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Operating Model of Obstructive Sleep Apnea Patients in North Karelia Central Hospital

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Abstract**—**This study aimed to describe the operating model of obstructive sleep apnea. Due to the large number of patients, the role of nurses in the diagnosis and treatment of sleep apnea was important. Pulmonary physicians met only a minority of the patients. The sleep apnea study in 2018 included about 800 patients, of which about 28% were normal and 180 patients were classified as severe (apnea-hypopnea index [AHI] over 30). The operating model has proven to be workable and appropriate. The patients understand well that they may not be referred to a pulmonary doctor. However, specialized medical follow-up on professional drivers continues every year.

Keywords**—** Sleep, apnea patient, operating model, hospital.

I. Introduction

OBSTRUCTIVE sleep apnea (OSA) has increased in recent years [1]. The American Academy of Sleep Medicine (AASM) states: "The prevalence of OSA varies significantly based on the population being studied and how OSA is defined (e.g., testing methodology, scoring criteria used, and AHI threshold)" [2]. The prevalence has been estimated to be 5% of women and 14% of men and, in population-based studies utilizing an AHI cutoff of ≥ 5 events/h (hypopneas associated with 4% oxygen desaturations) combined with clinical symptoms to define OSA [1], [2]. Obesity levels have increased also, partly explaining the increase in OSA prevalence [1].

Arnardottir et al. assessed the prevalence of OSA as defined by an AHI ⩾5 in the2 middle-aged general population, and the interrelationship between OSA, sleep-related symptoms, sleepiness, and vigilance. The study included a type 3 sleep study, questionnaire and a psychomotor vigilance test. A total of 415 subjects (40–65-year-old Icelanders) participated in the study. They found out that 56.9% had no OSA (AHI <5), 24.1% had mild OSA (AHI 5–14.9), 12.5% had moderate OSA (AHI 15–29.9) and 2.9% had severe OSA (AHI ⩾30). 3.6% of the patients had already been diagnosed and were receiving OSA treatment [3].

Wisconsin Sleep Cohort Study was also used to evaluate the prevalence of sleep disordered breathing (SDB) for the periods of 1988-18994 and 2007-2010 [1]. A total of 1,520 participants (30–70 years of age) participated. They estimated that prevalence substantially increased over the last two decades (relative increases of between 14% and 55% depending on the subgroup). The authors posited that the ongoing obesity epidemic in the United States was likely to result in "offspring epidemics" of obesity-related conditions and that overweight status/obesity are strong casual factors for SDB; moreover, in tandem with an escalation in the prevalence of obesity, the prevalence of SDB among adults has increased substantially [1]. Adult obesity is defined as a body mass index (BMI) of 30 kg/m^2 or greater, yet a given BMI might reflect vastly differing physiology and metabolic health. This distinction, according to the authors, is likely important reason for increase of the number of asthma patients [4].

Korpinen and Pääkkönen studied self-reported sleep disorders/disturbances associated with physical symptoms and usage of computers in Finland. The study was carried out as a cross-sectional study by posting a questionnaire to 15,000 working-age persons. The responses (6,121) included 1,016 (16.6%) respondents, who reported that they suffered quite often or more often sleeping disorders/disturbances during the last 12 months. Of those respondents, 708 (69.7%) were employed. In statistical analyses, comparisons have been made between the following groups: 1) workers who experience sleep disorders/disturbances quite often or more often and not and 2) employed and unemployed persons who experience sleep disorders/disturbances quite often or more often. We found considerable variation when comparing employed and unemployed individuals [5].

A working group set up by the Finnish Medical Society Duodecim, The Finnish Respiratory Society, and Finnish Sleep Research Society published Current Care Guidelines of Sleep Apnea (OSA in adults) in 2017 [6]. Table I shows the clinical assessment of sleep apnea severity based on daytime drowsiness and sleep registration [6]-[8].

TABLE I
Clinical Severity of Sleep Apnea [6]-[8]

Degree of difficulty	Oxygen saturation (%)	AHI
Light: Appears only when stationary, not necessarily daily, and causes little harm to social and work life	SaO2 average ≥ 90 and minimum ≥ 85	5…15
Moderate: Daily when activity is low and the situation requires moderate concentration (e.g., driving a car, attending a meeting, watching movies)	SaO2 average <90 and minimum ≥ 70	16…30
Severe: For daily tasks that require activity or clear concentration (e.g., driving a car, conversation, eating, walking). Causes significant harm to social life and work	SaO2 average <90 and minimum <70	> 30

North Karelia Central Hospital (PKKS) offers specialized medical care and services for the inhabitants of its 14 member municipalities. Annually, about 70,000 people use these

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services out of about 169,000 residents.

Due to the large number of patients at PKKS, the diagnosis and treatment of sleep apnea has been furthered by developing an operating model that emphasizes the role of the nurse. In this mode of operation, the physician only meets a small proportion of patients. With the exception of professional drivers, the majority of patients are not referred to a respiratory physician. The nurse instead informs the doctor who sent the patient to the consultation in terms of the outcome of the sleep study and possible start of treatment. The operating model and the lessons learned from it are presented here.

II. Materials and Methods

References to sleep apnea suspicions come to the Clinic of Pulmonary Diseases of PKKS from primary care units including both public and private clinics. The referrals are handled by a pulmonary physician who assesses the necessity and urgency of the investigation.

The operating model groups professional drivers into their own care path and others into their own. All patients are grouped according to BMI into two groups, depending on whether BMI is ≥ 40 kg/m^2 or not. If the BMI is ≥ 40 kg/m^2, in addition to a sleeping session, venous blood gas analysis is taken. If venous pCO2 is elevated, the doctor performs arterial blood gas analysis. Professional drivers have access to emergency sleep research and are directed to the doctor's office if sleep apnea is diagnosed. The nurses take care of all sleep tests, register the relevant information, and report to the doctor.

Nurses ask patients in advance about their interest in potential CPAP treatment if the finding is only a mild sleep apnea (AHI below 15/h). In this case, the patient is not invited to initiate CPAP treatment if he/she has not indicated an interest. On the other hand, in the case of mild apnea, patients receive information that they can contact the nurse if they want to try the device. Medium and severe sleep apnea cases are always referred to the nurse's reception for a possible starting point for CPAP treatment. The treatment is carried out with an autoCPAP device. Patients with mild sleep apnea are offered the opportunity to try modifying their posture by using a sleep belt. The construction of possible tooth rails has been transferred to primary health care. Fig. 1 shows our operating model of sleep apnea patients.

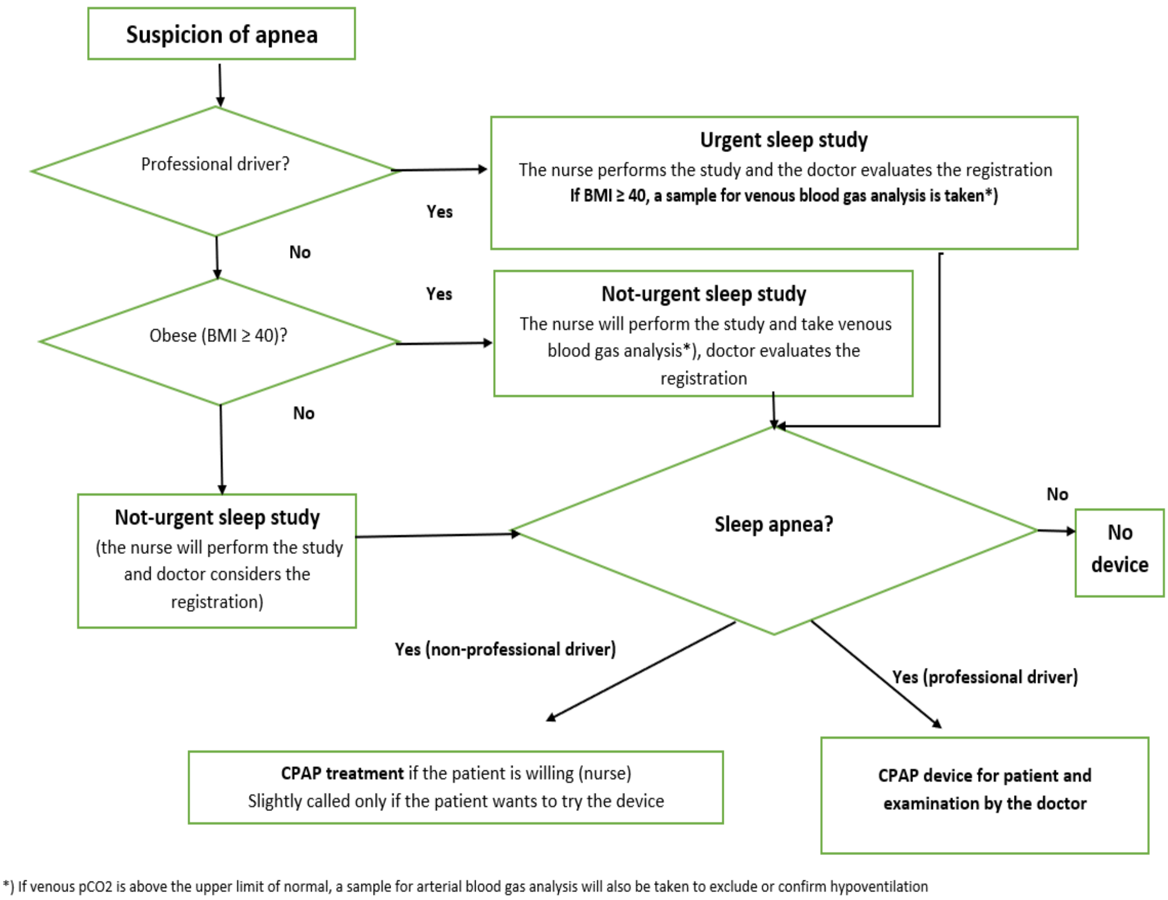

Fig. 1 Operating model of sleep apnea patients

III. Examples of Patients

The sleep apnea study was performed on about 800 patients, of which about 28% were normal (at 2018). Some 180 patients were classified as severe (AHI over 30), and in four cases, the AHI was over 100.

A. Case 1—38-Year-Old Man

The patient slept worse than usual. He spent 41.6% of the time on his back and weighed 126 kg, a BMI of 39.8. The snoring index was 32.7%. AHI over the night was 67.2 and was 70.8 on the back. The oxygen desaturation index (ODI) was 83.5 for the whole night and 103.1 on the back. In the graph, breath breaks were also seen in the side position and were mainly obstructive. The findings signify severe sleep apnea. Figs. 2 and 3 show examples of the sleep recordings.

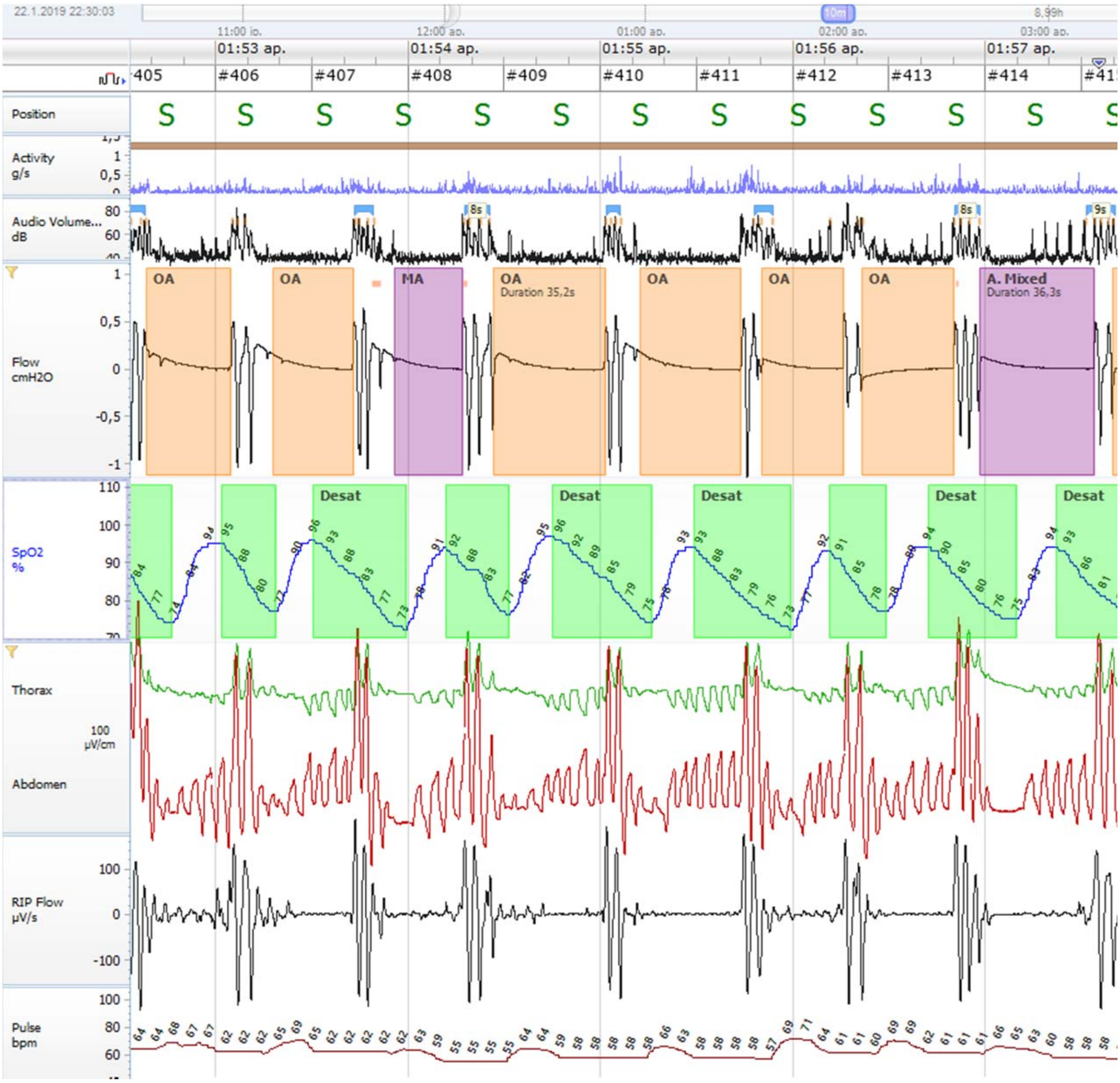

Fig. 2 Case 1: Examples of the obstructive apneas (including two mixed apneas) while lying on back

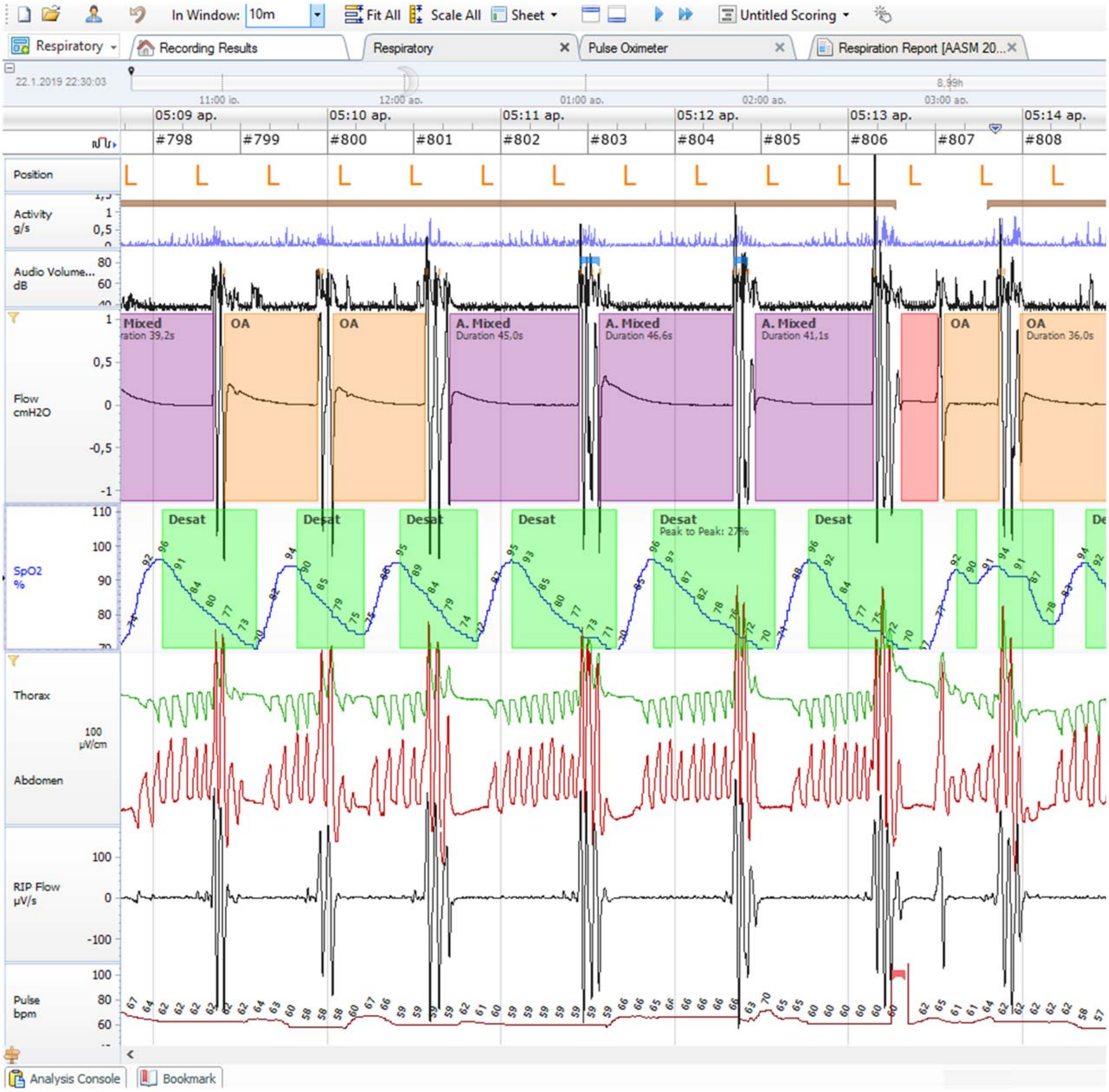

Fig. 3 Case 1: Examples of mixed and obstructive apneas on side and back positions

B. Case 2—63-Year-Old Man

During the night, the patient informed to have slept as well as usually. He spent 4.0% of the time on his back and weighed 84 kg, a BMI of 27.7. The snoring index was 51.9%, AHI over the night 10.6, and on the back 71.3. The ODI was 13.5 during the whole night and 74.7 on the back. Oxygen saturation averaged 90.3% and reached a minimum of 86.0%. In the chart, breathing breaks were seen on sleeping on one's side, and the breaks were most obstructive in nature. As a whole, the results fit into a light sleep apnea, but it was difficult for the patient to breathe on his back. Figs. 4 and 5 show examples of the sleep recordings.

IV. Discussion

The tried-and-tested operating model has been successful and it suits in most situations. The referring doctors have not expressed negative opinions on the activity. Patients understood well that they might not be directed to a pulmonary doctor. The nurses followed the success of CPAP partly by remote monitoring during the first year of specialized medical care, followed by primary health care. However, follow-up on professional drivers continues annually in specialized medical care.

All patients cannot use autoCPAP devices. Therefore, it is important to develop alternative treatments. Non-invasive and invasive methods for the electrical stimulation of upper airway dilator muscles have been demonstrated to be effective in selected patients [9]-[11].

Woodson et al. [8] studied the long term (36 month) clinical and polysomnographic outcomes in an OSA cohort of 59 treated with cranial nerve upper airway stimulation. The study included 126 participants. Authors concluded that cranial nerve stimulation for the treatment of moderate to severe OSA is a successful and appropriate long-term treatment of CPAP intolerant individuals with moderate to severe sleep apnea [8].

Huntley et al. [12] compared patients with OSA undergoing transoral robotic surgery (TORS) to those undergoing upper airway stimulation (UAS). Authors retrospectively reviewed patients treated with TORS and UAS using the senior authors' surgical database. They concluded that UAS is successful in treating OSA showing improved outcomes, length of stay, and readmission compared to TORS.

V. Conclusion

The developed operating model has been well-practiced. For professional drivers, it is particularly important that the operational model is clear and practical. If driver have diseases that can influence their driving health, it is recommended that all evaluation processes are easy and quick to perform. The treatment of OSA can change in the future. One interesting possibility is stimulations.

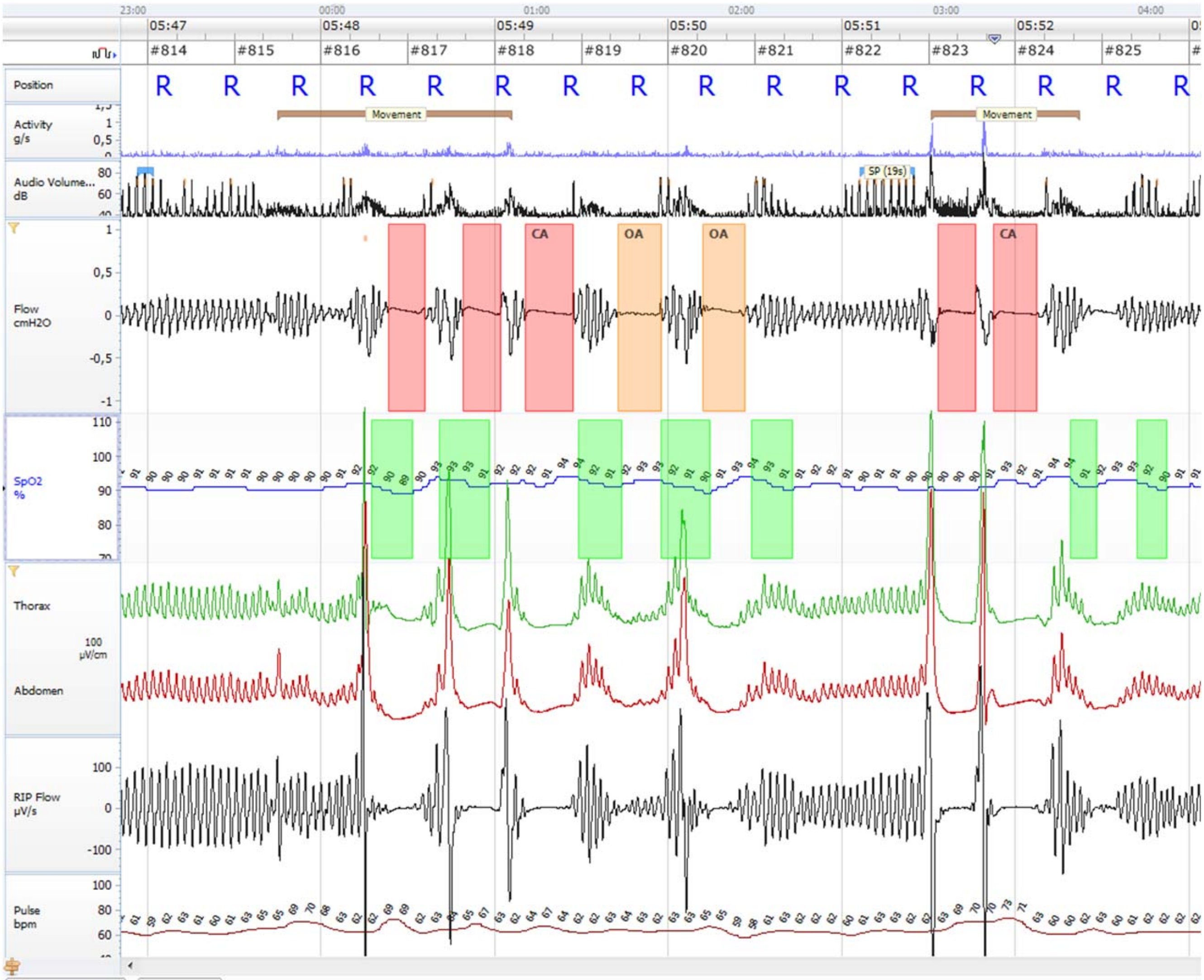

Fig. 4 Case 2: Examples of the light obstructive apneas on side positions

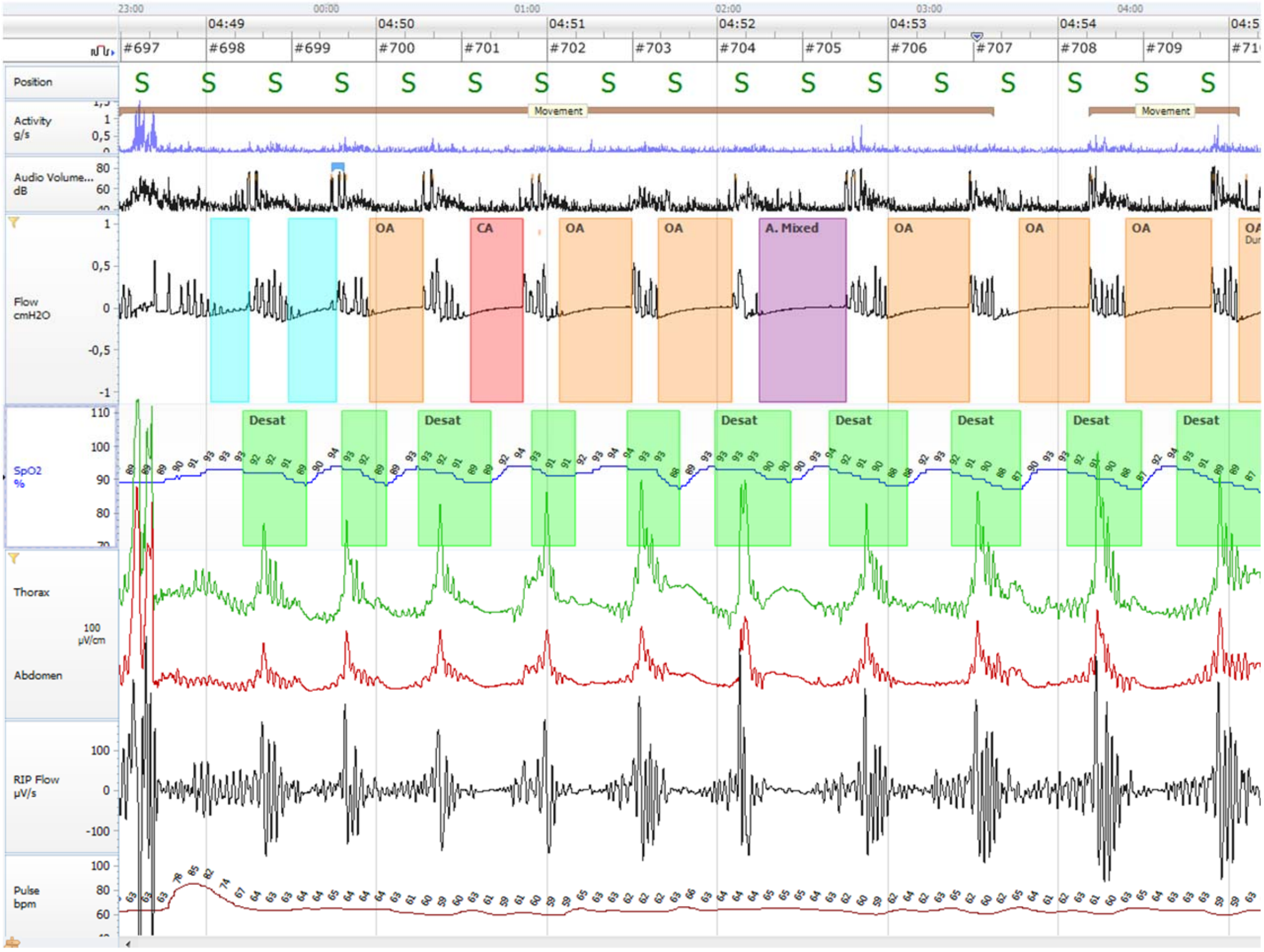

Fig. 5 Case 2: Examples of the obstructive and mixed apneas on the back position

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