



ESCOLA SUPERIOR DE
TECNOLOGIA DA SAÚDE
DE LISBOA
INSTITUTO POLITÉCNICO DE LISBOA

XV Seminário Temático em Fisiologia Clínica
11 de fevereiro de 2022



Sleep Profiler™:

monitorização wireless do sono

Estudantes: Joana Cangaia nº2018262
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Orientadora: Professora Joana Belo



Sono

- Mecanismo fundamental para o bem-estar e funcionamento do ser humano¹;
- Alterações do sono podem comprometer a saúde e o bem-estar¹;
- Essencial um estudo aprofundado quando existe a suspeita de distúrbios do sono¹.



Estudo do sono

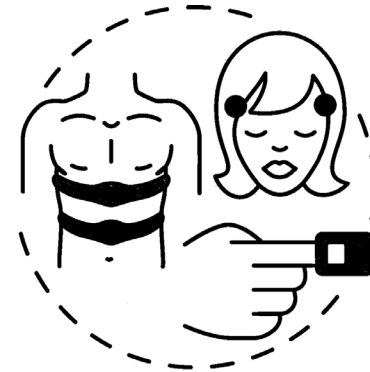
- **Poligrafia do Sono de nível I, II, III ou IV**

- Nível I: mais completa, inclui EEG, EOG, EMG SM e TA, fluxo e esforço respiratório, saturação O₂, ECG e posicionamento corporal, com supervisão profissional²;
- Nível II: idêntica à PSG Nível I, sem supervisão profissional²;
- Nível III: normalmente 4 canais, fluxo e esforço respiratório, ECG, saturação de O₂ e ronco, habitualmente sem supervisão profissional²;
- Nível IV: normalmente apenas 2 canais, ECG e saturação de O₂, sem supervisão profissional².

- **Actigrafia**

- **Avaliação da sonolência**

- Teste de latências múltiplas
- Pupilografia
- Teste de manutenção da vigília
- *The Oxford Sleep Resistance (OSLER)*
- Teste de vigilância psicomotora



Polissonografia (Nível I)

- Exame *Gold standard* no diagnóstico na maioria dos distúrbios do sono²;
- Permite o registo, em simultâneo, de vários parâmetros fisiológicos e comportamentais durante o sono².

Limitações:

- Necessidade de profissionais especializados²;
- Demorado²;
- Incómodo².



Sleep Profiler™

Sleep Profiler™³

2012

2016

2017

Validation of a Wireless, Self-Application, Ambulatory Electroencephalographic Sleep Monitoring Device in Healthy Volunteers⁶

Sleep Profiler PSG2™⁴

The Accuracy, Night-to-Night Variability, and Stability of Frontopolar Sleep Electroencephalography Biomarkers⁵

3. Sleep Profiler [Internet]. [cited 2022 Jan 31].

4. Sleep Profiler PSG2 [Internet]. [cited 2022 Jan 31]

5. Levendowski DJ, et al. The accuracy, night-to-night variability, and stability of frontopolar sleep electroencephalography biomarkers. 2017

6. Finan PH, et al. Validation of wireless self application ambulatory EEG. J Clin Sleep Med. 2016

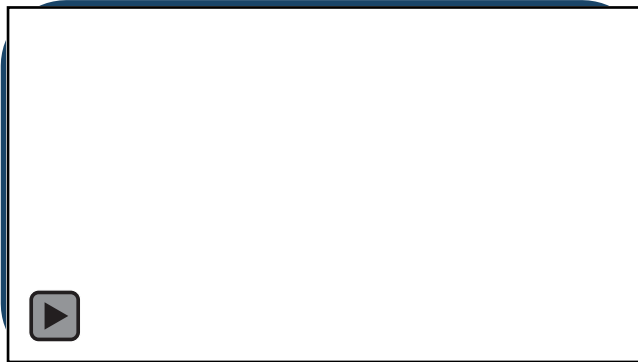
Sleep Profiler™

- Regista EEG, EOG, EMG, ECG, Ronco, Posição e movimento da cabeça;
- *Auto-staging* com equivalência a uma PSG;
- Até 30h de registo;
- Monitorização o estado do estudo e envia notificações.



Sleep Profiler PSG2™

- Regista EEG, EOG, EMG, ECG, Ronco, Posição e movimento da cabeça³;
- **Permite ainda o registo do Fluxo de ar, Esforço respiratório e Saturação³;**
- Deteção automática de hipopneias, apneias obstrutivas e centrais e dessaturações³;
- Monitoriza o estado do estudo e envia alertas de forma a melhorar o sinal³.



Artigos de Validação

The Accuracy, Night-to-Night Variability, and Stability of Frontopolar Sleep Electroencephalography Biomarkers⁵

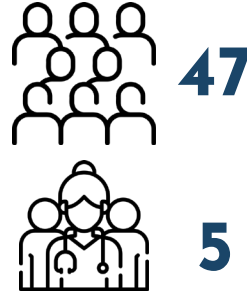


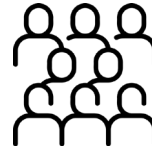
Table 4—Contingency table of agreement between majority PSG staging by human scorers versus Sleep Profiler expert edited default autostaging of pooled epochs.

Majority of scorers staged as:	Expert edited autostaging				
	Awake (%)	N1 (%)	N2 (%)	N3 (%)	REM (%)
Awake	86.8	32.2	3.0	0.3	1.9
N1	9.3	32.6	5.3	0.6	8.8
N2	2.7	33.3	86.0	16.2	9.3
N3	0.1	0.1	5.4	82.9	0.0
REM	1.2	1.8	0.3	0.0	80.0
No consensus	3.4	6.3	1.6	0.5	2.0
No. epochs	8,018	3,262	14,425	3,723	4,201

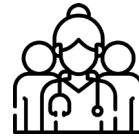
PSG = polysomnography.

Artigos de Validação

Validation of a Wireless, Self-Application, Ambulatory Electroencephalographic Sleep Monitoring Device in Healthy Volunteers⁶



14



2



Table 4—Agreement analysis of PSG versus SP Manual.

Stage	Agreement	κ (95% CI)	Sensitivity % (95% CI)	Specificity % (95% CI)
Wake	0.93	0.44 (0.32, 0.56)	40.08 (36.97, 43.26)	97.68 (97.39, 97.93)
N1	0.93	0.13 (0.10, 0.17)	27.03 (22.33, 32.14)	94.79 (94.39, 95.16)
N2	0.81	0.61 (0.52, 0.70)	75.91 (74.83, 76.97)	84.63 (83.77, 85.47)
N3	0.90	0.71 (0.67, 0.74)	73.92 (72.30, 75.50)	94.74 (94.29, 95.17)
REM	0.90	0.73 (0.65, 0.80)	86.03 (84.69, 87.31)	91.41 (90.86, 91.94)

Agreement, κ , sensitivity, and specificity, along with 95% confidence intervals, are presented for each stage for the comparison of average of the scored polysomnography records to the average of the primary manual score of the Sleep Profiler.

Estudos que utilizaram o Sleep Profiler™

ALZHEIMER'S DISEASE

Reduced non-rapid eye movement sleep is associated with tau pathology in early Alzheimer's disease

Brendan P. Lucey^{1,2,*}, Austin McCullough³, Eric C. Landsness¹, Cristina D. Toedebusch¹, Jennifer S. McLeLland¹, Aiad M. Zaza³, Anne M. Fagan^{1,2,4}, Lena McCue⁵, Chengjie Xiong⁵, John C. Morris^{1,2,4}, Tammie L. S. Benzinger^{3,4}, David M. Holtzman^{1,2,4,*}

REGULAR RESEARCH PAPER



Effects of deep sedation on sleep in critically ill medical patients on mechanical ventilation

Raymonde Jean¹ | Purav Shah² | Eric Yudelevich³ | Frank Genese⁴ | Katherine Gershner⁵ | Daniel Levendowski⁶ | Miguel Martillo⁷ | Iazmin Ventura⁸ | Anirban Basu⁹ | Pius Ochieng¹⁰ | Charlisha D. Gibson⁵

Multimodal assessment of sleep in men and women during treatment for opioid use disorder

Patrick H. Finan^{a,*}, Chung Jung Mun^a, David H. Epstein^b, William J. Kowalczyk^{b,1}, Karran A. Phillips^b, Daniel Agage^b, Michael T. Smith^a, Kenzie L. Preston^{b,**}

^a Johns Hopkins University School of Medicine, Baltimore, MD, 21224, United States

^b Intramural Research Program, National Institute on Drug Abuse, 251 Bayview Blvd., Suite 200, Baltimore, MD, 21224, United States

ASSESSMENT OF SLEEP ABNORMALITIES IN PATIENTS WITH NEURODEGENERATIVE DISEASE USING AN IN-HOME SLEEP PROFILING SYSTEM

Daniel Levendowski¹, Chris Berka¹, Amir Meghdadi¹, Greg Rupp¹, Stephanie Smith¹, Joanne Hamilton^{2,3}, David Salat^{4,5}, Kefron McCaw², Philip Westbrook¹

Can disrupted sleep affect mortality in the mechanically ventilated critically ill?

Shah PC¹, Yudelevich E¹, Genese F¹, Martillo M¹, Ventura I¹, Fuhrmann K¹, Mortel M, Levendowski D², Gibson CD³, Ochieng P¹, Jean R¹

Sleep duration and architecture in non-intubated Intensive

Care Unit patients: An observational study.

Stefano Romagnoli^{1,2,*}, Gianluca Villa¹, Lorenzo Fontanarosa², Lorenzo Tofan¹, Fulvio Pinelli², A. Raffaele De Gaudio¹, Zaccaria Ricci¹.

Processed EEG monitoring for anesthesia and intensive care practice

Stefano ROMAGNOLI^{1,2,*}, Federico FRANCHI³, Zaccaria RICCI⁴

Night to Night Variability in Sleep Architecture and Continuity in Patients Evaluated for Chronic Insomnia

Philip Westbrook¹, Daniel Levendowski¹, Mindy Cetel², Robert Rosenberg³, Mari Hirst³, Zoran Matic¹, Alexandra Cifelli¹ Advanced Brain Monitoring, Inc.¹, Integrative Insomnia and Sleep Health Center², Sleep Disorders Centers of Prescott Valley and Flagstaff³

Sleep in the ICU: An Analysis of Sleep Quality and Quantity in Mechanically Ventilated Patients

Eric Yudelevich MD¹, Katherine Fuhrmann, DO¹, Iazmin Ventura¹, Miguel Martillo¹, Frank Genese, DO², Charlisha Gibson², Pius Ochieng MD², Raymonde Jean MD²

¹Mount Sinai St Luke's and Mount Sinai Roosevelt Hospitals, Icahn School of Medicine New York, NY

²Division of Pulmonary and Critical Care at Montefiore Medical Center Bronx, NY

³Division of Pulmonary and Critical Care at Mount Sinai St Luke's and Mount Sinai Roosevelt Hospitals

CHARACTERIZATION OF SLEEP ABNORMALITIES IN ALZHEIMER'S DISEASE & MILD COGNITIVE IMPAIRMENT USING AN IN-HOME SLEEP PROFILING SYSTEM

Chris Berka¹, Daniel Levendowski¹, Amir Meghdadi¹, Greg Rupp¹, Marija Stevanovic Karik¹, Stephanie Smith¹, Joanne Hamilton^{2,3}, David Salat^{4,5}, Kefron McCaw², Philip Westbrook¹

Head Position During Sleep: Potential Implications for Patients with Neurodegenerative Disease

Daniel J. Levendowski^{a,*}, Charlene Gamalido^b, Erik K. St. Louis^a, Luigi Ferini-Strambi^d,

Joanne M. Hamilton^e, David Salat^{f,g}, Philip R. Westbrook^h and Chris Berka^a

^aAdvanced Brain Monitoring, Carlsbad, CA, USA

^bDepartment of Neurology, Johns Hopkins University School of Medicine, Baltimore, MD, USA

^cCenter for Sleep Medicine, Departments of Neurology and Medicine, Mayo Clinic College of Medicine and Science, Rochester, MN, USA

^dDepartment of Clinical Neurosciences, San Raffaele Scientific Institute, Sleep Disorders Center Università Vita-Salute San Raffaele, Milan, Italy

^eAdvanced Neurobehavioral Health, San Diego, CA, USA

^fHarvard Medical School, Boston, MA, USA

^gHarvard Medical School, Boston, MA, USA

^hMassachusetts General Hospital, Boston, MA, USA



Software do *Sleep Profiler*





Username:

Password:

[Login](#)

[Forgot your password?](#)



[SP Help Documents](#)



[SP Help Videos](#)



[Privacy Notice](#)



[Terms & Conditions](#)



[Software Download](#)



[Guest Exploration](#)

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Multi-Study Actions



Search Actions

Account: All

Status: All

Date Ordered From / To:

Date of Birth From / To:

Last Name:

First Name:

Device Serial Number (Do not include hyphen):

Study Reference Number:

Current Archived All

Available Studies

<input type="checkbox"/>	Last, First Name	Date of Birth	Type	Study Type	Status	Date Ordered	Edit Study	Actions & Reports
<input type="checkbox"/>	Undetected, OSA	31-Oct-1959	SP	Diagnostic	Tech Review Required	20-Apr-2020	Edit Study	Actions & Reports
<input type="checkbox"/>	Light Sleep, Anxiety	11-Dec-1950	SP	Diagnostic	Preliminary Report Available	20-Apr-2020	Edit Study	Actions & Reports
<input type="checkbox"/>	Hypersomnolence, Long Sleep	21-Dec-1946	SP	Diagnostic	Preliminary Report Available	20-Apr-2020	Edit Study	Actions & Reports
<input type="checkbox"/>	State Misperception, Sleep	27-Aug-1956	SP	Diagnostic	Final Report Available	14-Apr-2020	Edit Study	Actions & Reports
<input type="checkbox"/>	Positional, OSA	20-Jun-1963	PSG2	Diagnostic	Preliminary Report Available	16-Dec-2015	Edit Study	Actions & Reports
<input type="checkbox"/>	Severe, OSA	01-Apr-1952	PSG2	Diagnostic	Preliminary Report Available	16-Dec-2015	Edit Study	Actions & Reports
<input type="checkbox"/>	4 percent, 3 percent	07-Jun-1967	PSG2	Diagnostic	Interpretation Required	16-Dec-2015	Edit Study	Actions & Reports



ACTIONS

[Edit Questionnaire](#)

[New Sleep Diary](#)

[Edit Patient Info](#)

[Export EDF File](#)

[Export Epoch by Epoch](#)

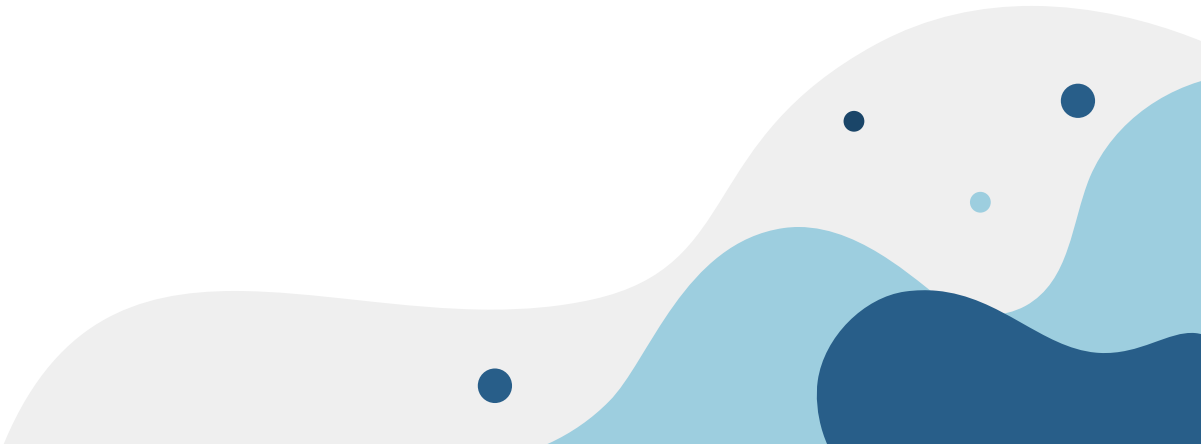
REPORTS

[Questionnaire Report](#)

[Sleep Profiler Report](#)

TROUBLESHOOTING

[Re-Process study](#)



Preparação do equipamento

Device Data

- Serial Number: 1601-00171
- Configuration: Sleep Profiler PSG2
- Oximeter BDA: 00:1c:05:01:09:9f
- Subject: Sample Patient
- ID: 0000011000081
- Study: 6.0 hours recorded
- Counter: 0.0 hours

Battery status



Status:

Prepared

 Recorded

Transferred

- Edit Patient Info
- Upload Study from Device
- Format Device
- Upgrade Firmware
- Device Setup
- Refresh
- Settings

Edit Patient Info

Patient Physician Study

Patient Info

First Name * Sample

Middle Name

Last Name * Patient

Date of Birth * 1/1/1990

Gender * Male

Patient ID

Transfer to device Cancel

Edit Patient Info

Patient Physician Study

Physician Info

Select physician Add new physician

First Name Sample

Last Name Physician

Credentials MD

Transfer to device Cancel

Edit Patient Info

Patient Physician Study

Study Info

Study Type Diagnostic

Night 1 No medication

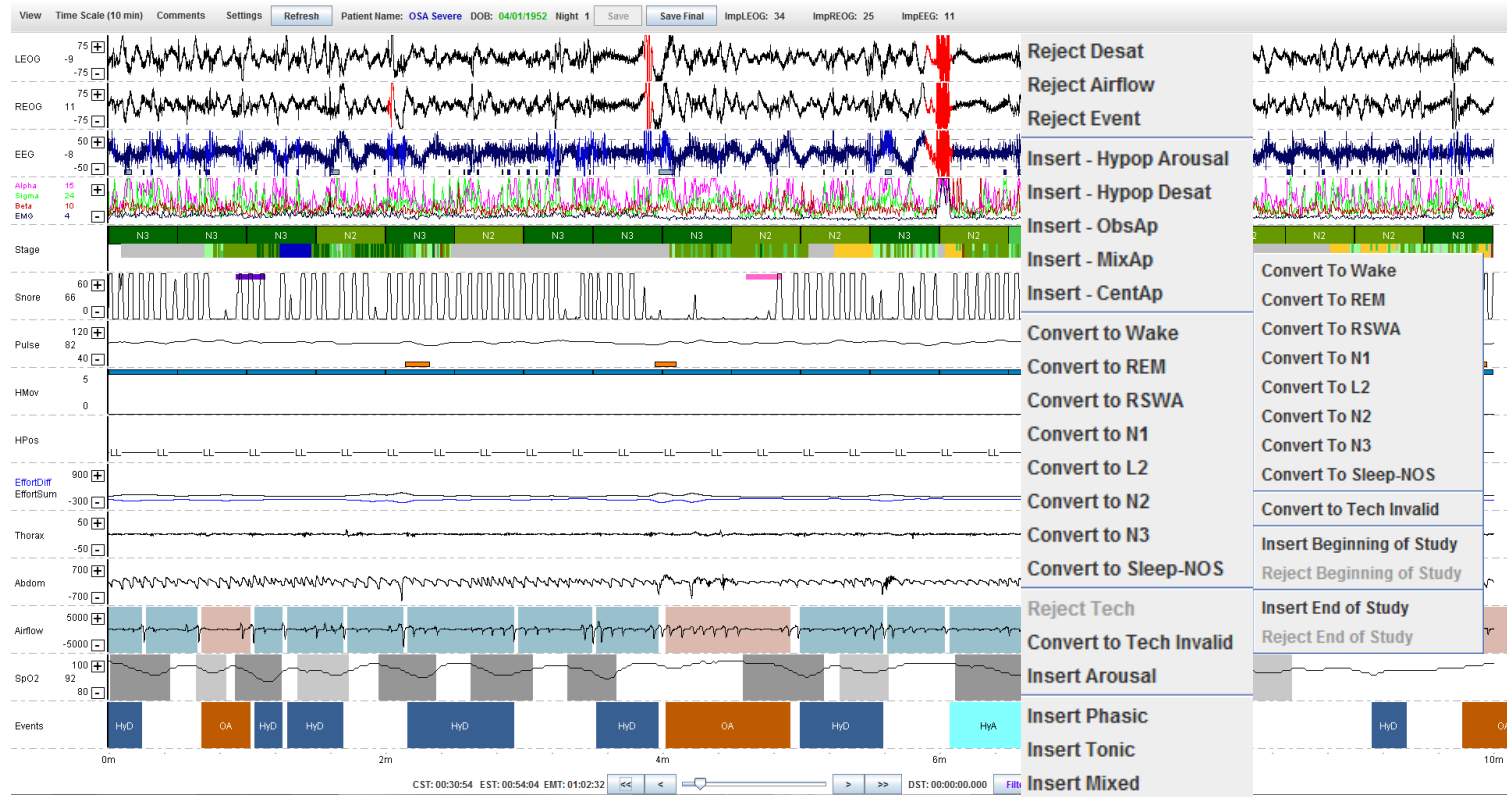
Night 2 With medication, full dosage

Night 3 With medication, half dosage

Study Status

Transfer to device Cancel

Visualização do estudo



Comentários

Clinician Comments

Enter your comments

Diagnosis: The findings are consistent with moderate positional obstructive sleep apnea.

Therapy: Nasal Continuous Positive Airway Pressure (CPAP) or positional therapy.

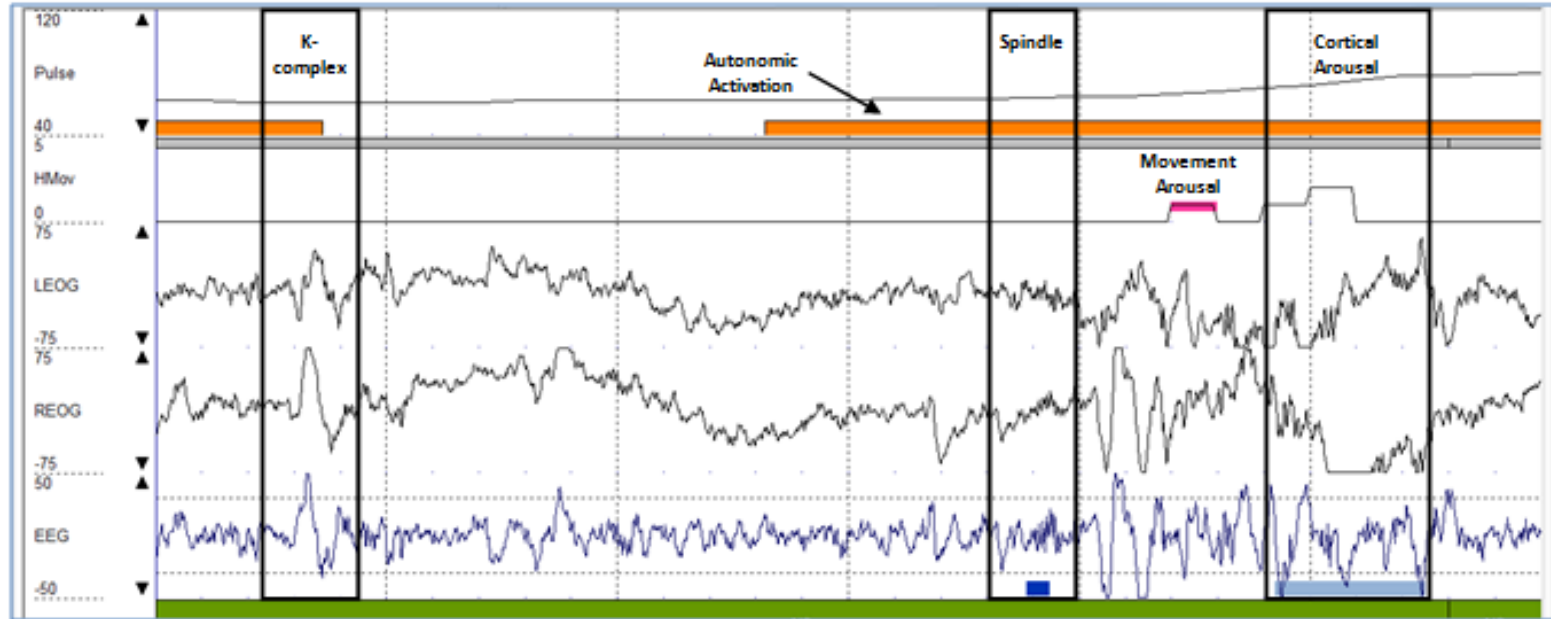
Other recommendations: Clinical correlation is advised.

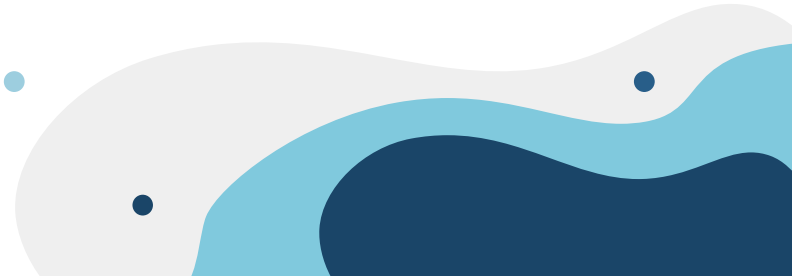
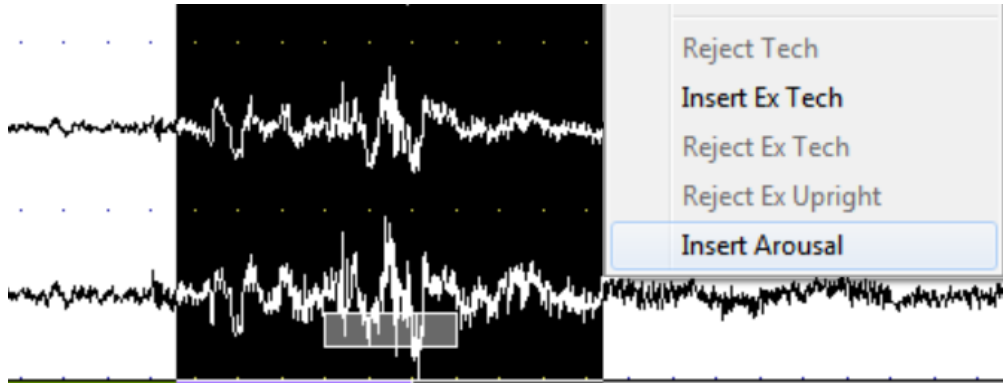
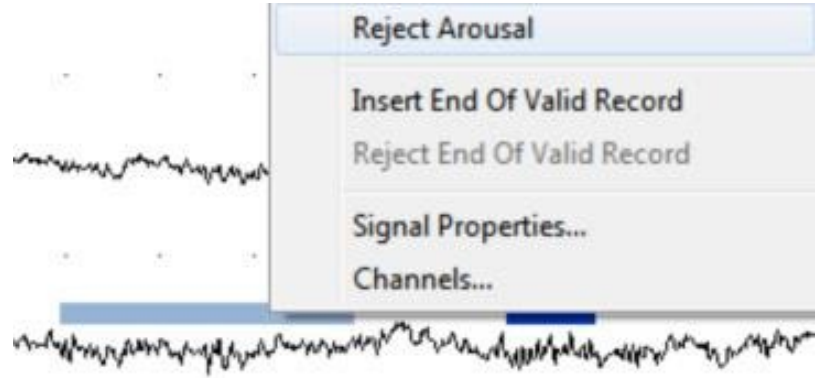
Diagnosis Therapy **Other recommendations**

Apply	Other recommendations	Add New
Apply	A repeat study may be considered to evaluate the treatment outcome.	Edit
Apply	Follow-up with the referring physician recommended to discuss the results and the next steps in the treatment plan.	Save Delete Cancel
Apply	Consider a sleep center based laboratory study.	Edit
Apply	Prior to initiating therapy, a sleep center based in-laboratory PAP titration study is recommended.	Edit
Apply	Clinical correlation is advised.	Edit

OK Cancel

Microdespertares





Questionário

- O Software do Sleep Profiler dispõe de um questionário dividido em:

Informação
demográfica⁷

Condições
diagnosticadas⁷

Questionário de
Epworth⁷

Problemas de
sono/insónia⁷

Hábitos⁷

Questionário
sobre a saúde
do paciente⁷

Distúrbios de
Ansiedade
Generalizada⁷

Medicação⁷

Diário de Sono

Add Sleep Diary

Sleep Diary and Sleep Profiler Comparison Report

Patient Name: Insomnia, Maintenance B

Did

Night 1	Date: March 15, 2013	Patient	Sleep Profiler
How	Took a prescription medication to help fall or stay asleep	No	
H	Number of alcoholic beverages consumed within 4 hours of bedtime	2	
H	Number of caffeinated beverages consumed within 4 hours of bedtime	1	
V	Time the study was started – device turned on and lights out	9:45 PM	9:40 PM
V	Minutes required to fall asleep (sleep onset)	20	5
V	Number of awakenings during the night	3	3
V	Minutes awake after initially falling asleep (wake after sleep onset)	40	25
How	Time of final awakening / turned the device off	6:15AM	6:20 AM
Wh	Total valid sleep time (hours:minutes)	7:30	8:00
Wh	Sleep Efficiency - % of valid time in bed patient was asleep	88%	93%
Wha	# times/hour brain exhibited an arousal		14
Wha	# times/hour heart rate exhibited an arousal		35
V	% of sleep time snoring was at least a mild level > 40 dB – overall		35%
V	– on back		52%
V	% of sleep time snoring was at a moderate level > 50 dB – overall		10%
V	– on back		14%

Wha

entire time you were asleep?

Save

Cancel

Relatório final

- No relatório está presente:

História
Clínica⁷

Resultados
obtidos no
estudo⁷

Relatório dos
comentários⁷

Resultados da
arquitetura do
sono⁷

Representação
gráfica⁷

Estatísticas
da Qualidade
do Sono⁷

Relato do
paciente⁷

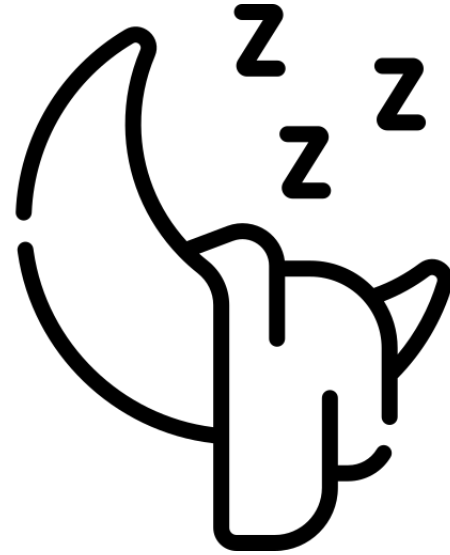
Considerações finais

- O Sleep Profiler PSG2™ permite:
 - ✓ Avaliação do sono menos dispendiosa e incómoda;
 - ✓ Colocação pelo paciente;
 - ✓ Maior acessibilidade;
 - ✓ Diagnóstico precoce.



Considerações finais

- Limitações:
 - ✗ Poucos estudos de validação;
 - ✗ Apenas um canal de EEG;
 - ✗ Apenas para adultos.



Referências

1. Chinoy ED, Cuellar JA, Huwa KE, Jameson JT, Watson CH, Bessman SC, et al. Performance of seven consumer sleep-tracking devices compared with polysomnography. *Sleep* [Internet]. 2021 May 1 [cited 2022 Jan 31];44(5). Available from: [/pmc/articles/PMC8120339/](https://pubmed.ncbi.nlm.nih.gov/348120339/)
2. Rundo JV, Downey R. Polysomnography. *Handb Clin Neurol*. 2019 Jan 1;160:381–92.
3. Sleep Profiler [Internet]. [cited 2022 Jan 31]. Available from: <https://www.advancedbrainmonitoring.com/products/sleep-profiler>
4. Sleep Profiler PSG2 [Internet]. [cited 2022 Jan 31]. Available from: <https://www.advancedbrainmonitoring.com/products/sleep-profiler-psg2>
5. Levendowski DJ, Ferini-Strambi L, Gamaldo C, Cetel M, Rosenberg R, Westbrook PR. The accuracy, night-to-night variability, and stability of frontopolar sleep electroencephalography biomarkers. *J Clin Sleep Med*. 2017;13(6):791–803.
6. Finan PH, Richards JM, Gamaldo CE, Han D, Leoutsakos JM, Salas R, et al. Validation of wireless self application ambulatory EEG. *J Clin Sleep Med* [Internet]. 2016 [cited 2022 Jan 31];12(11):1443–51. Available from: <https://advancedbrainmonitoring.app.box.com/s/j3mtk99h8yd8fhaqrxjr5iepgsglanr1>
7. Advanced Brain Monitoring I. Sleep Profiler PSG2 Portal Software Technical Manuallo Box [Internet]. [cited 2022 Jan 31]. Available from: <https://advancedbrainmonitoring.app.box.com/s/26ywta5m30ka4lpj61qydgr4r4glwgd4>



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