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Sleep Disorders and Traffic Accidents: Unveiling the Hidden Risks

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Patient: Male, 57-year-old
Final Diagnosis: Obstructive sleep apnea
Symptoms: Asleep • confusion • tired
Clinical Procedure: —
Specialty: Public Health • Pulmonology

Objective: Unusual clinical course

Background: Numerous countries, Vietnam included, have persistently high annual rates of traffic accidents. Despite concerted government efforts to reduce the annual traffic accident rate, the toll of fatalities and consequential injuries from these accidents rises each year. Various factors contribute to these incidents, notably including alcohol consumption while driving, inadequate awareness of traffic regulations, and substandard traffic infrastructure. However, an under-recognized risk in developing nations such as Vietnam is the prevalence of sleep disorders. Conditions such as obstructive sleep apnea syndrome and obesity hypoventilation syndrome, while prevalent, remain inadequately assessed and treated. These disorders represent significant yet largely unaddressed contributors to the heightened risk of traffic accidents.

Case Report: We describe the case of a 55-year-old Vietnamese man hospitalized due to long-standing respiratory complications and profound daytime sleepiness. Over the past 2 years, the patient gained 10 kg. Consequently, he frequently experienced drowsiness, leading to 4 traffic accidents. Despite previous hospitalizations, this sleep disorder had gone undiagnosed and untreated. Diagnostic assessments confirmed concurrent obstructive sleep apnea and obesity hypoventilation syndrome through polysomnography and blood gas analyses. Treatment involving non-invasive positive airway pressure therapy notably alleviated symptoms and substantially improved his quality of life within a concise 3-month period.

Conclusions: Obstructive sleep apnea and obesity hypoventilation syndrome are contributory factors to excessive daytime somnolence, significantly increasing vulnerability to traffic accidents. Regrettably, this critical intersection remains inadequately addressed. Addressing these concerns comprehensively through dedicated research initiatives should be imperative before considering the universal issuance of driver's licenses to all road users in Vietnam.

Keywords: Sleep Apnea Syndromes • Obesity Hypoventilation Syndrome • Accidents, Traffic • Human Trafficking

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Introduction

Every year, approximately 1.3 million lives are lost due to road traffic crashes, with an additional 20 to 50 million people sustaining non-fatal injuries, often leading to disabilities [1]. In 2022, Vietnam recorded approximately 11 500 traffic accidents [2], and the number of deaths caused by traffic accidents amounted to approximately 6 400 [3]. The economic impact of these incidents is profound, encompassing treatment costs, lost productivity for the injured or deceased, and the need for family members to take time off work or school to care for the affected. Globally, road traffic crashes account for about 3% of a country's gross domestic product [1].

While the World Health Organization (WHO) identifies various risks, such as speeding, driving under the influence, nonuse of helmets and seatbelts, distracted driving, inadequate road infrastructure, unsafe vehicles, and poor law enforcement, it overlooks sleep disorders. Studies have shown that drowsy driving increases the risk of a traffic accident by 2.5 times [4]. Driving while sleepy is akin to driving with a blood alcohol content of 0.9 g/L, an illegal act across all European Union countries [5,6].

Obstructive sleep apnea (OSA) involves airway blockages during sleep, while obesity hypoventilation syndrome (OHS) denotes inadequate breathing in individuals with obesity without other related conditions [7]. Around 90% of patients with OHS also have OSA, and about 70% have severe OSA [8]. Excessive daytime sleepiness, a common symptom of OSA, significantly impacts safety, function, productivity, mood, cognition, and quality of life [9-11]. Notably, excessive daytime sleepiness in patients with OSA increases the risk of motor vehicle and occupational accidents [12,13].

Despite their significance, the WHO has not included sleep-related respiratory disorders as risk factors for traffic accidents. Vietnam, as a developing nation, lacks sufficient research on sleep medicine and its implications, making it challenging to pinpoint the direct causes of accidents related to sleep disorders. Consequently, there are no specific regulations in Vietnam concerning driver's licenses and these disorders.

Case Report

The patient, a 55-year-old man and construction worker, had a medical history of challenging-to-control hypertension despite ACE inhibitors and calcium channel blockers, with a consistent blood pressure around 150/90 mmHg. He presented with a history of persistent snoring during sleep and was admitted to the hospital due to excessive sleepiness, breathing difficulties, and extreme fatigue. Emergency blood gas testing revealed chronic respiratory acidosis, leading to a diagnosis of an acute exacerbation of chronic obstructive pulmonary disease. Subsequently, he was admitted to the Respiratory Department for further care.

In the previous 2 years, the patient gained 10 kg and began loudly snoring during sleep, with intermittent breathing pauses and gasping, especially while lying on his back. Mornings brought symptoms of headaches, fatigue, and drowsiness, which severely impacted his ability to concentrate at work. Eventually, he had to quit his job due to impaired focus. Additionally, he experienced 4 traffic accidents in the previous 9 months, all attributed to drowsiness while driving a motorbike. The patient had no history of diabetes, epilepsy, or alcohol abuse. Importantly, in all 4 traffic accidents, he had not consumed alcohol. Despite multiple hospital visits, his condition remained undiagnosed, with treatment limited to blood pressure and cholesterol medication.

Just before admission, the patient fell asleep, causing his right eye to hit a table's edge, resulting in bruising (**Figure 1**). Examination revealed a body mass index (BMI) of 37.2 kg/m^2, Mallampati group IV classification, and a neck circumference of approximately 44 cm (**Figure 2**). Indicative assessment scores were as follows: STOP-Bang questionnaire: 8 points; Epworth Sleepiness Scale (ESS): 21 points; and Pittsburgh Sleep Quality Index (PSQI): 14 points across 7 subscales.

No signs of infection were evident in the patient's test results. However, the following awake arterial blood gas analysis revealed indications of chronic hypercapnic respiratory failure: pH level of 7.39, $PaCO_2$ level of 65.9, PaO_2 level of 73.3, and HCO_3^- level of 39.9. The chest X-ray displayed an enlarged heart shadow and a uniform, homogeneous, indistinct outline in the lung periphery and base bilaterally, possibly due to a thickened chest wall, as no abnormal sounds were detected upon auscultation.

An overnight polysomnography was conducted, revealing an apnea-hypopnea index score of 116.4. Predominantly, the obstructive events occurred while in the supine position, with the patient spending 93.5% of sleep in stage N2. The patient recorded an oxygen desaturation index of 127.6 events per hour, averaging an SpO_2 level of 78.7% (**Figure 3**). These findings led to a diagnosis of severe OSA syndrome and OHS.

Initially, the patient received mechanical ventilation in continuous positive airway pressure (CPAP) mode with a gradual increase in pressure levels. However, blood gas analysis indicated a tendency for the patient's $PaCO_2$ levels to rise to 74.4. Consequently, the ventilator mode was switched to bi-level (Bi) PAP, which the patient found more comfortable, and resulted in improved sleep quality and increased alertness. Subsequently, the patient's $PaCO_2$ levels showed a gradual decline.

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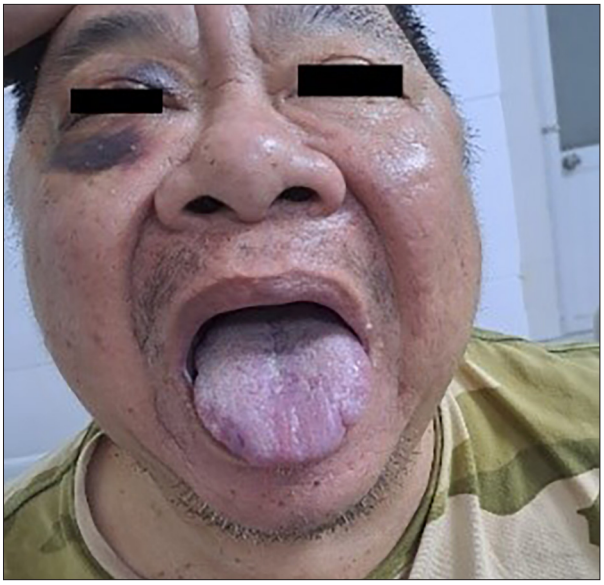

Figure 1. The right eye area of the patient, exhibiting visible bruising resulting from trauma.

Figure 2. The patient's neck circumference was measured to be 44 cm, and the Mallampati classification was IV.

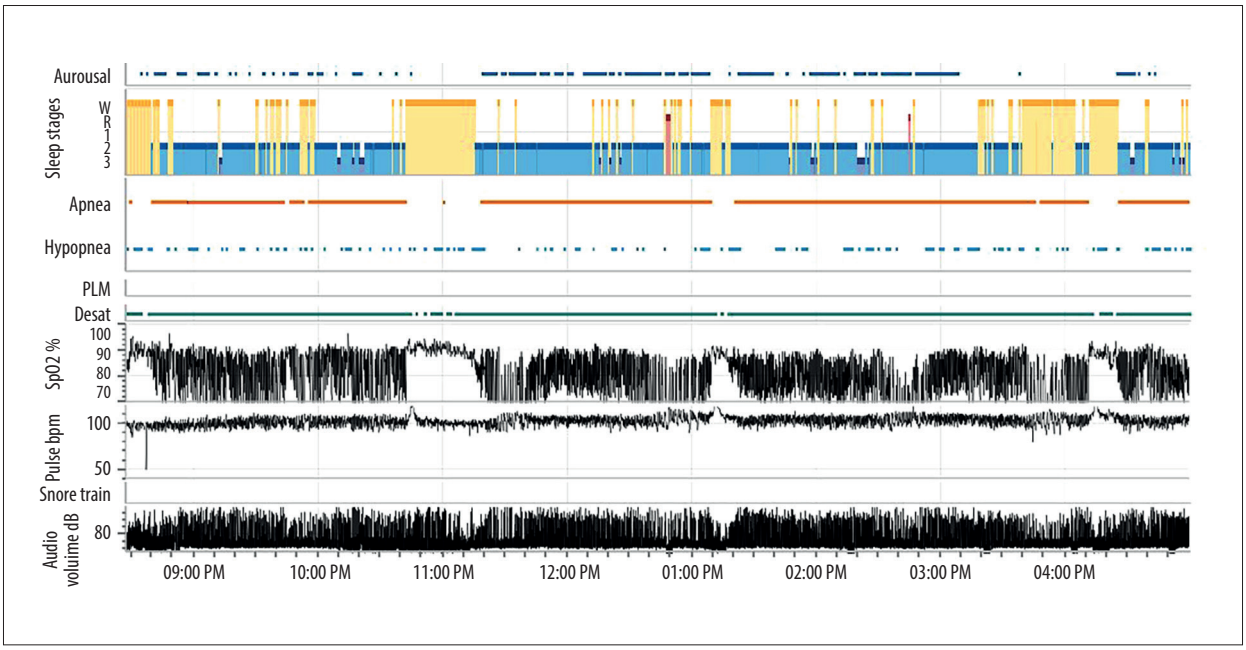

Figure 3. Graph shows events of apnea, hypopnea, arousal, mainly in the supine position, low oxygen saturation, and snoring in polysomnography.

The patient was advised to continue BiPAP therapy after hospital discharge for 5 to 6 h per night, while implementing lifestyle modifications, including dietary adjustments and weight management. After 3 months of consistent treatment, the patient's blood pressure stabilized, at 120/70 mmHg. In particular, the patient maintained the same blood pressure medication as before PAP treatment, including amlodipine 5 mg once per day and telmisartan 40 mg per day. Additionally, self-reported improvements included enhanced sleep quality, heightened daytime alertness, and significant enhancements in sleep assessment scales (**Figure 4**). Specifically, the patient's ESS remained at 4 points, whereas his PSQI score was 5 points, divided across several subscales. Additionally, he underwent a weight loss of 2 kg, resulting in a BMI of 36.4. Moreover, his SpO_2 index during sleep remained stable at 95% to 99%. Notably, the patient exhibited a notable improvement in his ability to concentrate on tasks such as work and safe driving in traffic, significantly enhancing his overall quality of life.

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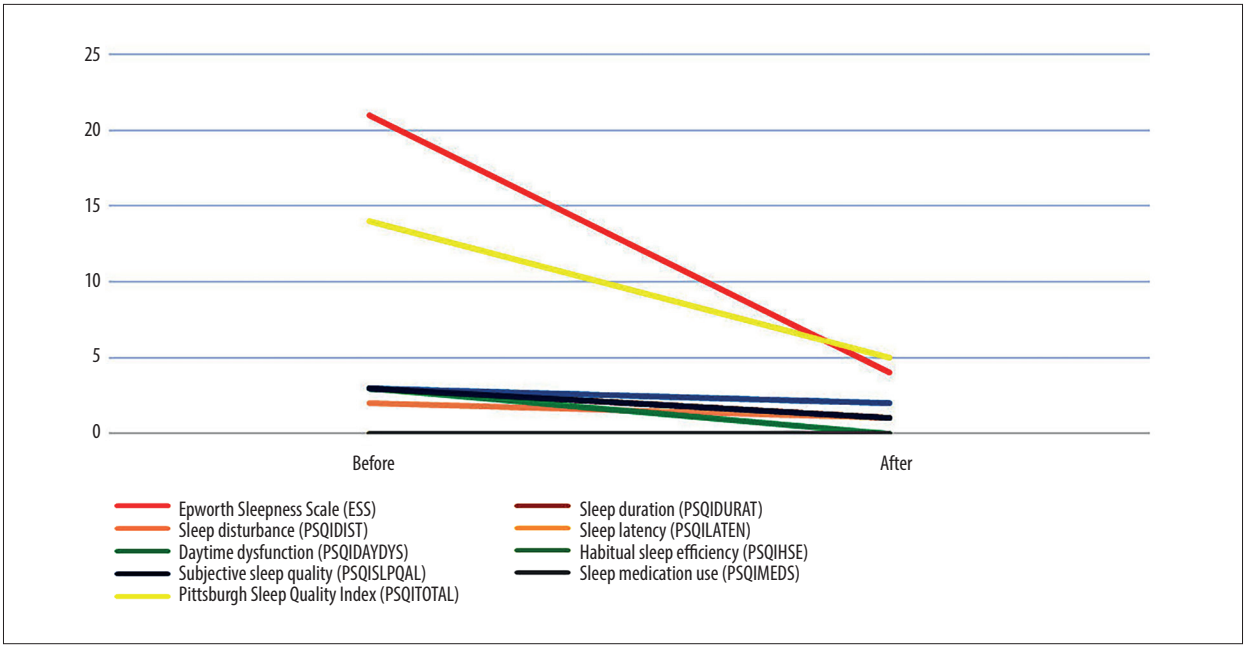

Figure 4. Graph depicting alterations in Epworth Sleepiness Scale and Pittsburgh Sleep Quality Index scores before and after 3 months of treatment.

Discussion

The International Classification of Sleep Disorders classifies sleep disorders into 7 distinct groups, among which sleep-related breathing disorders stand out [14]. Among these, OSA is prominent and is estimated to impact approximately 900 million adults globally, particularly those aged between 30 and 69 years [15]. Diagnosis of OSA relies on positive findings from polysomnography or home sleep apnea tests [16]. Criteria for diagnosis include more than 15 respiratory events per hour or more than 5 events per hour, along with typical symptoms, such as snoring, fatigue, excessive daytime sleepiness, or associated conditions, such as hypertension, coronary artery disease, or stroke [16,17].

OHS is characterized by obesity (BMI ≥30 kg/m^2), sleep-disordered breathing, and daytime hypercapnia ($PaCO_2$ ≥45 mmHg) without any other underlying causes for hypoventilation [18]. The pathophysiology of OHS primarily involves 3 mechanisms: respiratory system alterations due to obesity, changes in respiratory drive, and breathing irregularities during sleep [19].

According to a meta-analysis, 28% of patients with OHS were initially diagnosed with OSA. Among those who accurately received a diagnosis of OSA, higher BMI, apnea-hypopnea index, neck circumference, and lower percent predicted forced expiratory volume in 1 second were found to be associated with the development of OHS. Therefore, it is crucial to be cautious while diagnosing OHS in OSA patients with these factors, and early identification and appropriate treatment can significantly improve the prognosis [20]. Another study illustrated that elevated bicarbonate levels and decreased oxygen saturations in OSA patients with obesity should prompt clinicians to predict OHS [21].

The presented case involves the conditions OSA and OHS, which are widely discussed in global medical literature but relatively new in Vietnam. Delayed diagnosis and treatment of these conditions carry significant risks, potentially affecting health, the economy, and even risking lives due to traffic accidents.

Upon admission, our patient exhibited chronic hypercapnia, male characteristics, and advanced age, leading to a misdiagnosis of chronic obstructive pulmonary disease, a common confusion, as nearly 75% of OHS patients are initially misdiagnosed and treated for chronic obstructive pulmonary disease, despite the absence of airway obstruction evidence [19].

While most patients with OHS are hospitalized due to acute exacerbations of chronic respiratory failure [22], our patient's blood gas results upon admission did not necessitate immediate hospitalization. Instead, the admission was prompted by excessive daytime sleepiness, with an ESS score of 21, and poor sleep quality reflected in a PSQI score of 14, notably in sleep duration (PSQIDURAT: 3 points), daytime dysfunction (PSQIDAYDYS: 3 points), habitual sleep efficiency (PSQIHSE: 3 points), and subjective sleep quality (PSQISLPQUAL: 3 points).

This is exemplified by the patient's history of falling asleep while driving leading to multiple accidents, a critical concern, given

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studies linking OSA to increased traffic accidents. Research indicates that an ESS score exceeding 15 significantly correlates with higher motor vehicle accident rates [23]. The prevalence of traffic accidents attributed to sleepiness varies between 3.9% and 33% in different countries, including the United States [24], France [25,26], and New Zealand [27]. A study conducted at Haukeland University Hospital in Norway, revealed that excessive daytime sleepiness affects 40.5% to 58% of individuals with OSA [28].

Excessive daytime sleepiness commonly presents in OSA patients with obesity and nocturnal hypoxia, aligning with our patient's profile. Compared with non-OSA drivers, those with OSA face 2 to 3 times higher crash risks, albeit with challenges in precise risk prediction [29,30]. Hence, timely diagnosis, effective treatment, and comprehensive education for patients and their families are crucial to mitigate sleepiness-related accidents among high-risk drivers with OSA.

After 3 months of BiPAP therapy for 5 to 6 h each night, our patient displayed remarkable improvement, experiencing an enhanced quality of life, improved sleep, and reduced excessive daytime sleepiness. This positive progress aligned with the patient's improved ESS and PSQI scores (**Figure 4**). Notably, the patient regained the ability to safely operate a vehicle, echoing global literature indicating that PAP therapy can reduce the accident risk in patients with OSA to levels akin to those of the general population [31,32]. Thus, an expert panel unanimously agreed that consistent CPAP use, of at least 4 h on 70% of nights, deems a patient fit for driving after CPAP treatment.

Nevertheless, studies suggest that residual excessive daytime sleepiness can persist after CPAP treatment. Population-based estimations indicate that 9% to 22% of CPAP-treated patients report ongoing excessive daytime sleepiness [11,33]. In a prospective clinical practice-based study, 34% of patients initially presenting with excessive daytime sleepiness continued experiencing daytime sleepiness even after 3 months of CPAP usage, a percentage notably lower (22%) among those adhering to CPAP for over 6 h nightly [34]. Despite neuroimaging evidence of neuronal injury, the exact mechanisms behind residual excessive daytime sleepiness in OSA remain unclear [35]. This poses concerns, as persistent excessive daytime sleepiness retains a potential risk for traffic accidents. Regular follow-up visits are crucial to assess treatment efficacy and adjust therapy as needed. Unfortunately, our patient did not return for polysomnography or arterial blood gas testing after treatment, preventing accurate apnea-hypopnea index or $PaCO_2$ assessment.

In Vietnam, traffic accidents persistently rank high, driven by factors such as alcohol use and traffic congestion. Regrettably, sleep disorders, particularly in patients with OSA and OHS, receive inadequate attention. Robust studies are necessary to assess accident risks in individuals with sleep-related breathing disorders, enabling a structured assessment before driver's license issuance, akin to European practices [36]. Additionally, classifications and evaluations tailored to various driver types, notably long-haul truck drivers prone to driving while drowsy, demand attention [37].

Conclusions

In summary, both OSA and OHS manifest symptoms of excessive daytime sleepiness, substantially increasing the risk of traffic accidents. Regrettably, this issue has not received the required attention in Vietnam. Therefore, it is imperative to conduct thorough research to assess and establish regulations addressing these concerns before issuing driver's licenses to all road users.

Department and Institution Where Work Was Done

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Declaration of Figures' Authenticity

All figures submitted have been created by the authors who confirm that the images are original with no duplication and have not been previously published in whole or in part.

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