact that can create confusion with visual interpretation. A side effect of the band-stop filter that is effective in eliminating slow artifacts is that it also attenuates the amplitude of delta waves during slow wave sleep. The example below shows the impact of the band-pass filter on unfiltered and filtered signals.

Figure 2.4.1




The signal(s) can be presented with or without the bandstop filter visual interpretation using the following controls.

Figure 2.4.2




Several options are provided to navigate forward or backward in the record with the signal presented, with or without filtering.

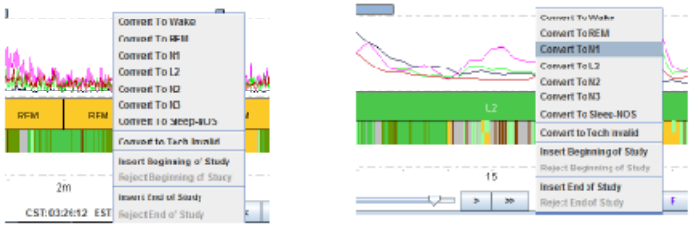
## 2.5: Editing Sleep Stages

The stage assigned to an epoch can be edited in one of three ways.

1. Use the key pad to assign an alternative stage and move forward to the next epoch.

| Stage | Number |
|---|---|
| Wake | 0 |
| Stage N1 | 1 |
| Stage N2 | 2 |
| Stage N3 | 3 |
| Light N2 | 4 |
| REM | 5 |
| Sleep NOS | 6 |
| Invalid | 9 |

2. Right click on the stage and use the dialog box to assign a new stage.




3. Left click and drag across multiple epochs, release and use the dialog box to assign the same stage to all included epochs.

## Section 3: Guidelines for Editing

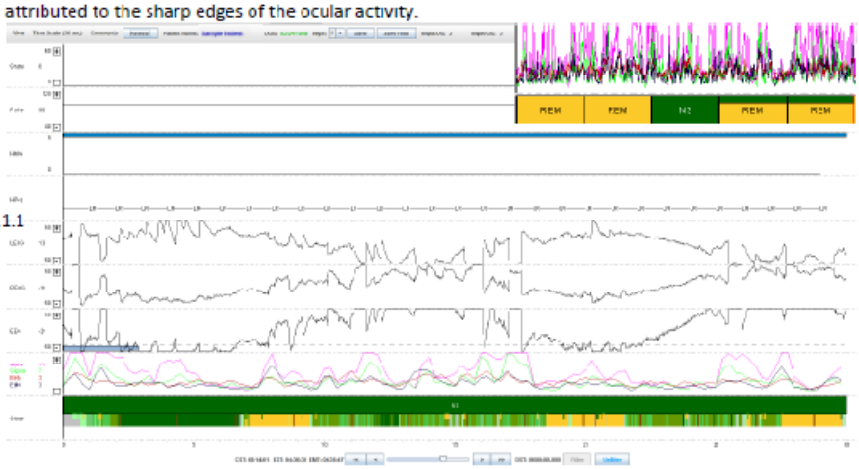
1. Ensure sleep onset is correctly set. Inspect epochs staged Awake with secondary N1 stripes to help make the necessary adjustments.
2. When snoring is constant and greater than 40 dB, but the epoch is called Awake due to high EMG PSD, stage as N1.
3. Inspect epochs assigned both REM and NREM primary and secondary stripes.
4. If the PSD transitions are not obvious, inspect 3 epochs before and after transitions that start and end REM blocks.
5. Recognize the rare cases in which large delta/theta waves are staged REM, or large dense REM ocular activity is staged N2 or N3, and edit accordingly. Use the up/down arrow to filter/unfilter the signal in order to assist with the pattern recognition.
6. Identify epochs staged N3 attributed to gross movement and stage as Awake, or if > 15 secs of sleep, assign the same stage as the previous epoch.
7. Resolve Awake with N1 secondary stripes by visual detection of at least 15 seconds of slowing EEG without movement and:
    a. If preceded by Awake or N1 or arousal occurs in the 1st half of the epoch, then stage N1.
    b. If preceded by L2, N2 or N3 and arousal is in 2nd half of epoch, stage L2.
    c. If preceded REM and arousal is in the 2nd half of the epoch, stage REM.
8. Resolve Awake with N2 secondary stripes by visual detection of at least 15 seconds of slowing EEG without movement and:
    a. If two or more spindles are visually confirmed, stage L2
    b. If one of the spindles can be visually confirmed, stage N1.
    c. If all spindles are insufficient amplitude, the stage should remain Awake.

### 3.1: Editing Transitions between NREM and REM

Review the transitions between REM and NREM and ensure that high amplitude dense REM that contributes large delta power is not misclassified as NREM.

Figure 3.1.1 shows extreme dense REM misclassified as N3 due to increased delta and EMG PSD (black color) attributed to the sharp edges of the ocular activity.

Figure 3.1.1




Because L2, N2 and N3 are presented with the band stop filter (Figure 3.1.1), press the up arrow to unfilter (Figure 3.1.2) and visually confirm the ocular activity and edit the epoch.

Figure 3.1.2

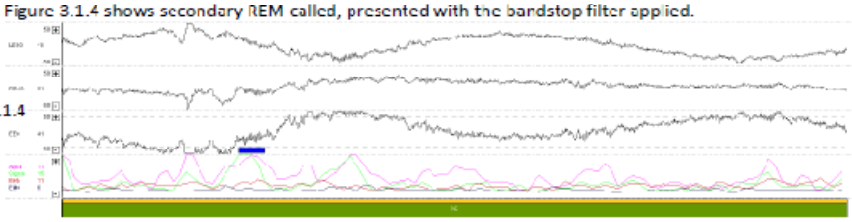
Use the primary and secondary stripes to identify periods that may require editing of REM and NREM.

Figure 3.1.3 shows a mixed pattern of N2 and REM. Use the up and down arrow to flip between the filtered and unfiltered signals to make a scoring decision. Unless the secondary stage is obviously correct, do not edit.

Figure 3.1.3

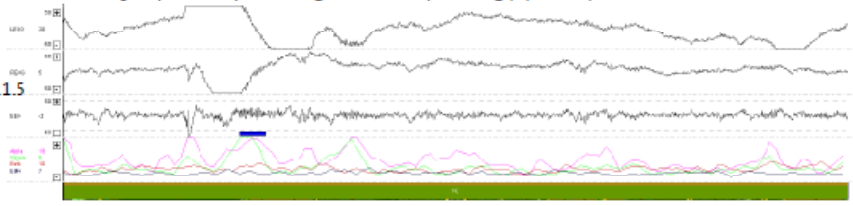

Figure 3.1.4 shows secondary REM called, presented with the bandstop filter applied.

Figure 3.1.4



Confirm the signal pattern by removing the bandstop filtering (up arrow).

Figure 3.1.5



For each REM block, from first indication of REM (primary or secondary REM stripe), go back 3 NREM epochs, confirm the transition to REM. From final epoch with a primary or secondary REM stripe, go forward 3 NREM epochs, confirm transition away from REM.

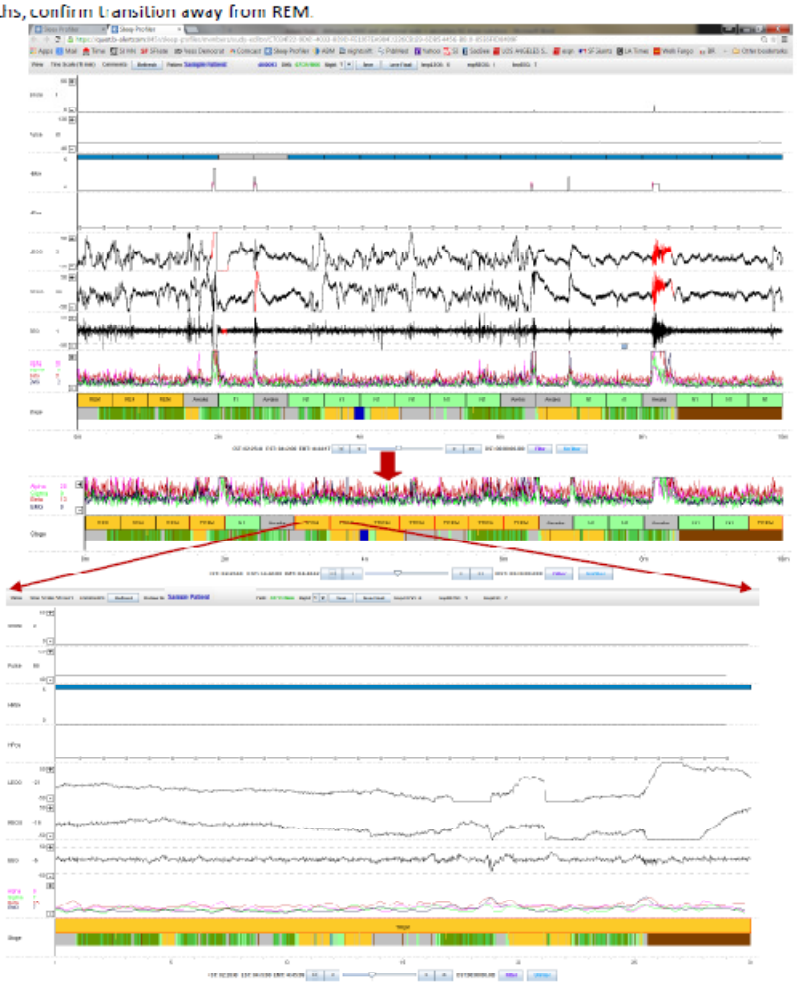


Figure 3.1.6

Avoid the tendency to over score. The auto-staging is designed to differentiate high beta activity without dense REM common during *medicated* light sleep (Figure 3.1.7) from similar appearances that should be staged REM (Figure 3.1.8). One of the REM auto-scoring rules is based on proximity of epochs with dense ocular activity to detect a REM period. Note the differences in magnitude of the beta PSD (rust color) and amount of ocular activity in the EOG channels in Figures 3.1.7 and 3.1.8 below.

Figure 3.1.7

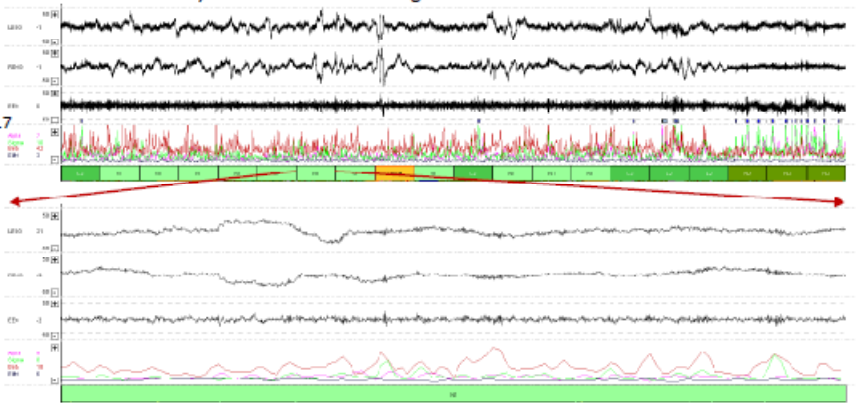
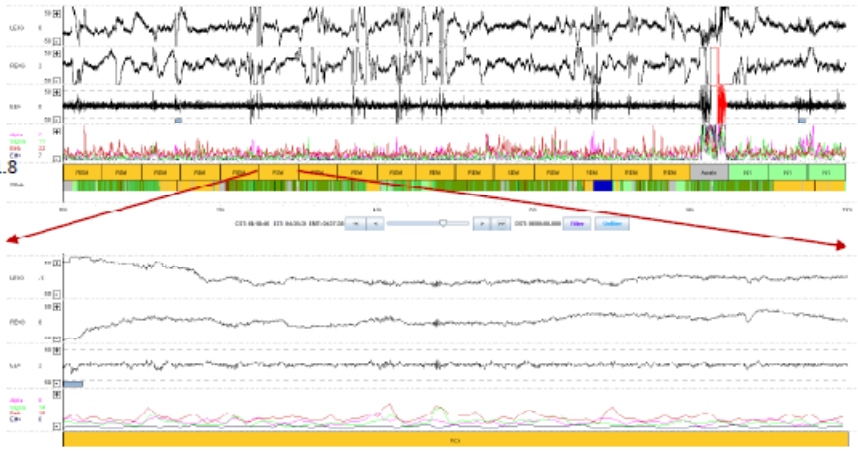


Figure 3.1.8



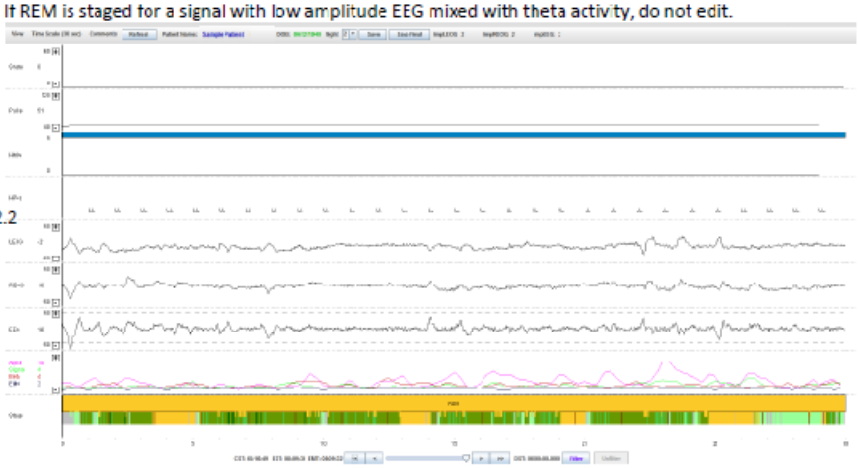
### 3.2: REM with Delta Waves to N2

In approximately 5% of cases, large amplitude mixed delta/theta waves may be misclassified as REM due to the measured high delta and low beta activity. The delta/theta activity in the EEG signal can be used to stage N2.

Figure 3.2.1

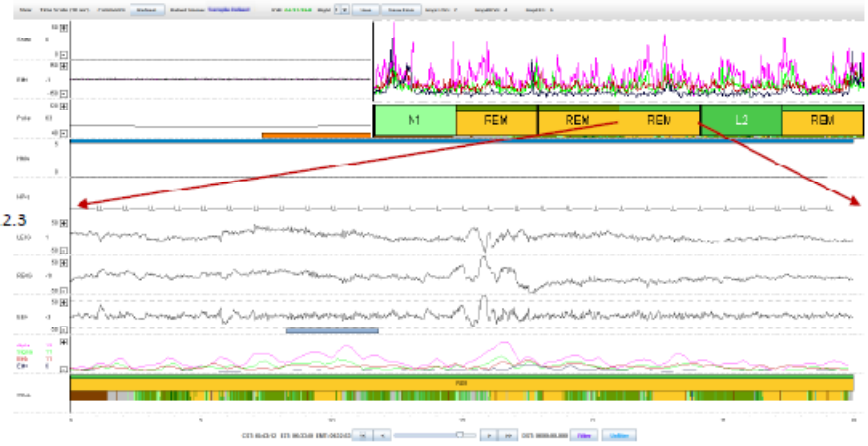
If REM is staged for a signal with low amplitude EEG mixed with theta activity, do not edit.

Figure 3.2.2



When REM is the primary and NREM is the secondary, use spindles and K-complexes to confirm secondary stage L2 is correct. In Figure 3.2.3 the four REM epochs should be changed to secondary call.

Figure 3.2.3



### 3.3: Loud Snoring to Stage N1

If Awake with:

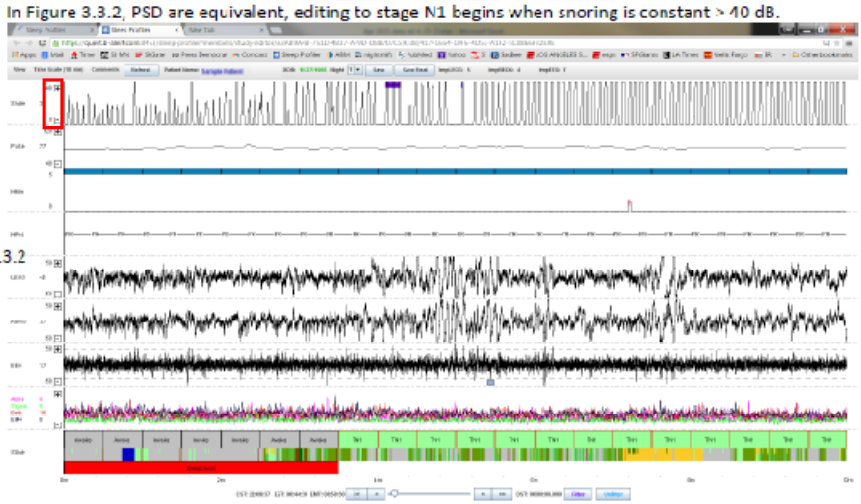
- no secondary N1 stripe
- *constant >40 dB* snoring
- all PSD equivalent (i.e., EMG (black) is not consistently elevated)
- slow eye rollers with no sharp edges

Then stage N1.

Figure 3.3.1


In Figure 3.3.2, PSD are equivalent, editing to stage N1 begins when snoring is constant > 40 dB.

Figure 3.3.2



In Figure 3.3.3, all PSD are equivalent and snoring >40 uV, however signal contains sharp edges (blinks) so keep as Awake.

Figure 3.3.3

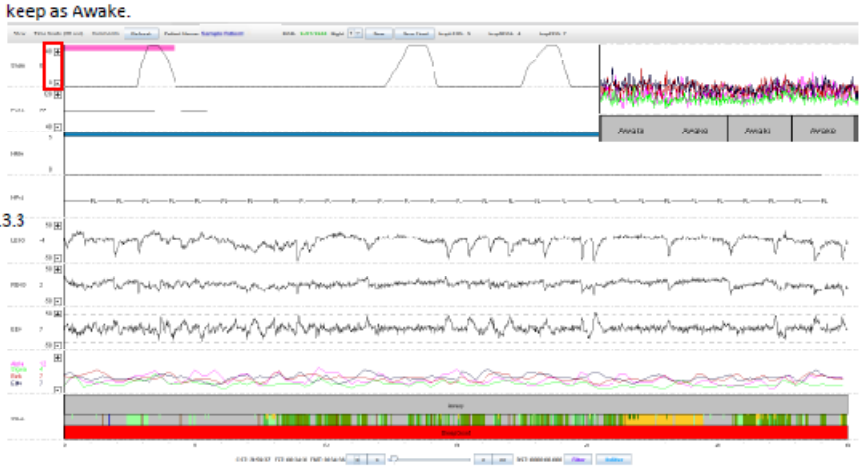
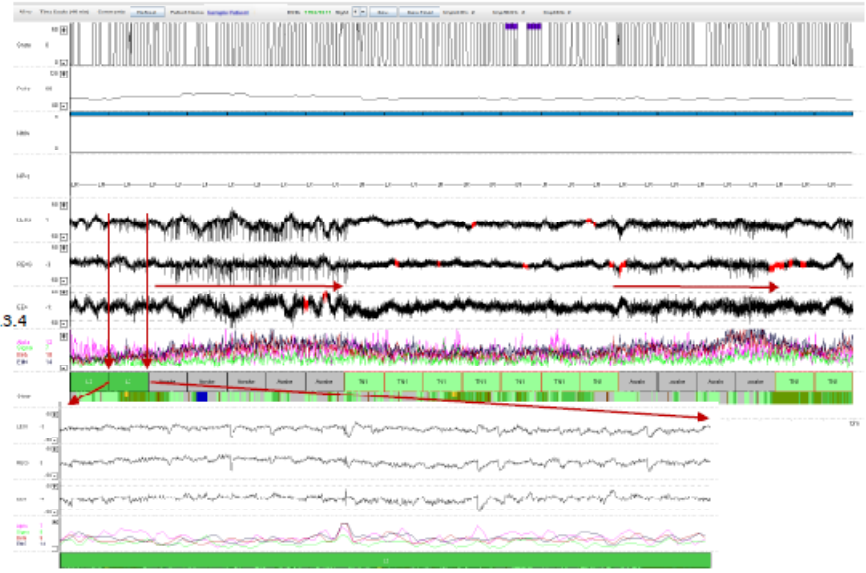


Figure 3.3.4 shows loud snoring > 50 dB for over 30 minutes staged wake due to EMG activity. Press down arrow to apply the bandstop filter and do not stage N1 regions with sharp edges contributing to the most extreme EMG.

Figure 3.3.4



Example of subtle sharp edges with insufficient amplitude to increase EMG PSD into stage wake.

If Awake with:

- ***constant >50 dB loud*** snoring
- elevated EMG PSD
- slow eye rollers and no sharp edges

then stage N1.

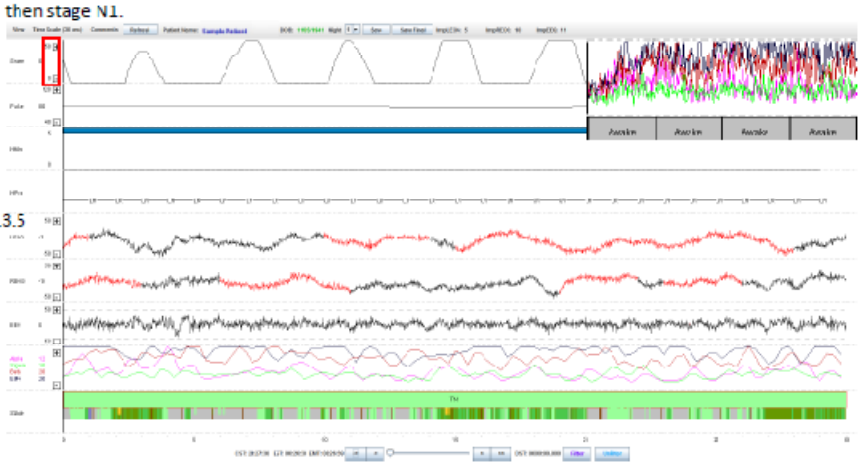



Figure 3.3.5

In Figure 3.3.6, snoring > 50 dB, signal is marked red due to EMG but EMG is not elevated, stage N1.

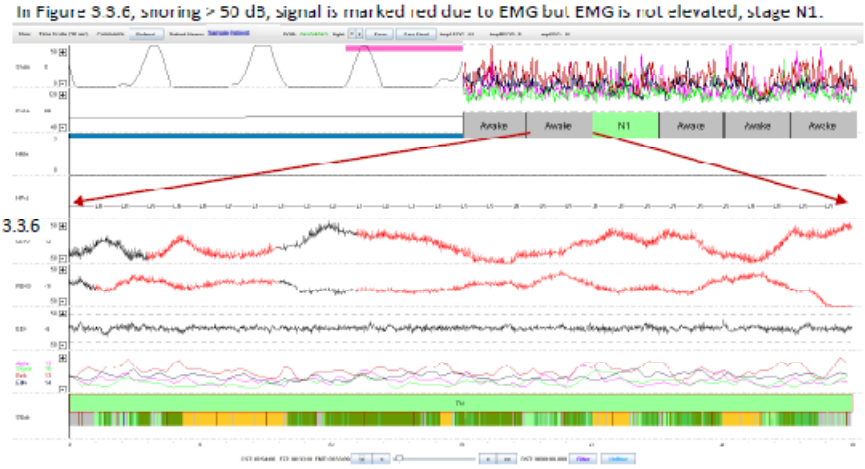
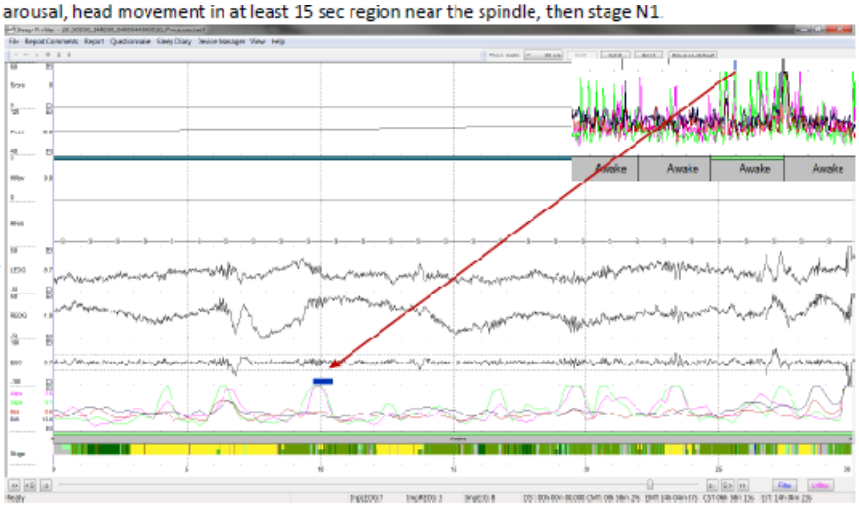



Figure 3.3.6

### 3.4: Awake with Spindles to NREM

If an epoch is staged Awake with one detected spindle, a secondary N1 stripe will be presented. If the spindle is visually confirmed and there is obvious EEG slowing (i.e., elevated EMG) with an absence of an arousal, head movement in at least 15 sec region near the spindle, then stage N1.

Figure 3.4.1




In Figure 3.4.2, the signal pattern slows (EMG drops) just prior to the 15 sec mark and there is one visually confirmed spindle, so stage N1.

Figure 3.4.2

In Figure 3.4.3, an arousal in the middle of the epoch negates the visually confirmed spindle, so the stage should remain Awake.

Figure 3.4.3

In Figure 3.4.4, the spindle is not of sufficient magnitude for visual confirmation and the EEG has not visually slowed, so the stage should remain Awake.

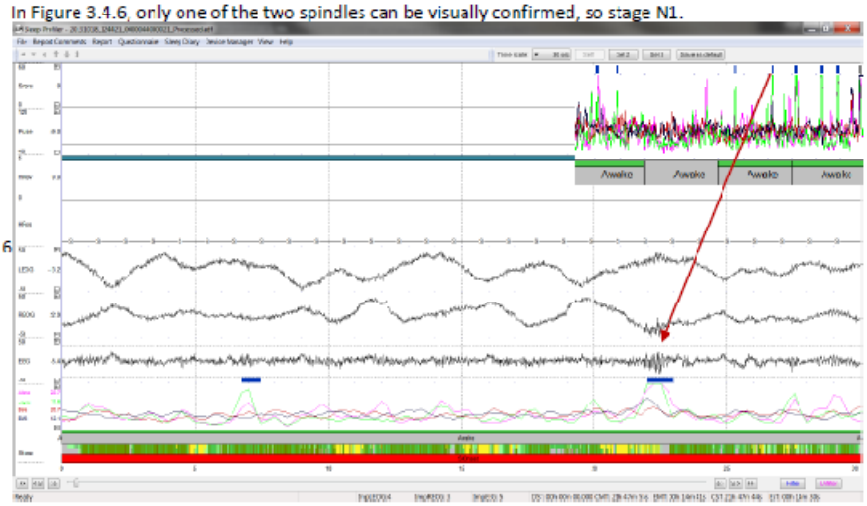
Figure 3.4.4

When two or more spindles are detected, the secondary stripe will be Light N2 (L2). Stage this epoch L2, given the three visually confirmed spindles and the absence of an arousal in the 15-sec period near the spindles.

Figure 3.4.5

In Figure 3.4.6, only one of the two spindles can be visually confirmed, so stage N1.

Figure 3.4.6



### 3.5: Awake with Secondary N1 to NREM

If Awake with:

- secondary N1 stripe with indications of slowing (i.e., alpha intrusion) and
- at least 15 seconds with no MOA arousal or head movement

then edit.

Figure 3.5.1 is preceded by Awake or N1 with arousal occurring in 2nd half of epoch, stage N1.

Figure 3.5.1

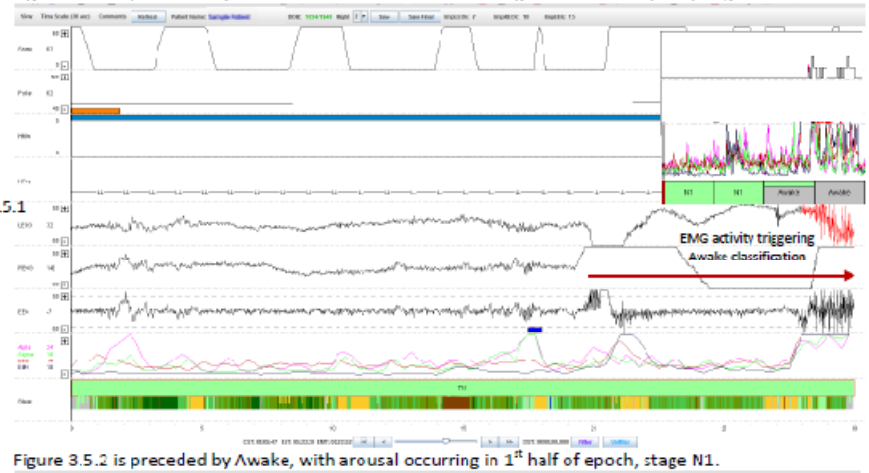
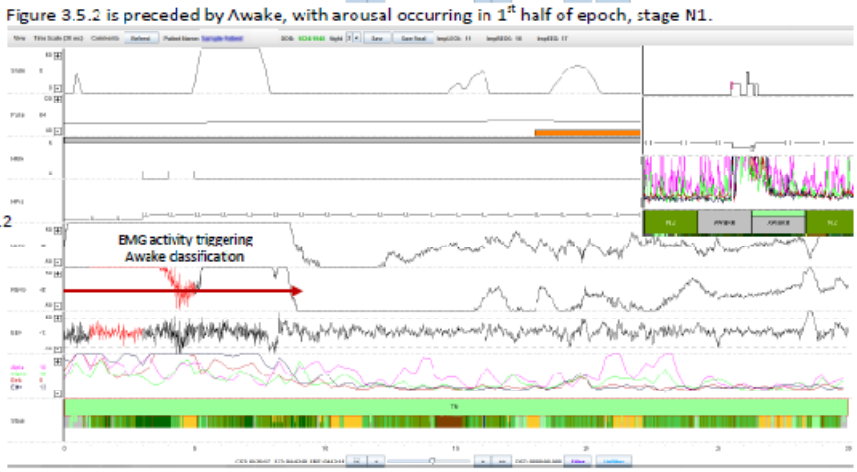



Figure 3.5.2 is preceded by Awake, with arousal occurring in 1st half of epoch, stage N1.

Figure 3.5.2

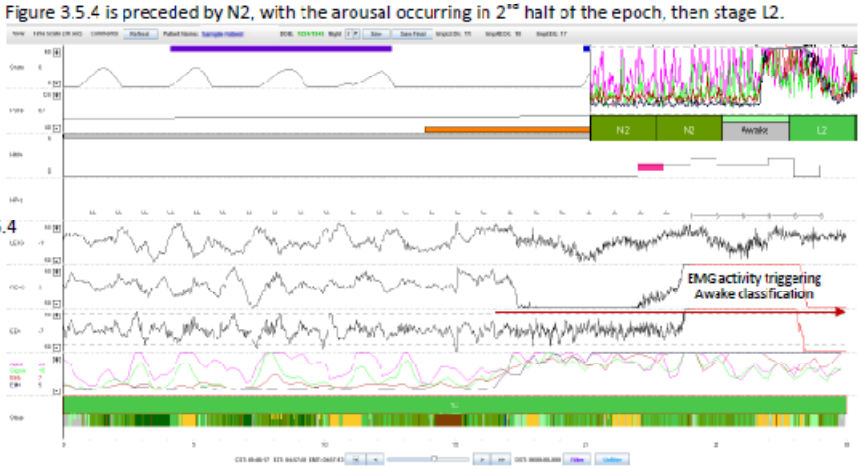


In Figure 3.5.3, arousal occurs in middle of epoch or > 50% of epoch is affected by arousal, then stage should remain Awake.

Figure 3.5.3

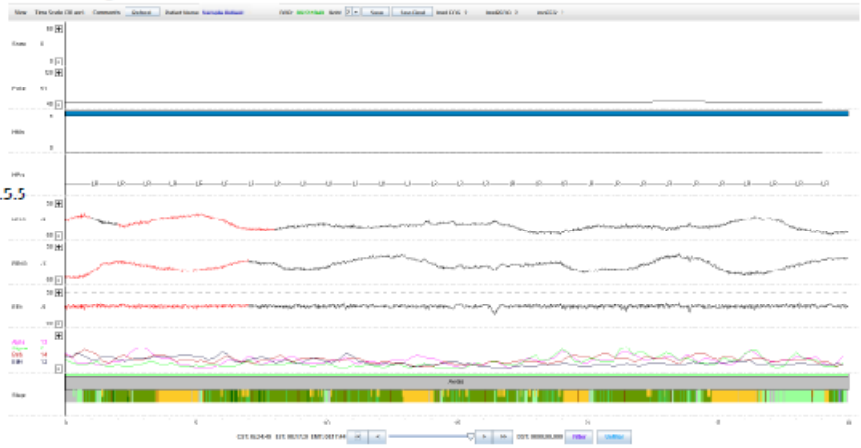

Figure 3.5.4 is preceded by N2, with the arousal occurring in 2nd half of the epoch, then stage L2.

Figure 3.5.4



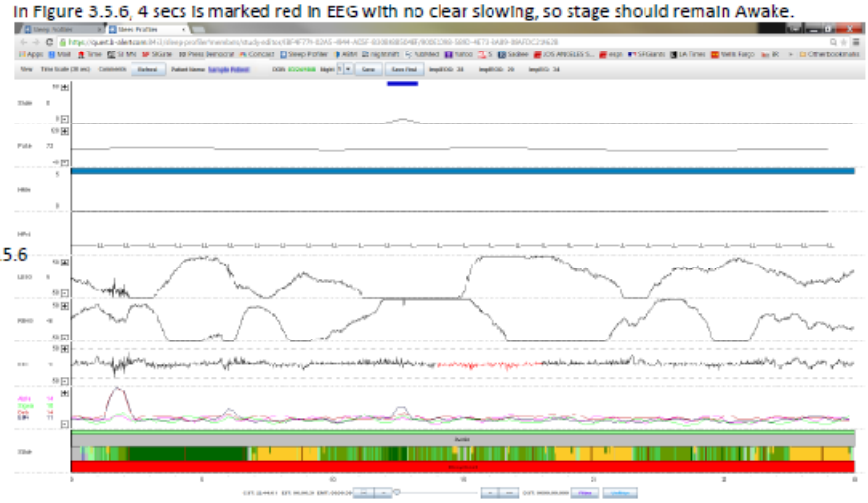
If Awake with secondary N1 insufficient slowing (i.e., > 5 secs marked as EMG artifact (RED) in the EEG signal), then the stage should remain Awake.

Figure 3.5.5



In Figure 3.5.6, 4 secs is marked red in EEG with no clear slowing, so stage should remain Awake.

Figure 3.5.6



In Figure 3.5.7, the EEG signal is not marked red but there is no clear slowing with alpha intrusion, so the stage should remain Awake.

Figure 3.5.7

## 3.6: NREM to Awake

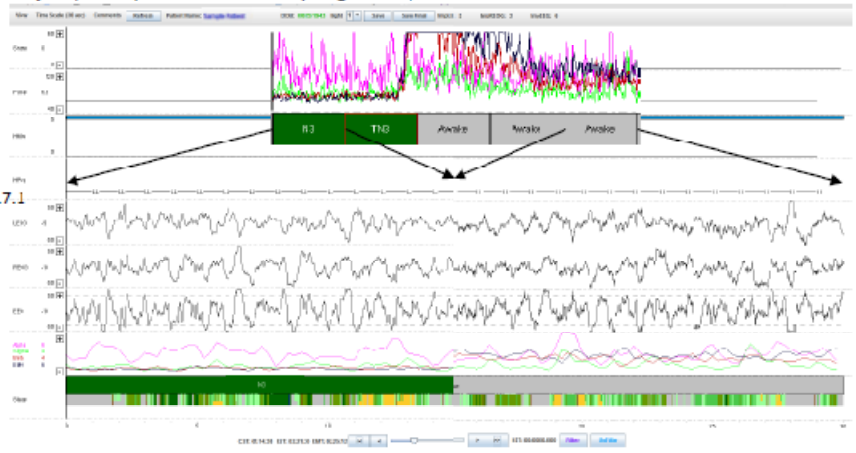
Epochs staged as NREM with contaminating blinks patterns (which distort the theta PSD) should be staged Awake.

Figure 3.6.1

## 3.7: Awake to Stage N3

In instances that sharp edges from high amplitude slow waves contribute to increased power in the EMG band, a misclassification of Awake can result. These misclassifications (observed in a rare number of subjects) usually occur near correctly staged N3 epochs.

Figure 3.7.1

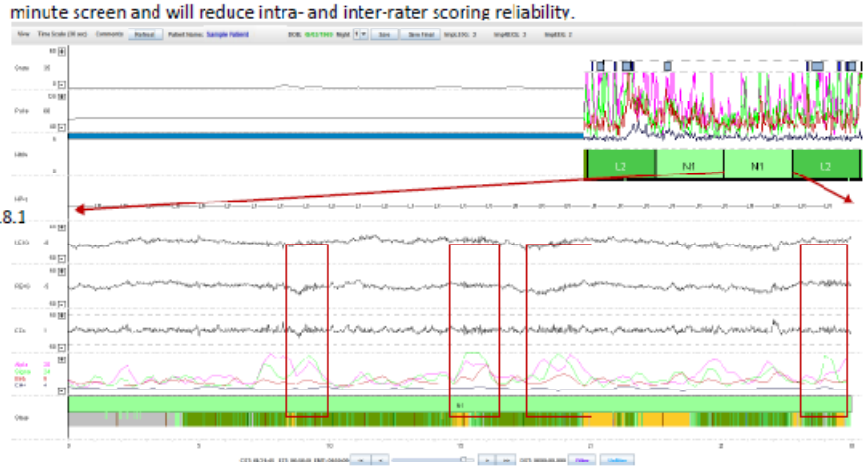


### 3.8: Awake with Undetected Spindle-like Patterns

Do not edit epochs staged N1 with low amplitude spindles. These patterns are not easily recognized on a 10-minute screen and will reduce intra- and inter-rater scoring reliability.

Figure 3.8.1

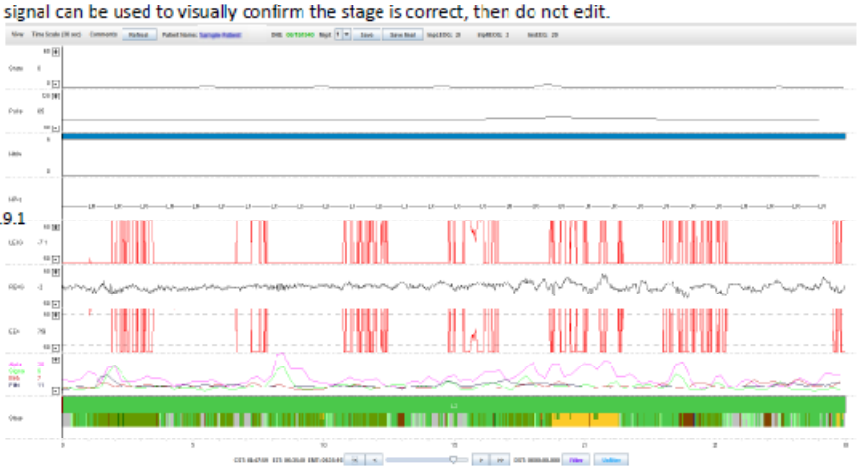


## 3.9: Interpreting/Rejecting Epochs with Artifact

If more than 50% of the EEG signal is marked red, then an alternative signal is being staged. If the alternative signal can be used to visually confirm the stage is correct, then do not edit.

Figure 3.9.1

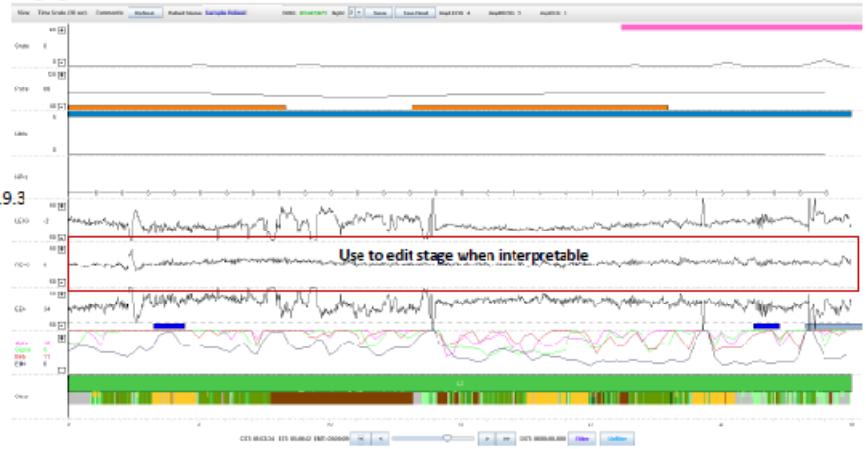


If less than 50% of the EEG signal is marked red and there is gross artifact colored black, then the art fact has been incorporated into the staging decision.

Figure 3.9.2

When the non-contaminated channel can be used to visually confirm the staging of the EEG channel is correct, the epoch can be used. In Figure 3.9.3, the intermittent noise in the EEG signal did not affect the staging.

Figure 3.9.3



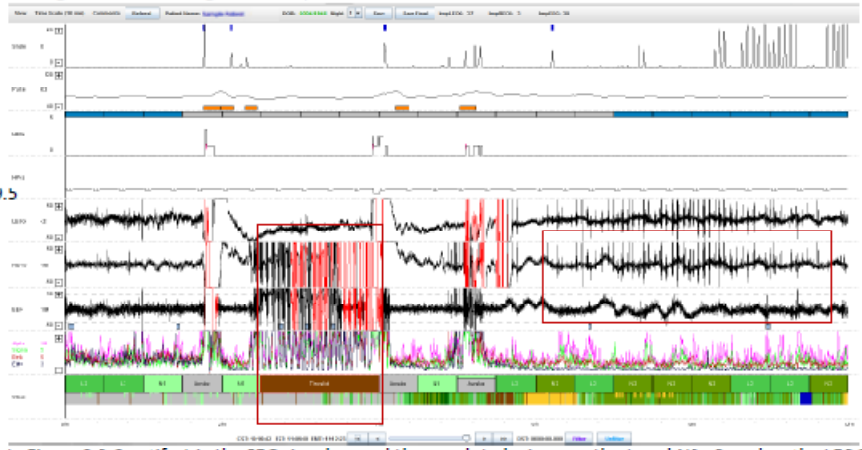

In Figure 3.9.4, the noise caused the epoch to be staged N3, however slow waves are not apparent in the REOG channel. This epoch should be edited to stage N2 (due to presence of theta waves and a spindle) or mark the epoch as invalid.

Figure 3.9.4

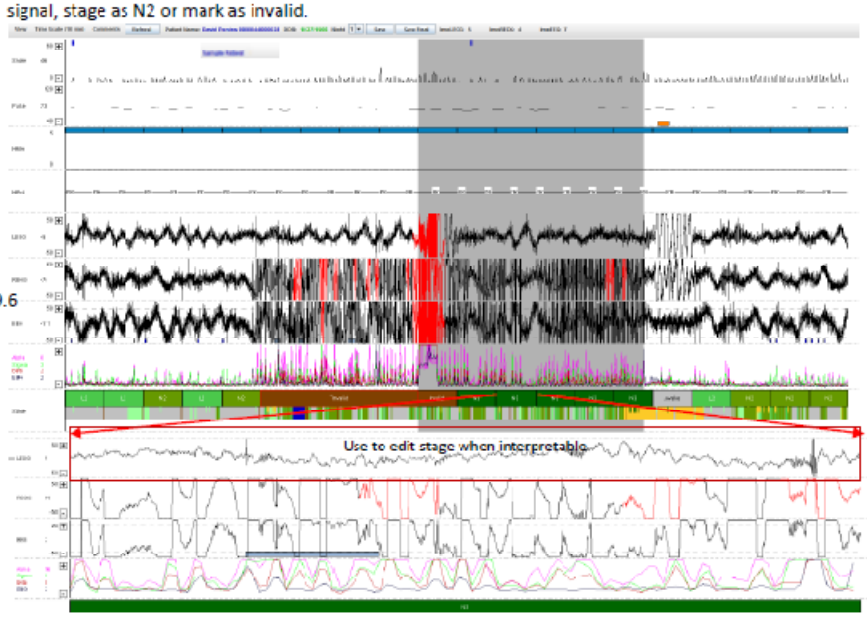
In Figure 3.9.5, the first section has artifact in the EEG and REOG channels and was not interpretable with the LEOG, so it was marked invalid. The second section artifact in the LEOG and REOG did not contaminate the EEG signal and it was staged correctly.

Figure 3.9.5



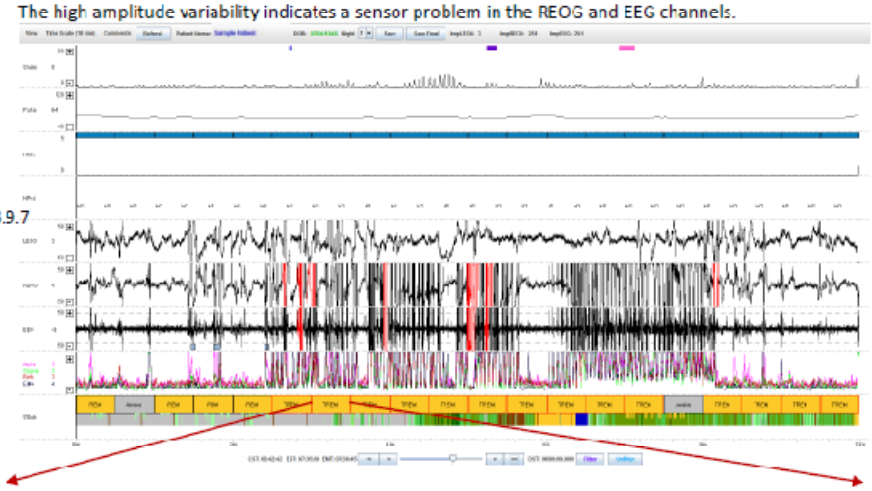
In Figure 3.9.6, artifact in the EEG signal caused the epoch to be incorrectly staged N3. Based on the LEOG signal, stage as N2 or mark as invalid.

Figure 3.9.6



The high amplitude variability indicates a sensor problem in the REOG and EEG channels.

Figure 3.9.7



In Figure 3.9.8, an epoch staged awake due to intermittent sensor noise with obvious dense ocular activity should be staged REM.

Figure 3.9.8

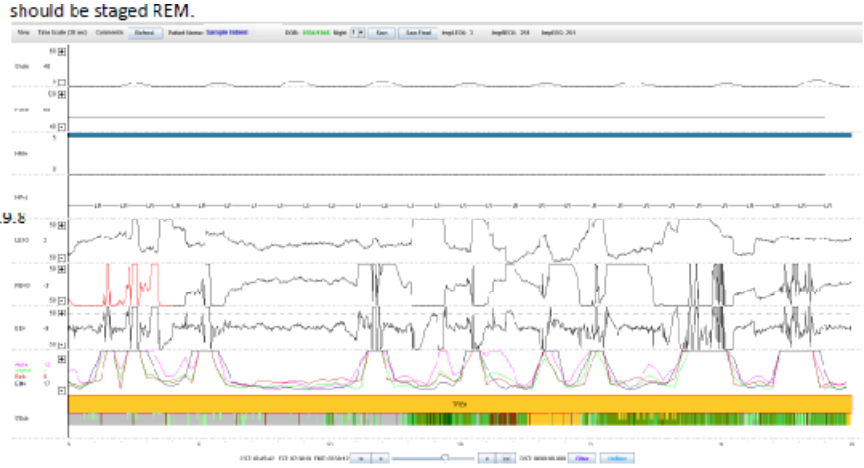
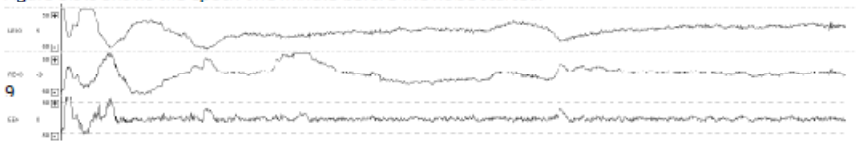


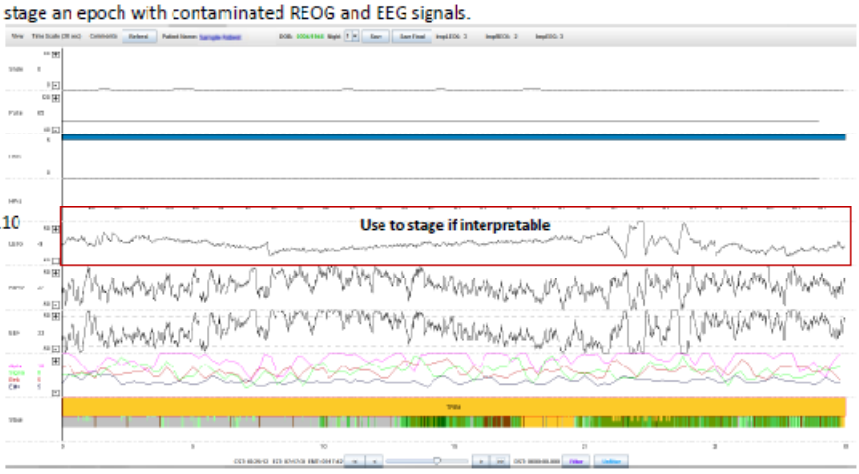
Figure 3.9.9 shows the epoch one minute before the noise started.

Figure 3.9.9



In Figure 3.9.10, the low amplitude EEG combined with the sharp ocular edges in the LEOG channel is used to stage an epoch with contaminated REOG and EEG signals.

Figure 3.9.10




Epochs marked as invalid due to the impedance test should not be edited, even if the correct stage can be assessed. In most cases that an epoch is invalid due to the impedance test, over 75% of the epoch is excluded (marked red) from detection of spindles, arousals, slow wave, and dense REM. The respective indices will be distorted by inclusion of the epoch with no detected events.

Figure 3.9.11

## Section 4: Report Definitions

**Sleep Architecture:**

1. Study Time: Elapsed time from when the device was turned on until it was turned off less any time manually excluded.
2. Excluded Time: Invalid time in study.
3. Recording Time: Study Time less invalid time.
4. Sleep Time: Record Time minus wake time.
5. Sleep Efficiency: Sleep Time divided by Record Time.
6. % Sleep Time Supine: Supine Time divided by Sleep Time.
7. % Time Stage Wake: Hours of valid Wake divided by hours of sleep time.
8. % Time Stage R: Hours of valid REM divided by hours of sleep time.
9. % Time Stage N1: Hours of valid stage 1 sleep divided by hours of sleep time.
10. % Time Stage N2 Total: Hours of valid stage 2 (N2 and L2) sleep divided by hours of sleep time.
11. % Time Stage N2 Light: Hours of valid stage Light N2 (L2) sleep divided by hours of sleep time.
12. % Time Stage N3: Hours of valid stage 3 sleep divided by hours of sleep time.
13. % Time Sleep NOS: Hours of valid Sleep Not Otherwise Specified divided by hours of sleep time.
14. Sleep Onset Latency: Elapsed time from the start of recording until the start of the first three consecutive non-Wake epochs at the start of the night.
15. REM Latency: Elapsed time from sleep onset until the start of the first three consecutive REM epochs at the start of the night.
16. NREM3 Latency: Elapsed time from sleep onset until the start of the first three consecutive Stage N3 epochs at the start of the night.
17. WASO: Wake after sleep onset sums all minutes the patient was awake after sleep onset until the end of the record.

**Awakenings and Arousals:**

18. Cortical Arousal Index: Number of cortical arousals occurrences per hour of sleep time.
19. Microarousal Index: Number of microarousal occurrences per hour of sleep time.
20. Autonomic Activation Index
    a. Overall: Number of pulse rate increases/decreases (≥6 BPM within 10 sec window) divided by the sleep time.
    b. Non-REM: Number of pulse rate increases/decreases (≥6 BPM within 10 sec window) divided by the Non-REM sleep time.
    c. REM Number of pulse rate increases/decreases (>6 BPM within 10 sec window) divided by the REM sleep time.
21. Movement Arousal Index: Number of occurrences of substantial movements per hour of sleep time.
22. Awakenings ≥ 30 sec: Number of occurrences (lasting 30 seconds or longer) of a transition from sleep to Awake and back to sleep subsequent to sleep onset.
23. Awakenings ≥ 90 sec: Number of occurrences (lasting 90 seconds or longer) of a transition from sleep to Awake and back to sleep subsequent to sleep onset.
24. Spindle duration: Sum of length (minutes) of spindles detected during stages L2, N2 and N3.

**Other:**

25. % Time Snoring Overall: Sum of seconds with snoring > 40 or 50 dB divided by sleep time.
26. % Time Snoring Supine: Sum of seconds while supine and with snoring > 40 or 50 dB, divided by supine sleep time.
27. % Time Snoring Non Supine: Sum of seconds while non-supine and with snoring > 40 or 50 dB, divided by non-supine sleep time.

28. Cardio Mean: Mean pulse rate plus or minus one standard deviation.
29. Max/Min Pulse Rate: Maximum and minimum pulse rate located in Recording Time.
30. Daytime Sleepiness: Epworth scores: Not clinically significant = 0-7; Sub-threshold = 8-10; Moderate = 11-14; Severe = 15-19; Very severe = 20-24.
31. Insomnia: Insomnia Severity Index: Not clinically significant = 0-7; Sub-threshold = 8-14; Moderate = 15-21; Severe = 22-28.
32. Depression: PHQ-9 scores: None = 0, Minimal = 1-4, Mild = 5-9, Moderate = 10-14, Moderately severe – 15-19, Severe – 20-27.
33. Anxiety: GAD-7 scores: Minimal = 0-4, Mild = 5-9, Moderate = 10-14, Severe = 15-21.
34. Chronic Disease Comments: The following non-editable comments are inserted when the applicable check box is selected:
    a. "Irregularity of the heart rate signals indicates possible cardiac dysrhythmia. If clinically appropriate, further cardiac evaluation is suggested."
    b. "The patient's report of difficulty keeping his/her legs still at night is confirmed by repeated pulse rate increases and head movements. If clinically appropriate, further evaluation for Restless Leg Syndrome is suggested."
    c. "The regularity of the snoring, pulse rate, and head movement arousals indicates possible Sleep Disordered Breathing. If clinically appropriate, further evaluation is suggested."
    d. "Patterns of high density, early onset REM, suggests possible Co-morbid Depression."
35. Clinician Comments: This editable comment is inserted when the applicable check box is selected.
36. Snore definitions:
    a. Gasp: Snore > 40dB without snoring within 5 seconds of either side
    b. Three Snores: Three consecutive (≤ 3 seconds between end of previous and start of next) snores with similar amplitude and at least two > 40dB
    c. Crescendo: 3 or more consecutive (≤ 3 seconds between end of previous and start of next) snores that have consistent increasing amplitudes with at least one snore > 40dB

**Epoch by Epoch File Definitions:** File is standard Comma Separated Value (.csv) file and contains the following data for every epoch:

**Column A – Subject number**
The unique, 13-digit Reference Number for this study

**Column B – Night**
The night of study the epoch belongs to (1, 2, or 3)

**Column C – Study Date**
Date that night starts on

**Column D – Elapsed Time**
Time from the start of record to start of epoch expressed in format hh:mm:ss

**Column E – Elapsed Time (sec)**
Total number of seconds from the start of record to start of epoch

**Column F – Clock Time**
Calendar time from real time clock of the start of epoch

**Column G – Primary Auto Stage**
Primary stage classification from the auto-scoring. Stage is numerically coded as:
0 – Wake
1 – N1
2 – N2
3 – N3
4 – L2 (light N2)

5 – REM
6 – NOS (Sleep not otherwise specified)
9 – INVALID

**Column H – Secondary Auto Stage**
Secondary stage assigned to epochs when patterns are detected that suggest an alternative stage to the primary stage should be considered. Stages are numerically coded the same as the primary stage.

**Column I – Tech Edit Stage**
Stage assigned during technical review (when applicable). Stages are numerically coded the same as the primary stage

**Column J – Channel staged**
Channel used for staging the epoch; EEG, LEOG or REOG

**Column K – Sleep/Wake Actigraphy**
Detected sleep/wake pattern by actigraphy. Stage is numerically coded as:
0 – Wake
1 – SLEEP

**Column L – Spindles**
Number of spindles, either automatically detected or manually inserted, that start in the 30-sec epoch

**Column M – Cortical+MicroArousals**
Number of cortical arousals and microarousals, either automatically detected or manually inserted, that start in the 30-sec epoch

**Column N – Snoring Mean**
Average snoring level (dB) across the 30-sec epoch

**Column O Snoring Minimum**
Least detectable snore (dB) across the 30-sec epoch

**Column P – Snoring Maximum**
Loudest snore (dB) across the 30-sec epoch

**Column Q – Autonomic Activations**
Number of autonomic activations across the 30-sec epoch based on a 6+ bpm pulse rate increase/decrease compared to the previous 10$^{th}$ beat

**Column R – Pulse Mean**
Average pulse rate across the 30-sec epoch

**Column S – Pulse Minimum**
Minimum (lowest) pulse rate across the 30-sec epoch

**Column T – Pulse Maximum**
Maximum (greatest) pulse rate across the 30-sec epoch

**Column U – Movement**
Number of arousal movements that start across the 30-sec epoch

**Column V – Position**
Detected position of the head. Position is alphabetically coded as:
S – Supine
LR – Lateral Right
LL – Lateral Left
PR – Prone Right
PL – Prone Left
U – Upright

**Columns W – AD**

Average power across the 30 sec epoch for each of the frequent ranges/bands:

- Delta (1 Hz – 3.5 Hz)
- DeltaC (same as Delta but with ocular artifact removed by median filter)
- Theta (4 Hz – 6.5 Hz)
- Alpha (8 Hz – 12 Hz)
- Sigma (12 Hz – 16 Hz)
- Beta (18 Hz – 28 Hz)
- EMG (above 64 Hz 3 dB roll off low pass filtering)
- EMGm (with 40 Hz 3 dB roll off low pass filter)

**Column AE Mean Correlation**

Mean cross correlation between the LEOG and REOG, values appear more negative during dense REM activity

**Column AF - # REM Events**

Number of sharp edged changes in the EEG that suggests REM activity.

**Column AG - # Bad Seconds**

Number of seconds considered bad (red signal) in related epoch and in the channel that is used for staging that epoch

**Column AH – SWsecs**

Number of seconds of slow wave sleep detected in the epoch

**Column AI – Flip Stage**

Identifies epochs converted from REM (NREM) to NREM (REM) due to e 1 if the staging was flipped automatically

**Column AJ – DREM**

Identifies epochs staged REM and characterized with dense ocular activity.

**Columns AK AR**

Average power value within related epoch for unfiltered bands (frequency ranges):

- Delta (1 Hz – 3.5 Hz)
- DeltaC (same as Delta but with ocular artifact removed by median filter)
- Theta (4 Hz – 6.5 Hz)
- Alpha (8 Hz – 12 Hz)
- Sigma (12 Hz – 16 Hz)
- Beta (18 Hz – 28 Hz)
- EMG (above 64 Hz 3 dB roll off low pass filtering)
- EMGm (with 40 Hz 3 dB roll off low pass filter)

**Only applicable if Brux events are manually scored**

**Column AS – number of bruxism events phasic**

Number of phasic bruxism events. An event belongs to an epoch if more than 50% of event overlaps the epoch

**Column AT – number of bruxism events tonic**

Number of tonic bruxism events. An event belongs to an epoch if more than 50% of event overlaps the epoch

**Column AU – number of bruxism events mixed**

Number of mixed bruxism events. An event belongs to an epoch if more than 50% of event overlaps the epoch

**Column AW – Spindle Arousal Count**

Sum of detected spindles that occur simultaneously with a detected arousal.

**Column AX – Spindle Duration (seconds)**

Sum of spindle time detected in the epoch.

**Column AY – AveAplMx**
Average of the peak alpha power of the spindles detected in the epoch.
**Column AZ – AveSigMx**
Average of the peak sigma power of the spindles detected in the epoch.
**Column BA – AveAplAve**
Average alpha power across the spindle duration in the epoch.
**Column BB – AveSigAve**
Average sigma power across the spindle duration in the epoch.