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27th Congress of the European Sleep Research Society

Seville, Spain I 24 – 27 September 2024

Abstracts for the 27th Congress of the European Sleep Research Society
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ABSTRACT

Poster sessions

P01
Poster Session–Basic Animal–Day 1 (Poster)

Olfactory Bulb oscillations as markers of ferret vigilance states

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Introduction: The interplay between cortico-hippocampal interactions and memory consolidation relies greatly on the vigilance state of animals. However, current sleep-scoring methods are limited by their reliance on behavioural indicators rather than brain signals alone. Moreover, in head-fixed experimental protocols necessary for certain types of experiments, relying on motor activity becomes impractical. Inspired by previous studies in mice (Bagur et al., 2018), this study introduces a brain-based approach using olfactory bulb (OB) oscillations to classify vigilance states in ferrets.
Method: Local field potential (LFP) recordings were obtained from both freely-moving and head-fixed ferrets ($n = 2$) in the olfactory bulb, hippocampus, and prefrontal cortex. Additional measures included electromyogram, electrocardiogram, pupil tracking and accelerometer data. Pharmacological interventions, involving atropine (0.05–0.5 mg/kg), medetomidine (0.05 mg/kg) and atipamezole (0.05 mg/kg) subcutaneous injections, were used to validate sleep scoring against known features of rapid eye movement (REM), non-REM sleep and anaesthesia.
Results: Analysis of LFP recordings revealed that gamma (40–60 Hz) power in the OB reliably distinguishes between sleep and wakefulness, offering brain-based metrics independent of motor activity. Furthermore, the hippocampal theta/delta ratio effectively differentiates non-REM from REM sleep, validated by physiological markers, such as muscular atonia, pupil contraction and movement, as well as pharmacological interventions, including atropine to suppress REM sleep and to alter the theta/delta ratio. Additionally, a distinct frequency band (0.1–0.5 Hz) in the OB divides sleep into discrete states, although not perfectly overlapping with the hippocampal theta/delta ratio, underscoring the complex nature of sleep substates in ferrets. With this fully brain-based sleep scoring method, we observed structural differences in arousal states in ferrets compared to mice, characterized by increased sleep duration and a higher proportion of REM sleep. These findings highlight species-specific variations in sleep architecture.
Conclusion: Our findings offer insights into ferret sleep dynamics, with distinct gamma oscillation patterns correlating with vigilance states. The identification of sleep sub-stages, coupled with the validation of sleep-related neural mechanisms across species, contributes to our understanding of ferret sleep structure and dynamics. Our results suggest that these mechanisms are conserved across species evolutionarily distant from one another.
Conflict of Interest: Yes.
COI Disclosure: The authors have declared no competing interests.
Funding: Agence Nationale de la Recherche (ANR-17-EURE-0017; ANR-10-IDEX-0001–02).

P02
1034 Achieving healthy organ function amid chronic impairment of the circadian clock Basic Animal P02 Basic Animal - Day 1 (Poster)

Changes in sleep after forced swimming in rats

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Introduction: It is known that acute inescapable stress (i.e. electric foot-shocks) leads to long-lasting alteration in sleep-wakefulness and behavior. The forced swimming, despite the contradictory interpretation of recorded behavioural changes (depression-like behaviour, despair, coping style, strategy or learned response), is used as inescapable stress model as well, but its effect on sleep is still poorly investigated. Considering the relationship between stress and sleep disturbances, we aimed to study sleep-wakefulness changes after forced swimming in rats.
Method: The experiments were performed in 7–8-month male white breedless rats ($m = 250–300$ g, $n = 7$). Animals were individually subjected to one 15 min swimming session in a tank filled with water (26°C). Continuous EEG and EMG registration and animals' locomotor activity video recording were performed before, immediately after and the day after swimming. Sleep stages were scored off-line by visual inspection of 4 s epochs. Data were means ± D, compared by ANOVA.
Results: After swimming the daytime Wakefulness percentage increased from 24.99 ± 21.71 up to 38.55 ± 18.38 ($p > 0.01$, $F = 6.608$, control vs. swimming), and NREMS percentage decreased and from 65.37 ± 37.25 down to 53.75 ± 9.52 ($p > 0.02$, $F = 6.608$,

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Introduction: Obstructive sleep apnea (OSA) and insomnia frequently co-occur, termed comorbid insomnia and sleep apnea (COMISA). Intermittent occurrences of insomnia-related symptoms suggest that a single night measurement of sleep may not provide sufficient information. We investigated the differences in nocturnal wake parameters between patients with COMISA and patients with OSA alone using multiple night measurements.

Method: Data was obtained from the Characterizing Sleep In COMISA (CHARISMA) study. Sleep structure was assessed using well-validated automatic analyses methods based on wrist-worn photoplethysmography and actigraphy measurements (Wulterkens et al., 2021). Investigated parameters included total sleep time (TST), sleep efficiency (SE), sleep onset latency (SOL), total number of awakenings (WKN), wake after sleep onset (WASO) and mean duration of an awakening. Based on previous work (Wulterkens et al., 2023), we performed a detailed analysis of prolonged awakenings: total number of awakenings with a duration of 5 min or longer (WKN ≥5 min) and WASO containing only awakenings with a duration of 5 min or longer (WASO $_{\geq}$5 min). Mixed-effects models were employed to investigate differences between the COMISA and OSA group.

Results: We analyzed data from 67 patients with COMISA and 50 patients with OSA alone for an average of 13.4 (SD 5.2) nights. No group differences were found for TST. Patients in the COMISA group as compared to patients with OSA demonstrated a lower SE (ratio: 0.79 [95% CI: 0.69, 0.91], $p = 0.001$), a longer SOL (ratio: 1.34 [95% CI: 1.06, 1.70], $p = 0.02$) and a longer mean duration of awakening (ratio: 1.21 [95% CI: 1.07, 1.36], $p = 0.003$). Among patients who encountered long awakenings (WKN ≥5 min), patients with COMISA had a higher frequency of such wakeful episodes and a longer WASO ≥5 min compared to patients with OSA (ratio: 1.13 [95% CI: 1.01 to 1.25], $p = 0.03$, and ratio: 1.30 [95% CI: 1.08 to 1.57], $p = 0.005$ respectively).

Conclusion: Multiple night sleep measurements revealed differences in nocturnal wake parameters including sleep onset latency and the duration and frequency of long awakenings between patients with COMISA compared to patients with OSA alone.

Conflict of Interest: No.

P933

Poster Session–Respiratory–Day 2 (Poster)

An explainable artificial intelligence approach for sleep staging in sleep apnea patients across all age subgroups from pulse oximetry signals

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Introduction: Characterization of sleep stages is essential in the diagnosis of sleep-related disorders but relies on the labor-intensive and manual scoring of overnight polysomnography recordings. To streamline this process, deep learning (DL) algorithms have been developed using pulse rate (PR) and blood oxygen saturation (SpO_2) signals from pulse oximetry, with a particular focus on obstructive sleep apnea (OSA) patient cohorts. However, lack of interpretability and its validation across patients from various age groups are two common concerns. Accordingly, we introduce an interpretable DL model aimed at accurately classifying sleep stages in OSA patients across all age ranges from pulse oximetry data.

Method: Overnight PR and SpO_2 signals from 17,303 sleep studies of six different datasets encompassing children, adolescents, adults, and elderly OSA patients were used. A DL model based on the U-Net framework was tailored to accurately perform 4-class sleep stage classification (wake, light sleep, deep sleep, and rapid-eye movement sleep) in OSA patients across all age subgroups from whole-night PR and SpO_2 signals. An eXplainable Artificial Intelligence (XAI) methodology based on Semantic Segmentation via Gradient-Weighted Class Activation Mapping (Seg-Grad-CAM) was applied to identify the time-frequency characteristics of the pulse oximetry signals that drive the model to score each sleep stage.

Results: The DL model showed a high performance for the 4-stage classification procedure, with accuracies ranging from 81.5% to 84.5% and Cohen's kappa values ranging from 0.726 to 0.779 in the test set of the six databases, outperforming DL models trained using PR or SpO_2 signals alone, as well as state-of-the-art studies. The Seg-Grad-CAM heatmaps revealed the key roles of mean and variance in PR and SpO_2 amplitude, along with changes in the spectral content of PR and SpO_2 within 0–0.01 Hz, 0.01–0.1 Hz, and 0.2–0.4 Hz bands, in the sleep staging process. XAI analysis also indicated slight variations in these time-frequency patterns among different age and OSA severity subgroups.

Conclusion: These findings suggest that an explainable DL model to analyze pulse oximetry signals could be integrated in the healthcare environment for automatic sleep staging in abbreviated tests for OSA diagnosis, targeting all individuals irrespectively of their age.

Conflict of Interest: Yes- This research was funded by "Ministerio de Ciencia e Innovación/Agencia Estatal de Investigación/10.13039/501100011033/", "ERDF A way of making Europe", and "NextGenerationEU/PRTR" under projects PID2020-115468RB-I00, CPP2022-009735, and PDC2021-120775-I00, and by "CIBER

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P934

Poster Session–Respiratory–Day 2 (Poster)

FESS decreases the risk of cardiovascular events in an OSA population: A TriNetX database study

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Introduction: It is well-documented in current literature that patients with obstructive sleep apnea (OSA) are at a high risk for developing cardiovascular disease. The current recommended treatment for OSA is continuous positive airway pressure (CPAP), which has shown evidence to decrease the incidence of developing comorbidities. Functional endoscopic sinus surgery (FESS) is used in patients with severe chronic rhinosinusitis (CRS) who are not responsive to noninvasive treatments. FESS has shown efficacy in improving CRS and nasal obstruction that contribute to OSA symptoms and its resulting cardiovascular disease (CVD). This study aimed to investigate the effects of FESS on the incidence of CVD among patients with OSA and a concomitant diagnosis of CRS through utilization of a large-scale database.

Method: We queried the TriNetX Research Network, a global federated health research network providing access to electronic health record data from over 120 million patients, to identify OSA patients with a concomitant diagnosis of CRS. Propensity score matching was utilized to match patients with OSA and CRS who underwent FESS to those who did not undergo surgery (control), allowing us to explore the 90-day incidence of new-onset atrial fibrillation/flutter (AFib), myocardial infarction (MI), and cerebrovascular accident (CVA) between these groups. Patients were propensity score matched for age, sex, race, and the presence of nasal polyps.

Results: After propensity score matching, each cohort was comprised of 23,895 patients. Propensity score matching showed no significant difference ($p > 0.05$) between the two cohorts. Odds of experiencing new-onset MI (OR 1.522, 95% CI 1.156–2.004, $p = 0.0026$), CVA (OR 1.417, 95% CI 1.12–1.794, $p = 0.0036$), and AFib (OR 1.639, 95% CI 1.278–2.102, $p < 0.0001$) were all significantly higher in the non-surgical cohort.

Conclusion: In OSA patients with a comorbid diagnosis of CRS, undergoing FESS decreased the odds of developing new-onset adverse cardiac events including MI, CVA, and AFib as demonstrated in a large research network database analysis.

Conflict of Interest: No.

P935

Poster Session–Respiratory–Day 2 (Poster)

New onset insomnia is related to subjective worsening of sense of smell

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Introduction: Loss of smell is both a symptom of acute corona virus disease (COVID) and a frequent post infective complaint. Within the studies from the International COVID Sleep Study (ICOSS) II, we have previously identified a bidirectional relationship between insomnia and symptoms of long COVID. In this analysis, we aim to focus on the relationship between acute COVID loss of smell and new onset insomnia.

Methods: A total of 15,859 individuals responded to the ICOSS-II. Among these, 2065 participants answering to the question "Has your sense of smell (olfactory sense) changed during COVID compared to the time before you had COVID?". Insomnia was defined by the question "Do you have insomnia?" New onset insomnia was categorized by answering "I have developed this disease during the pandemic without relation to infection" or "I have developed this after I had a COVID infection". Statistical tests of difference were weighted by nationality and age. The association between new onset insomnia and loss of smell was estimated by multivariate logistic regression. Variables significantly associated with loss of smell in bivariate analyses were added as covariates.

Results: The 2065 participants who answered the question on loss of smell were significantly younger, more often female, had higher BMI, had been treated at the intensive care unit and smoked less than the 13,794 non-participants. Only eight participants reported loss of smell and no infection. Accordingly, COVID y/n was not considered in further analyses. Fifty one percent ($n = 1055$) reported worsening of smell. Participants reporting worsening of smell were significantly older (mean 41 (SD = 16) vs. 39 (SD = 14) years, $p = 0.0016$), more often female (80% vs. 71%, $p = 0.000$) and more likely to report new onset insomnia (20% vs. 13%, $p = 0.0007$) than participant with no worsening. Worsening of smell contributed to the model of new onset insomnia (OR = 1.9, 95% CI 1.3–2.7, $p = 0.001$) after adjustment for age (OR = 1.0, 95% CI 1.0–1.0, $p = 0.000$) and gender ($p = 0.182$).

Conclusion: Loss of smell during COVID doubled the odds of reporting new onset insomnia.

Conflict of Interest: No.

for prediabetes. Median apnea-hypopnea index (AHI) was similar among groups (19.8 overall, 20.96 in those with PAP, 19.6 in those without PAP). Median residual AHI was low at 3.65 after 6-month PAP use. Median follow up was 1465 days (nearly 4 years). Among those with PAP use, median initial HbA1C was 6, which remained stable at 6 at follow up, with 25% progressed to DM; whereas in those without PAP, median initial HbA1C was 6, but had progressed to 6.5 at follow up, with 53% progressed to diabetes. Ingredient effect of pharmacotherapy was also noted. Those on PAP along with medications seem to have best outcome where median HbA1c 6.1, decreased to 5.85 on follow up, and only 22% progressed to DM. Whereas, those neither on PAP nor medications had worse outcome, where median initial HbA1C of 6.07, had progressed to 7.4 at follow up, with 60% progressing to DM.

Conclusion: Our results, though limited by small sample size, show a positive impact of adherent PAP therapy on stabilizing HbA1C in pre-diabetics with OSA and slowing the progression to diabetes mellitus, especially when combined with pharmacotherapy for pre-diabetes.

Conflict of Interest: No.

P1487

Poster Session–Respiratory–Day 3 (Poster)

Reliability of Berlin questionnaire in acute myocardial infarction patients: Insight from the AMI-sleep study

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Introduction: Berlin questionnaire have been developed to screen for sleep apnea in general population but was never tested in patients with ischemic heart disease despite the high prevalence of the disorder in this population. We aimed to test the reliability of the Berlin questionnaire in patient hospitalized for acute myocardial infarction (AMI).

Method: We prospectively enrolled a subset of patients hospitalized for AMI of the French Cohort of Myocardial Infarction Evaluation (FRENCHIE) registry included from January 2019 and December 2022 in the 16 AMI-Sleep-trained centers. Before discharge, a simplified polygraphy through ApneaLink Air+™ was performed overnight and patients completed the Berlin Questionnaire. Data were scored in centralized manner at a single center where trained physicians ascertained SDB characteristics (central or obstructive) and severity based on Apnea-Hypopnea index (AHI).

Results: Among 1363 patients, 553 (40.6%) had a positive Berlin Questionnaire, 1164 (85.4%) had an AHI ≥5/h and 734 (53.9%) had an AHI≥15/h. Being in the high-risk group on Berlin questionnaire predicted an AHI ≥5/h with a sensitivity of 0.43, a specificity of 0.74 (Kappa Coefficient = 0.0744 95% CI [0.0434; 0.1054]) and an AHI ≥15/h with a sensitivity of 0.47 and a specificity of 0.67 (Kappa Coefficient = 0.1336 95% CI [0.0830; 0.1842]). In the sub-population of patients with obstructive sleep apnea sensitivity and specificity were also sub-optimal, respectively 0.54 and 0.74 for an AHI ≥5/h (kappa coefficient of 0.2615 95% CI [0.1429; 0.3802]) and 0.58 and 0.74 (kappa coefficient of 0.2782 95% CI [0.1605; 0.3959]) for an AHI ≥15/h.

Conclusion: Berlin questionnaire was not reliable for sleep apnea diagnosis in patients hospitalized for acute myocardial infarction. Other screening tools should be developed to screen apnoeic patient in this population.

Conflict of Interest: No.

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