Using Hospital Sleep Quality to Predict Functional Recovery of Inpatients With Stroke

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Introduction

- Sleep enhances **neuroplasticity** – essential for stroke recovery[1]
- Inpatient sleep is often **poor** – affected by hospital conditions, nighttime care, and patient symptoms[2]
- Better sleep quality & therapy is often associated with **better recovery and physical function**[3]

Aim: Compare combinations of sleep measures, admission data, and demographics to determine best performing model to predict functional outcomes.

Materials & Methods

Participants

Demographics (N=167)		N
Age	<40	19
	40-59	50
	60-79	85
	80-90+	13
Sex	Male	87
	Female	80
Stroke Type	Hemorrhagic	44
	Ischemic	100
	Both	11
Lifestyle	Sedentary	28
	Moderately Active	56
	Highly Active	67
Smoker	Yes	32
	No	129
History	COPD/Asthma	24
	Diabetes	48
	CHF	7
	ESRD	3

	Median	Std Error
Age	62	8.01
BMI	26.4	0.55
Length of Stay	21	0.6

	Median	Std Error
Sleep Time (min)	450.75	2.85
WASO	58.29	2.29
Efficiency (%)	85.21	0.50
Fragmentation	25.67	0.42

Procedure

Data Used:

- Objective Daily Sleep Data: ActiWatch

- Subjective Admission Data: FACIT-F, PSQI
- Objective Admission Data: Self-Care QI (SC QI), Mobility QI (Mob QI)
- Functional Outcome Tests: 6MWT, 10MWT, BBS, ARAT

Python Models:

- *Poor performing model architectures:* Single and Multiple Variable Linear Regression, k-NN Regression
- *Best performing model architectures:* Random Forest, Gradient Boosting, LASSO
- *Best overall:* Gradient Boosting

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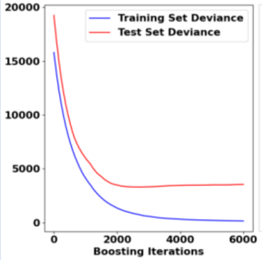
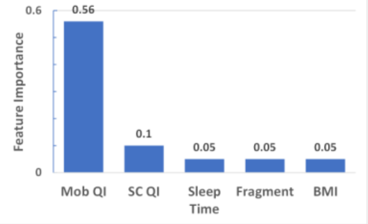
Results

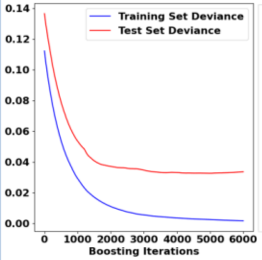
- Gradient Boosting Regression models use many weak learners that each try to reduce the error of the previous.
- Model error decreases over 6000 iterations as it is trained on known data (blue). Model predictions are compared against actual values in the testing process (red).

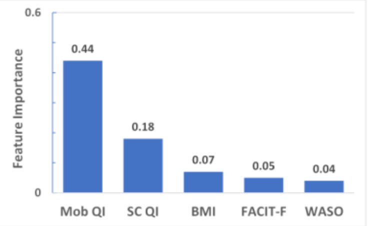
6MWT: N = 150, R^2 = 0.81



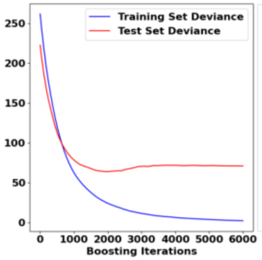


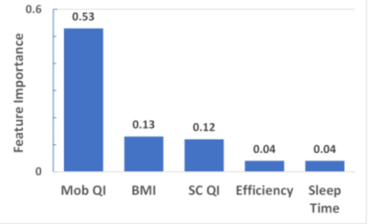
10MWT: N = 157, R^2 = 0.73





BBS: N = 137, R^2 = 0.64



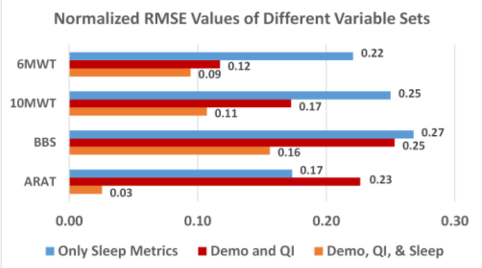


ARAT: N = 35, R^2 = 0.43 with subgroup (Omitted for small sample size)

Correlations (R^2) of individual variables with functional outcomes.

Test	Mob	SC	BMI	Sleep Time	Efficiency	WASO	Fragment
6MWT	0.688	0.646	-0.17	-0.055	0.154	-0.197	-0.158
10MWT	0.662	0.631	-0.01	-0.109	-0.044	-0.066	-0.044
BBS	0.687	0.646	-0.07	-0.093	-0.036	0.011	0.024

QI (Mob, SC) Demographics (BMI) Sleep Metrics (Sleep Time, Efficiency, WASO, Fragment)



- A value closer to 0 represents a lower prediction error.
- Models built with only sleep metrics had higher error than models with only demographics and QI.

Conclusion

- Self-Care and Mobility metrics at admission had highest model importance and correlation with functional outcomes
- Better sleep by itself is not predictive of functional outcomes due to high model error
- Daily sleep metrics individually do not contribute much, but when combined with demographics and initial subjective measures improve model accuracy substantially

Limitations

- Some subjects had missing data from admission surveys
- Models did not include daily subjective sleep surveys

Acknowledgements

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Special thanks to the whole Project SIESTA Team!

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Summer 2023

Assessing the Effect of Pain Medications on the Recovery and Sleep Quality of Patient's in Acute Stroke Rehabilitation

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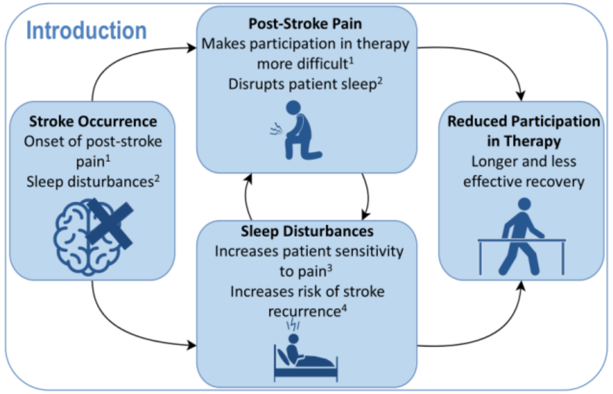
Introduction



Materials & Methods

Participants

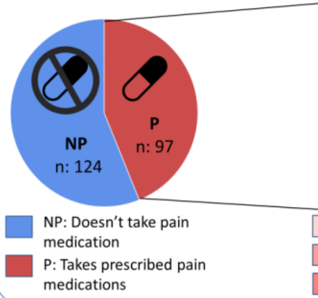
Demographics (n = 219)		x̄(σ)
Age		60.4(15.1)
Length of Stay		22.3(7.2)
		n(%)
Stroke Type	Ischemic	139(63.6)
	Hemorrhagic	59(26.9)
	Both/Unknown	21(9.6)
Gender	Male	114(52.1)
	Female	105(47.9)

Procedure

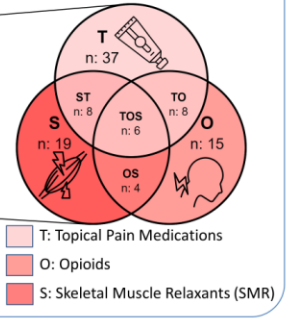
Data Used:

- Objective Daily Sleep Data: ActiWatch , ActiGraph and ANNE chest and limb sensors
- Subjective data: Pittsburgh Quality Sleep Index (PQSI), Functional Outcomes of Sleep Questionnaire (FOSQ)

Groups



Types of Pain Medication



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Results

Figure 1: Overall means between P and NP

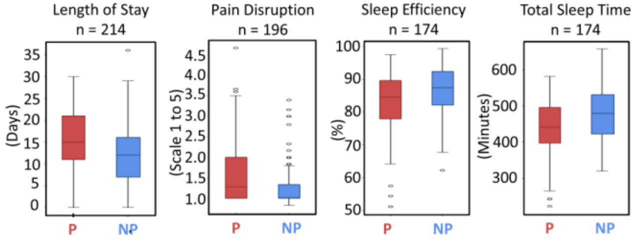


Figure 2: Average WASO between P and NP over percent stay

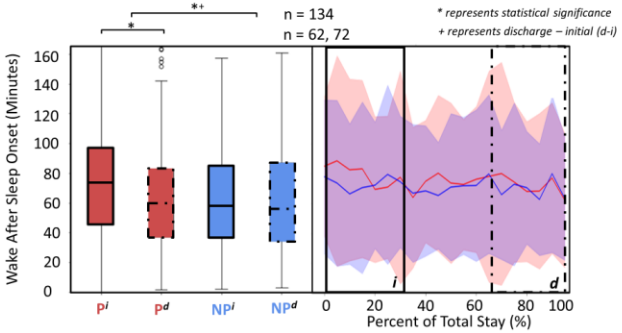


Figure 3: Average nighttime activity between P and NP over percent stay

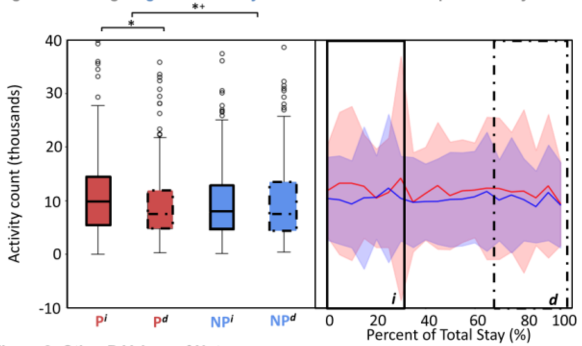
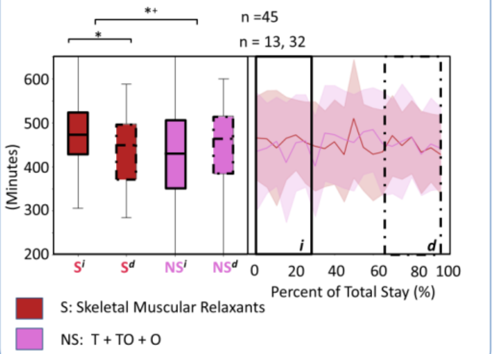


Figure 3: Other P-Values of Note

Metric	P-Value	P	NP
Change in FOSQ score	0.038	-0.33[1]	0[1]
Change in Mean Heart Rate	0.019	-1.95(6.0)	0.47 (6.3)

Figure 4: Average sleep time between S and NS over percent stay



Conclusion

- Overall, patients who take pain medications have a **significantly lower sleep quality** than those without pain medications.
- Despite this, patients who take pain medication see **significantly higher recovery in sleep quality** than those without pain medications.
- The skeletal muscular relaxant group seemed to have the greatest effect in decreasing sleep times.

Future Research

- Research should be done on the effect on physical measures of functional outcomes like the 6 minute walk test.
- Further elucidation of the effect of specific medications that help pain, including those classed as anti-depressants.

Limitations

- Some subjects had missing data from missing surveys and sensor error.
- Our population excludes those with Obstructive Sleep Apnea.
- Study conducted at one location, may reduce generalizability.

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Special thanks to the whole Project SIESTA Team! Special thanks to the 11th and 26th floors for putting up with this year's interns!

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Summer 2024

Temporal Analysis of the Effects of the COVID-19 Pandemic on Sleep Quality in an Acute Stroke Rehabilitation Setting

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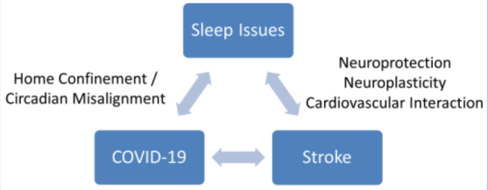
Introduction

Sleep is essential for promoting stroke recovery:

- *Neuroprotective*: Sleep rebound and ischemic preconditioning[1]
- *Neuroplastic*: Neurogenesis, axonal sprouting[1]
- *Cardiovascular Interaction*: Hypertension, atherosclerosis, etc.[2]

During the COVID-19 pandemic, sleep issues and stroke were exacerbated:

- *Home confinement*: circadian misalignment[3]
- *COVID-19 inflammation*: stroke risk[4]
- *Fear of Hospitals*: less likely to receive acute care on time[5]



Materials & Methods

Participants

SIESTA-rehab study, non-intervention patients: **n = 144**

Figure 1: COVID Timeline

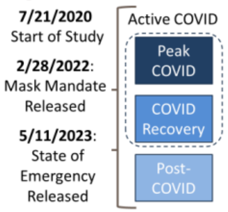


Figure 2: Demographic Table

	Demographics	n = 98
Sex	Male	46
	Female	52
Age	<40	13
	40-59	26
	60-79	51
	80+	8
Stroke Type	Hemorrhagic	31
	Ischemic	58
	Both	9
Lifestyle	Sedentary	20
	Moderate	38
	Highly Active	40
Smoking	Yes	20
	No	78
History	COPD/Asthma	14
	Diabetes	32
	CHF	2
	ESRD	2
	Other	48

Procedure

- Objective Measures: Actigraph, Actiwatch, ANNE
- Subjective Measures: Sleep Questionnaires (Karolinska, PHSD, FOSQ), Demographics

COVID Grouping (Figure 1):

- Subjects assigned to group in which they spent majority of time

Analysis Techniques:

- Significance: ANOVA, Kruskal-Wallis, Independent t-tests, Mann-Whitney U test
- Normality and Variance Checks: Shapiro-Wilkes, Levene's

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Results

Significant differences were found overall between the COVID-19 groups in numerous categories, particularly in physiological measures and sleep disruptions.

Figure 3: ANOVA analysis of sleep quality across pandemic periods

Variable	P-Value
Mean chest temperature	0.000037
Mean blood oxygen saturation	0.000085
Disruption from medical testing (ex. blood tests)	0.00057
Disruption from turning in bed	0.0045
Disruption from pain	0.037
Disruption from anxiety	0.057
Length of stay	0.0049
Karolinska score	0.015
Wake time	0.018

= Physiological Measures
= Disruptions to Sleep
= Miscellaneous

Figure 4: COVID-19 timeline and t-test analysis of sleep quality measures between COVID-19 groups

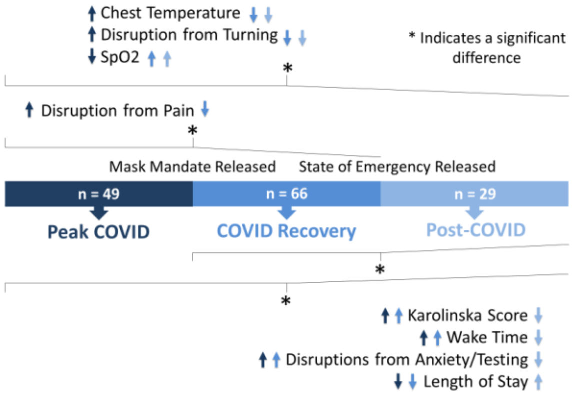
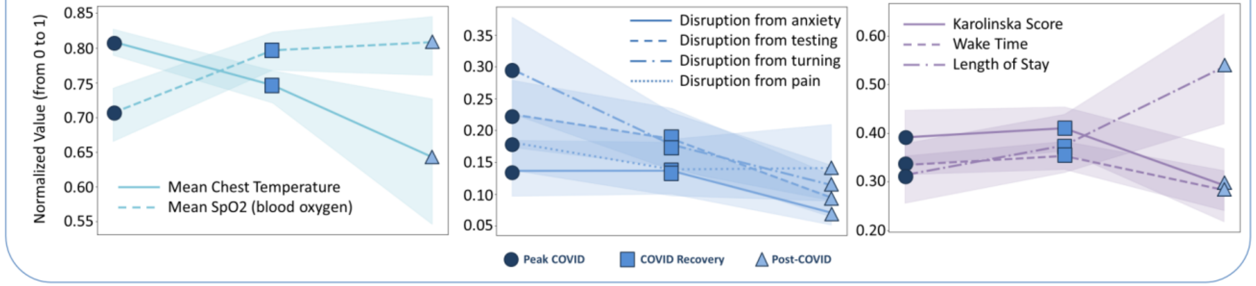


Figure 5: Normalized trends of physiological measures, sleep disturbances, and miscellaneous variables



Conclusion

Active COVID vs Post-COVID:

- **Significant improvement in sleep quality** as measured by the decreased Karolinska score and sleep disruptions. Possibly due to less circadian misalignment in the post-COVID group or hospital policy
- Subjects **waking up earlier** in the day and **staying in the hospital for longer**
- Over time, chest temperature decreased while oxygen saturation increased

Future Investigations

- Performing circadian analysis of COVID time periods to investigate reasons for improved sleep quality
- Exploring connection between chest temperature, oxygen saturation and sleep quality during COVID
- Repeating study in other stroke hospitals to ensure data validity and identify trends

Limitations

- Analysis did not consider initial vs. discharge, only mean values rather than differences
- Presence or absence of COVID-19 infection was not accounted for
- Subjects were not matched by demographic during analysis

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Summer 2024

Proposing a Transcultural Approach for SIESTA-Rehab Considering Cognitive Impairment in Patient's with Stroke

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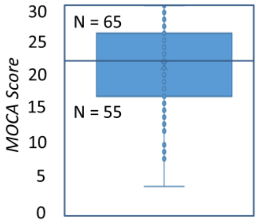
Introduction & Background

- SIESTA-Rehab, a longitudinal sleep study, monitors sleep of patient's with stroke during acute inpatient rehabilitation. Research has found that post-stroke there is a **higher prevalence of cognitive impairment**[2] which has been shown to **decrease sleep quality**.[4]
- Across 120 patients enrolled in SIESTA-Rehab, we have found supporting evidence as a majority of post-stroke patients are below the provided Montreal Cognitive Assessment (MOCA) cutoff of 26[3], with a median of 22. Additionally those with lower cognitive function (MOCA < 22) have significantly different sleep quality to those with higher cognitive function (MOCA ≥ 22).

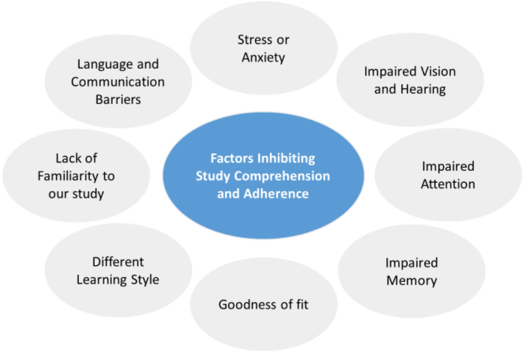
SIESTA MOCA Scores



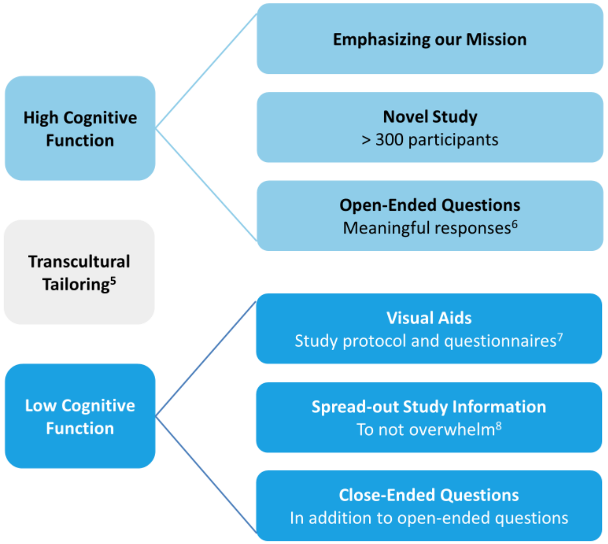
Significant P-Values <0.05 *

Measures	P-Value
Total Sleep Duration	0.03*
Sleep Latency	0.013*
Karolinska Sleep Survey	0.014*

- Given the lower MOCA scores, we have noted challenges in study protocol adherence, including device wear and survey responses. Therefore, we propose that <u>being mindful of our patients cognitive ability and cultural background during the study protocol will improve study motivation and adherence</u>.



Methods to Increase Enrollments & Compliance



Transcultural Tailoring

A Brazilian Study **adapted their MOCA questionnaire** to consider their populations <u>education status</u> and altered the questionnaire to include more <u>culturally familiar</u> pictures, improving cognitive evaluation accuracy.[5]

High Cognitive Function

- Emphasizing our mission and the novelty of the study **motivates individuals to participate** and understand its relevance.
- Open ended questions **encourage meaningful responses** which better <u>reflects cultural background</u>.[6]

Low Cognitive Function

- Visual aids **improve study understanding** by simplifying the complexity of study protocols and providing assistance to questionnaires.[7]
- Delaying ongoing participation opportunity will **decrease the immediate feelings of overwhelmingness.**[8]
- Close-ended questions **provide clarification** to open ended questions.

Application to SIESTA-Rehab

- Consider **cultural and historical background** when screening patients to <u>improve interpersonal communication</u>
  - Noting demographics (Religion, Education level)
- Improve **study materials** to <u>enhance comprehension of the study</u>
  - Provide visual aids (Photos of sensor placement, questionnaire graphics)
- Promote **family involvement** to <u>provide more insights about patients</u>
  - Helps researchers determine goodness of fit
- Conduct **frequent check ins** to <u>promptly address potential concerns</u>
  - Alleviates patient anxiety about participation
- Encourage elaborate and detailed **patient feedback** to <u>refine the study direction</u>
  - Provide researchers with a wide range of perspectives

Conclusion

Implementing cultural and cognitive considerations can be beneficial for all research studies to encourage engagement and improve patient compliance.

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