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COMPARISON OF SLEEP QUALITY AFTER SPINAL AND GENERAL ANESTHESIA IN NON-OBSTETRIC ASA CLASS I PATIENTS

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ABSTRACT

Background:

Sleep quality refers to various sleep measures, including total sleep time, sleep onset latency, and sleep efficiency. Research shows a significant relationship between sleep and surgery, and their outcomes postoperatively. Post-surgery, patients often experience sleep disturbances, with higher age causing lower efficiency and higher apnea-hypopnea index. The purpose of study is to investigate the effect of spinal and general anesthesia on postoperative sleep quality.

Methodology:

In this study comparatively analyze sleep quality through the Pittsburg sleep Quality Index (PSQI) of 130 patients both spinal and general anesthesia comprising 65 patients. Ethical consideration and consent approved from IRB and hospitals. Data was collected by asking patients about their previous 01-month sleep quality preoperatively and 15 days after surgery postoperatively. A frequency percentage and paired sample t-test were used to analyze the results.

Results:

Spinal Anesthesia having pre-op PSQI Score comprising mean ± standard deviation was 2.415 and 8.225, and post-op PSQI score comprising mean ± standard deviation was 2.329 and 9.97 their correlation was 0.377 and significance value was 0.002.

While general anesthesia having pre-op PSQI Score comprising mean ± standard deviation was 2.129 and 7.251, and post-op PSQI score comprising mean ± standard deviation was 2.266 and 8.034, their correlation was 0.696 and significance value was 0.000.

Conclusion:

This study reveals that patients with spinal anesthesia experience poorer postoperative sleep quality compared to preoperative sleep, and those with poor preoperative sleep quality are more likely to suffer from more worsen sleep quality postoperatively. sleep quality varies amongst patients under general anesthesia and can even be worse or more severe postoperatively. The impact of spinal anesthesia on sleep quality is worse than that of general anesthesia patients.

Keywords: *Spinal Anesthesia, General Anesthesia, Sleep quality, PSQI Score.*

INTRODUCTION

Anesthesia, derived from the Greek word anaisthaesia meaning "insensibility," refers to the loss of sensation caused by drugs that inhibit nerve tissue activity or within the central nervous system (CNS) cause anesthesia [1]. General anesthesia induces unconsciousness with pain-free sensations using various drugs, aiming to achieve analgesia, amnesia, immobility, hypnosis, and paralysis [2]. Spinal anesthesia is a simple, efficient procedure that injects a small amount of local anesthetic into the lumbar cerebrospinal fluid, resulting in effective anesthetic, analgesia, and lower limb sympathetic and motor block [3].

Sleep quality encompasses various sleep measures like total sleep time, sleep onset latency, degree of fragmentation, total wake time, sleep efficiency, and disruptive events like spontaneous arousals or apnea [4]. Sleep is a regular physiological and psychological condition characterized by reduced awareness, sensory activity, voluntary muscle inhibition, and reduced environmental interactions [5]. Sleep is a crucial physiological activity for the human body to regulate its internal state and combat exhaustion [6].

In the normal population, the cycle of spontaneous sleep and wakefulness repeats every 24 hours [7]. Sleep consists of five stages: slow-wave sleep (SWS) and rapid eye movement (REM), with three to five daily cycles consisting of NREM, REM, and waking phases [8]. The aim of current research study is to comparatively analyze Sleep Quality after Spinal and General Anesthesia in Non-Obstetric ASA Class I Patients.

Research indicates that postoperative sleep disorders are more prevalent in evening operations, and the quality of sleep significantly impacts surgical patients' recovery [6]. After surgery, patients may experience varied outcomes from surgeries that result in high levels of physical and psychological stress [9].

Patients usually experience sleep disturbances following surgery, and this can be detrimental to their ability to recover postoperatively [10-18]. Significant sleep disturbances are frequently experienced by patients right after surgery, especially major surgery [5, 16]. Severe sleep deprivation, fragmentation of sleep, and reduction or loss of SWS and REM sleep during the night following surgery are typical polysomnographic manifestations [10, 11, 15-18]. Patients may experience frequent nightmares, shorter sleep durations, more arousals or awakenings, and poorer sleep quality [19]. Sleep structure progressively returns to normal during the ensuing postoperative phase, with a REM rebound occurring within a week [11]. In the study of *Chung et al* Higher age is linked to lower sleep efficiency following surgery and a higher apnea-hypopnea index (AHI) [18]. Older patients are therefore more likely to experience postoperative sleep disturbances [5]. An electroencephalography (EEG) study in 1990 on postoperative sleep revealed that during the first seven nights following surgery, sleep patterns can be seriously disrupted [11]. A number of things, including the anesthetic used, postoperative pain, sympathetic activation, and psychological reactions, might result in postoperative sleep disturbance [19].

The structure and quality of postoperative sleep are altered as a result of circadian rhythm desynchronization, which is independently associated with general anesthesia [20, 21]. Insomnia, hypersomnia, parasomnia, and breathing disorders related to sleep are a few of the outcomes of poor sleep quality [22]. Inadequate sleep after surgery may affect recuperation and mental abilities [23]. Sevoflurane, isoflurane, and halothane are examples of volatile general anesthetic that can cause short-term sleep disruption and fragmentation [11]. Recent research has shown certain similarities between the systems controlling sleep and general anesthesia [24, 25]. *Pick et al.* discovered that, without influencing wakefulness or non-REM sleep, sevoflurane inhalation can cause REM sleep deficits, delayed REM sleep recovery, and decreased latency to REM sleep anesthesia [24, 25]. Sleep disturbances have been linked to the onset and progression of a number of illnesses, including obesity, hypertension, and other metabolic conditions, as well as heart and brain disorders [26, 27]. Sleep disturbances following surgery may have an impact on mood, leading to a decrease in energy and an increase in the subjective perception of weariness and sleepiness [13].

Postoperative pain is linked to sleep disturbances and poor-quality sleep [24, 28], behavioural alterations and low emotional health [24, 29]. It has been suggested that opioids may be the cause of postoperative sleep disturbance [11, 30]. Lack of sleep may impair immunity and make an organism more vulnerable to infection [31]. Research has

shown that the immune system is directly regulated by sleep [32]. one of the known mechanisms is the increase of proinflammatory mediators in patients with sleep disorders, which leads to the aggravation of pain [6]. Preoperative sleep disturbance was linked to a higher risk of postoperative delirium in patients having arthroplasty or noncardiac surgery [33, 34]. Anesthetic techniques have the potential to alter the postoperative course by modulating the physiological response [35].

The previous research studies tell the impact of general or regional anesthesia on sleep quality. The previous study demonstrates that with general anesthesia patients feel poor sleep quality postoperatively. There are some studies about spinal anesthesia outcomes that no significance impact of spinal anesthesia on sleep quality but not clear evidence were present and limited research studies on spinal anesthesia was present. Is spinal anesthesia have no impact on patients sleeps quality or sleep disturbed by spinal anesthesia? and what are the outcomes if we comparatively analyze spinal anesthesia with general anesthesia and from which anesthesia technique patients suffer with poor sleep quality postoperatively. This research study results signifies that whether it is need to modify anesthesia techniques to overcome the consequences from which patients suffer bad sleep postoperatively.

The objective of this study is to evaluate the pre operative sleep quality of the patients undergoing spinal and general anesthesia 01 month before surgery through Pittsburg Sleep Quality Index (PSQI) [36]. To evaluate the post operative sleep quality of the patients undergone spinal and general anesthesia 15 days after surgery through PSQI.

Methodology:

This was an observational cross-sectional study. In current research study comparatively analyze sleep quality through the Pittsburgh sleep Quality Index (PSQI) of 130 patients both spinal and general anesthesia comprising 65 patients. This study was carried out from Federal Govt. Polyclinic Hospital Islamabad, Dr. Akbar Niazi teaching Hospital Islamabad, DHQ Hospital Sheikhupura, DHQ Hospital Layyah and Shaikh Zayed Hospital Lahore. Ethical consideration and consent approved from IRB and hospitals. Data was collected by asking patients about their previous 01-month sleep quality preoperatively and 15 days after surgery postoperatively. A frequency percentage and paired sample t-test were used to analyze the results.

The duration of study was 3 months (October - December, 2023). The sampling technique was used in this study to collect Data from patients to check sleep quality through Pittsburg sleep Quality index (PSQI) [36].

The inclusion criteria for this study are patients age between 18–45-year, elective procedures, Body mass index (BMI) between 18.5 and 30 kg/m^2, Health status American Society of Anesthesiologists (ASA) grade I, Operation time between 1 h and 3 h.

The Exclusion criteria for this study is Patients >45-year age (to eradicate age related sleep disorders), frequent night time awakening, chronic drug abusers, Body mass index exceeding 30kg/m^2, Surgery time longer than 3 hour, Patients with ASA status II or more than II, undergoing emergency surgery, unable to communicate normally.

Statistical Analysis:

Data was analyzed by using IBM SPSS statistics. The Categorical data was analyzed by using paired sample t test and expressed as percentages. Continuous data are expressed as mean and standard deviation. P value 0.05 or less was considered significant.

Results:

Table 3.1 has variables Anesthesia Plan, gender, age, and marital status. Both spinal and general Anesthesia comprise 65 patients. Spinal Anesthesia comprises 29 (44.6%) females and 36 (55.4%) males. While general Anesthesia comprises 33 (50.8%) females and 32 (49.2%) males. Patients in spinal Anesthesia having age ranges from 18 to 23 years were 13 (20.0%), 24 to 29 years were 18 (27.7%), 30 to 35 years were 14 (21.5%), 36 to 41 years were 07 (10.8%), and 42 to 47 years were 13 (20.0%). While patients in general Anesthesia had age ranges from 18 to 23 years (32.3%), 24 to 29 years (13.8%), 30 to 35 years (14.9%), 36 to 41 years (10.9%), and 42 to 47 years (11.9%). The marital status of patients in spinal anesthesia, comprising 37 (56.9%), was married and 28 (43.1%) was unmarried, while in general anesthesia, 37 (56.9%), was married and 28 (43.1%) was unmarried.

Table 3.1: Demographic Variables' Analysis

	Spinal Anesthesia [n=65]		General Anesthesia [n=65]	
	F	%	F	%
Female	29	44.6%	33	50.8%
Male	36	55.4%	32	49.2%
18 to 23	13	20.0%	21	32.3%
24 to 29	18	27.7%	9	13.8%
30 to 35	14	21.5%	14	16.9%
36 to 41	7	10.8%	10	16.9%
42 to 47	13	20.0%	11	16.9%
Married	37	56.9%	37	56.9%
Unmarried	28	43.1%	28	43.1%

N=130

Figure 3.1 has variables socio-economic status in which patients from lower class was 17(13.08%), from middle class was 95(73.08%) and from upper class was 18(13.85%).

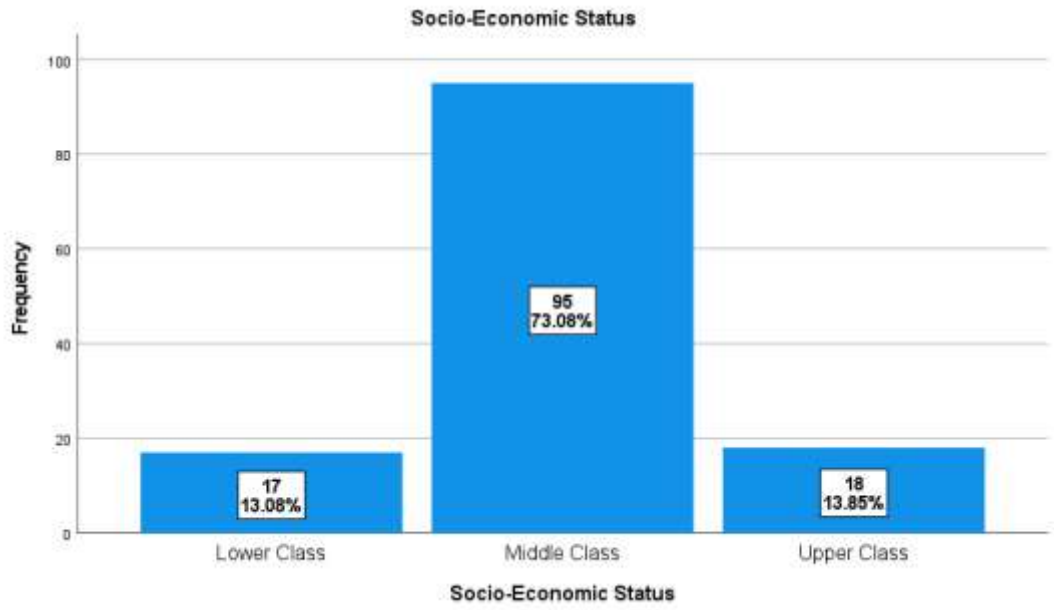

Figure 3.1: Socio-Economic Status Patients

Assessment of Sleep Quality of Patients

Table 3.3 Comprising pre-op spinal anesthesia PSQI-Score in which patients having good quality sleep psqi-score (0 to 04) was 35(53.8%), bad quality sleep psqi-score (05 to 10) was 24(36.9%) and very bad sleep quality sleep psqi-score (11 to 15) was 6(9.2%).

Table 3.3: pre-op spinal anesthesia PSQI-Score

	PSQI-Score	F	%
Good Quality Sleep	0 to 04	35	53.8%
Bad Quality Sleep	05 to 10	24	36.9%
Very Bad Quality Sleep	11 to 15	6	9.2%

Table 3.4 Comprising post-op spinal anesthesia PSQI-Score in which patients having good quality sleep psqi-score (0 to 04) was 25(38.5%), bad quality sleep psqi-score (05 to 10) was 32(49.2%), very bad sleep quality sleep psqi-score (11 to 15) was 5(7.7%) and worse quality sleep psqi-score (16 to 21) was 3(4.6%).

Table 3.4: post-op spinal anesthesia PSQI-Score

	PSQI-Score	F	%
Good Quality Sleep	0 to 04	25	38.5%
Bad Quality Sleep	05 to 10	32	49.2%
Very Bad Quality Sleep	11 to 15	5	7.7%
Worse Quality Sleep	16 to 21	3	4.6%

Table 3.5 Comprising pre-op general anesthesia PSQI-Score in which patients having good quality sleep psqi-score (0 to 04) was 33(50.8%), bad quality sleep psqi-score (05 to 10) was 30(46.2%) and very bad sleep quality sleep psqi-score (11 to 15) was 2(3.1%).

Table 3.5: pre-op general anesthesia PSQI-Score

	PSQI-Score	F	%
Good Quality Sleep	0 to 04	33	50.8%
Bad Quality Sleep	05 to 10	30	46.2%
very Bad Quality Sleep	11 to 15	2	3.1%

Table 3.6 Comprising post-op general anesthesia PSQI-Score in which patients having good quality sleep psqi-score (0 to 04) was 31(47.7%), bad quality sleep psqi-score (05 to 10) was 32(49.2%) and very bad sleep quality sleep psqi-score (11 to 15) was 2(3.1%).

Table 3.6: post-op general anesthesia PSQI-Score

	PSQI-Score	F	%
Good Quality Sleep	0 to 04	31	47.7%
Bad Quality Sleep	05 to 10	32	49.2%
Very Bad Quality Sleep	11 to 15	2	3.1%

Table 3.7 has Comparison of Perioperative Sleep Quality in which Patients with spinal anesthesia having pre-op PSQI Score comprising mean ± standard deviation i.e. 5.32±2.905 indicating good sleep (PSQI Score 2.415) to bad sleep (PSQI Score 8.225) and post-op psqi score comprising mean ± standard deviation 6.15±3.821 indicating good sleep (PSQI Score 2.329) to bad sleep (PSQI Score 9.97), but more than preoperatively, their correlation was 0.377 and significance value was 0.002. Patients with general anesthesia having pre-op PSQI Score comprising mean ± standard deviation i.e. 4.69±2.561 indicating good sleep quality (PSQI score 2.129) to bad sleep (PSQI Score 7.251) and post-op psqi score comprising mean ± standard deviation 5.15±2.884 indicating good sleep (PSQI Score 2.266) to bad sleep (PSQI Score 8.034) but more than preoperatively, their correlation was 0.696 and significance value was 0.000.

Table 3.7: Comparison of Spinal & General Anesthesia's Sleep Quality

	N	Mean	Std. Deviation	R	Sig.
Pre-Op PSQI Score		5.32	2.905	0.377	0.002

Spinal Anesthesia	Post-Op PSQI Score	65	6.15	3.821		
General Anesthesia	Pre-Op PSQI Score	65	4.69	2.561	0.696	0.000
	Post-Op PSQI Score		5.15	2.884		

Discussion:

The results of this study demonstrate that patients with spinal anesthesia have poor sleep quality postoperatively as compared to preoperatively. The results also show that patients with spinal anesthesia who had poor or bad sleep quality preoperatively were more likely to suffer from bad sleep quality postoperatively. The prospective study of *Çay, D., et al.*, conducted in *Pendik State Hospital and s, Kartal Dr. Lütfi Kırdar City Hospital, İstanbul, Türkiye* was found that there was no correlation when the relationship between PSQI and visual analogue scale (VAS) was analyzed. It was discovered that there was not a noticeable difference in the quality of sleep under spinal anesthesia [9]. But current research study shows that spinal anesthesia disturbs patients' sleep quality when analyze their sleep quality perioperatively.

The results of this study also demonstrate that the preoperative and postoperative sleep quality varies amongst patients under general anesthesia and can even be worse or more severe postoperatively. The research study of *Tan, W.f., et al.*, conducted at *The First Hospital of China Medical University, Shenyang, China* demonstrate the Thoracic Epidural Anesthesia (TEA) has the benefit of improving pain management and IL-6 expression inhibition, which results in improved quality of sleep following surgery [35]. The research study of *Nilsson, U., et al.*, conducted at *Karolinska University Hospital, Stockholm, Sweden* was discovered that patients having GA surgery reported much higher levels of postoperative discomfort than patients having RA surgery. Physical, psychological, and social issues were all sources of discomfort; the way these issues were generally felt and handled appeared to be correlated with individual expectations for the healing process [37]. There is evidence which support current research study which means that patient undergoing general anesthesia facing sleep disturbance postoperatively. However, it has been noted that, in general, GA is thought to carry a higher risk of perioperative complications than RA [37-39]. A research study of *Kjølhede, P., et al.*, conducted at *Linköping University. Department of Anesthesia and Intensive Care, County Council of Östergötland, Sweden* demonstrate when compared to the women who had spinal anesthesia, the general anesthesia group's postoperative nighttime sleep quality was significantly worse. This was almost exclusively linked to the general anesthesia group's noticeably higher postoperative opioid consumption [13]. In current research study outcomes comparison of perioperative sleep quality, it has been shown that patients in spinal anesthesia feel worse sleep quality than patients in general anesthesia.

The research study of *Su, X. and D.-X. Wang*, conducted at *Peking University First Hospital, Beijing, China* conclude that Significant sleep disturbances are frequently experienced by patients right after surgery, especially major surgery [5, 15-18]. The research study of *Rosenberg-Adamsen, S., et al.*, conducted at *South Cleveland Hospital, Cleveland TS4 3BW, England* found that a number of things, including the anesthetic used, postoperative pain, sympathetic activation, and psychological reactions, might result in postoperative sleep disturbance [19]. The study of *Chung, F., et al.*, conducted at *Toronto Western Hospital, Ontario, Canada* conclude that a decrease in or loss of rapid eye movement (REM) and slow-wave sleep (SWS) may be observed in affected patients, as well as polysomnographic evidence of severe sleep deprivation or fragmentation [17, 18]. The study of *Li, C. and S. Shang*, conducted at *School of Nursing, Peking University, 38 Xueyuan Road, Hai Dian District, Beijing 100191, China* conclude that sleep disturbances have been linked to the onset and progression of a number of illnesses, including obesity, hypertension, and other metabolic conditions, as well as heart and brain disorders [26, 27].

A research study of Knill, R.L., et al., demonstrate that changes in sleep structure, increased frequency of waking, and symptoms of insomnia, hypersomnia, and narcolepsy are characteristics of postoperative sleep disturbances [11, 40]. The study of Olson, D.M., et al., conducted at *Duke University Medical center, Durham* suggested that postoperative delirium was more common in

patients with preoperative sleep disorders. In the event that it gets severe, there could be mental health issues [such as hallucinations, inattention, seclusion, agitation, and even aggression] [41]. A cohort research study of *Wu, M.-P., et al.*,conducted at *Taiwan National Health Insurance Research Database* demonstrate that lack of sleep can lead to the onset of cardiovascular disease, raise the risk of stroke, and have an impact on the recovery from a stroke [42].

The research study of Ruiz, F.S., et al., observed that lack of sleep may impair immunity and make an organism more vulnerable to infection [31]. Research of *Man, K., A. Loudon, and A. Chawla,* has shown that the immune system is directly regulated by sleep [32]. The research study of *Tan, W.f., et al.*, Anesthetic techniques have the potential to alter the postoperative course by modulating the physiological response [35]. Prolonged sleep deficiency (e.g., short sleep duration, sleep disturbance) can lead to chronic, systemic low-grade inflammation and is associated with various diseases that have an inflammatory component, like diabetes, atherosclerosis, and neurodegeneration[43].

4.1 Conclusions:

This study concludes that patients with spinal anesthesia have poor sleep quality postoperatively as compared to preoperatively and results also show that patients with spinal anesthesia who had poor or bad sleep quality preoperatively were more likely to suffer from worsen sleep quality postoperatively. According to the study, preoperative and postoperative sleep quality varies amongst patients under general anesthesia and can even be worse or more severe postoperatively. Comparison of perioperative sleep quality, it has been shown that impact of spinal anesthesia on patients' sleep quality was worse than sleep quality of patients in general anesthesia.

4.2 Recommendations:

This research studies are based on comparatively check the patients' sleep quality with spinal and general anesthesia. There are limited research studies on sleep quality with spinal anesthesia and also limited time duration to analyze sleep quality of the patients. It is recommended to conduct more studies on spinal anesthesia and also check sleep quality after exposure of anesthesia for long time period. It is also recommended to conduct a research study on factors which disturbed the sleep quality and to evaluate which anesthetic drugs were more prone to disturbed the patients' sleep quality. It is also advised to evaluate whether the change of anesthesia induction method or use of intravenous anesthetic as premedication improve the sleep quality post operatively.

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Authors Contributions:

Muhammad Azeem, Tehseen Zahra, Aqsa Batool: Substantial contributions to the conception and design of the work.

Ahtisham nisar, Aziz Ahmad, Rabeea Samad: Design of the work and the acquisition. Drafting the work.

Adnan Iqbal, Muhammad Abdullah: Final approval of the version to be published.

REFERENCES:

1. Tranquilli, W.J. and K.A. Grimm, *Introduction: use, definitions, history, concepts, classification, and considerations for anesthesia and analgesia.* Veterinary Anesthesia and Analgesia: The Fifth Edition of Lumb and Jones, 2015: p. 1-10.
2. Brown, E.N., R. Lydic, and N.D. Schiff, *General anesthesia, sleep, and coma.* New England Journal of Medicine, 2010. **363**(27): p. 2638-2650.
3. Kokki, H., *Spinal blocks.* Pediatric Anesthesia, 2012. **22**(1): p. 56-64.
4. Krystal, A.D. and J.D. Edinger, *Measuring sleep quality.* Sleep medicine, 2008. **9**: p. S10-S17.
5. Su, X. and D.-X. Wang, *Improve postoperative sleep: what can we do?* Current opinion in anaesthesiology, 2018. **31**(1): p. 83.
6. Yu, S., et al., *Effects of Preoperative Sleep Disorders on Anesthesia Recovery and Postoperative Pain in Patients Undergoing Laparoscopic Gynecological Surgery under General Anesthesia.* Mediators of Inflammation, 2022. **2022**.
7. Wichniak, A., et al., *Standardy leczenia zaburzeń rytmu okołodobowego snu i czuwania opracowane przez Polskie Towarzystwo Badań nad Snem i Sekcję Psychiatrii Biologicznej Polskiego Towarzystwa Psychiatrycznego. Część*

I. Fizjologia, metody oceny i oddziaływania terapeutyczne. Psychiatria Polska, 2017. **51**(5).
8. Nelson, L.E., N.P. Franks, and M. Maze, *Rested and refreshed after anesthesia? Overlapping neurobiologic mechanisms of sleep and anesthesia.* The Journal of the American Society of Anesthesiologists, 2004. **100**(6): p. 1341-1342.
9. Çay, D., et al., *Effect of Circadian Rhythm and Sleep Quality on Post-operative Pain in Patients with Spinal Anesthesia.* Southern Clinics of Istanbul Eurasia, 2023. **34**(3).
10. Aurell, J. and D. Elmqvist, *Sleep in the surgical intensive care unit: continuous polygraphic recording of sleep in nine patients receiving postoperative care.* Br Med J (Clin Res Ed), 1985. **290**(6474): p. 1029-1032.
11. Knill, R.L., et al., *Anesthesia with abdominal surgery leads to intense REM sleep during the first postoperative week.* Anesthesiology, 1990. **73**(1): p. 52-61.
12. Dette, F., et al., *Occurrence of rapid eye movement sleep deprivation after surgery under regional anesthesia.* Anesthesia & Analgesia, 2013. **116**(4): p. 939-943.
13. Kjølhede, P., et al., *The impact of quality of sleep on recovery from fast-track abdominal hysterectomy.* Journal of Clinical Sleep Medicine, 2012. **8**(4): p. 395-402.
14. Fernandes, N.M., et al., *Symptoms of disturbed sleep predict major adverse cardiac events after percutaneous coronary intervention.* Canadian Journal of Cardiology, 2014. **30**(1): p. 118-124.
15. Elliott, R., S. McKinley, and P. Cistulli, *The quality and duration of sleep in the intensive care setting: an integrative review.* International journal of nursing studies, 2011. **48**(3): p. 384-400.
16. McNamara, P., et al., *REM and NREM sleep mentation.* International review of neurobiology, 2010. **92**: p. 69-86.
17. Chung, F., et al., *Postoperative changes in sleep-disordered breathing and sleep architecture in patients with obstructive sleep apnea.* Anesthesiology, 2014. **120**(2): p. 287-298.
18. Chung, F., et al., *Factors associated with postoperative exacerbation of sleep-disordered breathing.* Anesthesiology, 2014. **120**(2): p. 299-311.
19. Rosenberg-Adamsen, S., et al., *Postoperative sleep disturbances: mechanisms and clinical implications.* British journal of anaesthesia, 1996. **76**(4): p. 552-559.
20. Closs, S.J., *Patients' night-time pain, analgesic provision and sleep after surgery.* International Journal of Nursing Studies, 1992. **29**(4): p. 381-392.
21. Krenk, L., P. Jennum, and H. Kehlet, *Sleep disturbances after fast-track hip and knee arthroplasty.* British journal of anaesthesia, 2012. **109**(5): p. 769-775.
22. Luo, M., B. Song, and J. Zhu, *Electroacupuncture: a new approach for improved postoperative sleep quality after general anesthesia.* Nature and science of sleep, 2020: p. 583-592.
23. Chouchou, F., et al., *Postoperative sleep disruptions: a potential catalyst of acute pain?* Sleep medicine reviews, 2014. **18**(3): p. 273-282.
24. Selvadurai, S., et al., *Evaluating the effects of general anesthesia on sleep in children undergoing elective surgery: an observational case–control study.* Sleep, 2018. **41**(8): p. zsy094.
25. RD, M., *Miller's anesthesia. Philadelphia, PA: Churchill Livingstone.* 2010, Elsevier.
26. Li, C. and S. Shang, *Relationship between Sleep and Hypertension: Findings from the NHANES (2007–2014).* International journal of environmental research and public health, 2021. **18**(15): p. 7867.
27. Okunowo, O., et al., *Age-and body weight-dependent association between sleep duration and hypertension in US adults: findings from the 2014-2017 National Health Interview Survey.* Sleep health, 2019. **5**(5): p. 509-513.
28. Kain, Z.N., et al., *Sleeping characteristics of children undergoing outpatient elective surgery.* The Journal of the American Society of Anesthesiologists, 2002. **97**(5): p. 1093-1101.
29. Sadeh, A., R. Gruber, and A. Raviv, *Sleep, neurobehavioral functioning, and behavior problems in school-age children.* Child development, 2002. **73**(2): p. 405-417.
30. Cronin, A.J., et al., *Postoperative sleep disturbance: influences of opioids and pain in humans.* Sleep, 2001. **24**(1): p. 39-44.

31. Ruiz, F.S., et al., *Sleep influences the immune response and the rejection process alters sleep pattern: evidence from a skin allograft model in mice.* Brain, Behavior, and Immunity, 2017. **61**: p. 274-288.
32. Man, K., A. Loudon, and A. Chawla, *Immunity around the clock.* Science, 2016. **354**(6315): p. 999-1003.
33. Leung, J.M., et al., *Preoperative sleep disruption and postoperative delirium.* Journal of Clinical Sleep Medicine, 2015. **11**(8): p. 907-913.
34. Todd, O.M., et al., *Sleep disruption at home as an independent risk factor for postoperative delirium.* Journal of the American Geriatrics Society, 2017. **65**(5): p. 949-957.
35. Tan, W.f., et al., *Changes in postoperative night bispectral index of patients undergoing thoracic surgery with different types of anaesthesia management: a randomized controlled trial.* Clinical and Experimental Pharmacology and Physiology, 2016. **43**(3): p. 304-311.
36. Deng, C.-M., et al., *Effect of intraoperative remimazolam on postoperative sleep quality in elderly patients after total joint arthroplasty: a randomized control trial.* Journal of Anesthesia, 2023: p. 1-11.
37. Nilsson, U., et al., *Postoperative recovery after general and regional anesthesia in patients undergoing day surgery: a mixed methods study.* Journal of Perianesthesia Nursing, 2019. **34**(3): p. 517-528.
38. Liu, S.S., et al., *A comparison of regional versus general anesthesia for ambulatory anesthesia: a meta-analysis of randomized controlled trials.* Anesthesia & Analgesia, 2005. **101**(6): p. 1634-1642.
39. Grauman, S., J. Boethius, and J. Johansson, *Regional anaesthesia is associated with shorter postanaesthetic care and less pain than general anaesthesia after upper extremity surgery.* Anesthesiology Research and Practice, 2016. **2016**.
40. Cavalcante, A.N., et al., *Perioperative risks of narcolepsy in patients undergoing general anesthesia: a case-control study.* Journal of clinical anesthesia, 2017. **41**: p. 120-125.
41. Olson, D.M., et al., *Quiet time: a nursing intervention to promote sleep in neurocritical care units.* American Journal of Critical Care, 2001. **10**(2): p. 74.
42. Wu, M.-P., et al., *Insomnia subtypes and the subsequent risks of stroke: report from a nationally representative cohort.* Stroke, 2014. **45**(5): p. 1349-1354.
43. Besedovsky, L., T. Lange, and M. Haack, *The sleep-immune crosstalk in health and disease.* Physiological reviews, 2019.