RAMS/NATO STO Technical Course 2022

Obstructive sleep apnea in aircrew members: how to assess the risk of sleepiness ?

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Background

It has been known for many years that Obstructive Sleep Apnea Syndrome (OSAS) increases the risk of road accidents by a factor of 2 to 3. We can of course transpose this risk to aeronautics, which requires particular vigilance.
For the French military, it is specified in the 2021 regulation that sleep apnea syndrome leads to unfitness for pilots, flight mechanics or Air traffic controllers. The Aircrew members will then have to ask for a waiver to the military medical commission of aeronautics, in order to be able to return to fly duties.
For civilian private and professional pilots, it is specified in the European regulation that OSAS requires a referral (or consultation) to the licensing authority. A satisfactory respiratory and cardiological assessment is also required. The acceptable means of compliance specify that a pilot with unsatisfactorily treated sleep apnea syndrome should be assessed as unfit.
It is this issue of satisfactory treatment that need to be discussed, especially the existence of residual sleepiness.

Residual Sleepiness

Residual sleepiness in patients with OSAS is generally defined as an Epworth score greater than or equal to 11 despite an appropriate treatment. Its prevalence is estimated at 12% at 1 year from the start of OSAS treatment.
Multiple causes are described in the literature :

- A defect in the efficacy, compliance and tolerance of the treatment (not adapted mask or mouthpiece, leaks, dryness of the mucous membranes, etc.)
- An unappropriated/incomplete diagnosis, for example in case of associated sleep pathology, such as restless legs syndrome, narcolepsy or idiopathic hypersomnia
- Depression, insomnia or hypersomnia is a criterion in the definition of severe depressive episode in the DSM V
- Residual sleepiness, as a sequel to intermittent cerebral hypoxia. In this case, the patient must be referred to a sleep medicine department to discuss medications like wake-promoting agents.

Maintenance of Wakefulness Tests

In current clinical practice, sleepiness screening is essentially based on the Epworth sleepiness scale (ESS). Nonetheless, it has been shown in the literature that there is not a good correlation between a subjective test such as the ESS and an objective measure such as the maintenance of wakefulness tests (MWT). The main reason given is that patients with chronic sleep disorders have a poor perception of sleepiness, in which an improvement in the disorder may wrongly suggest that the disorder has disappeared. Moreover, in the context of fitness evaluation, the ESS may not always be honestly reported in a pilot who has been potentially declared unfit since the diagnosis of his/her illness, and who is hoping for a favorable decision from the medical center.
In this context, MWT are an interesting tool. These are sleep laboratory tests that measure a subject's ability to stay awake16. They are used in 2 situations: when hypovigilance is a public or personal safety issue, and to assess response to treatment in sleepy patients. This test is therefore doubly indicated in aircrews.
During this test, the patient is comfortably seated with EEG, EOG and EMG sensors in a semidark room. He is asked to look ahead, keep his eyes open and stay awake, fighting sleep as much as possible. It is forbidden to do some waking maneuvers such as looking at the cell phone, reading, chewing gum, pinching oneself... Between tests, the subject must not sleep but may go about his or her business.
This test is repeated 4 times in the same day, every 2 hours, after a good quality sleep the night before the tests.
If the subject does not sleep, the test lasts 40 minutes. Otherwise, the test is stopped as soon as the subject falls asleep (with the need for 3 consecutive 30-seconds epochs in the case of stage 1 sleep). The sleep latency corresponding to the average of the 4 tests is thus calculated. So, if the subject did not sleep during the test, the average sleep latency is 40 minutes.
To determine the values that may correspond to a decreased alertness, the MWT results were compared to actual driving performance. In this context, the 2008 study from Philip et al is very interesting. 38 patients with untreated OSAS to 14 control subjects were asked perform MWT but also a 90-minute test of real driving performance. It was thus shown that patients considered as drowsy (MWT 20-34min) or very drowsy (MWT <20min) made significantly more driving errors than control subjects and patients considered as vigilant (MWT 34-40min). On the other hand, there was no significant difference between vigilant patients (MWT 34-40min) and control subjects.

Method

In order to study the evaluation of the risk of sleepiness in aircrew members, we decided to perform **a retrospective monocentric study** with cases of OSAS in AM. The included population was composed of all AM with a history of OSAS, seen in our AeMC **between 2011 and 2018**. We decided to exclude cabin crews because of the less important consequences of sleepiness on flight safety in this population.

All files of AM with a **mild to severe OSAS and/or a treated OSAS** were extracted from our database. Several data were reported: socio-demographic data, flight duty, disease severity, treatment, fitness assessment and fitness decision.
We focused in particular on the **residual sleepiness evaluation** (ESS, MWT or others tests) in order to determine its prevalence in this population, and to describe the aeromedical assessment in this context. AM with residual sleepiness were compared to those without sleepiness in order to find risk factors of sleepiness which could be detected during the aeromedical examination.

This study was approved by a local ethic committee and by the commission on information technology and liberties (Commission Nationale de l'Informatique et des Libertés, CNIL).
Quantitative data are described in term of mean +/- standard deviation and compared with a Student test, qualitative data are described in term of percentage +/- standard deviation and compared with a Chi² test.

I have no financial relationships to disclose. I will not discuss off-label use and/or investigational use in this poster

Results

Our population:

138 aircrew members
mean age 50.1+/-9.6yo
76.8% of civilians
80.4% of pilots

At the time of diagnosis :

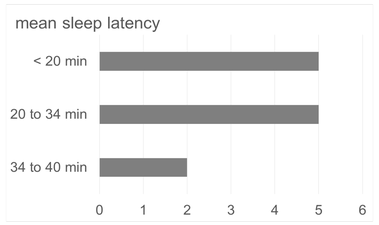
Snoring 66.7%	Obesity 60%
Excessive daytime sleepiness 47.1%	Hypertension 38%
Nocturnal respiratory pauses 15.2%	Cardiovascular disease 24%
Nycturia 6.5%	

- Initial Epworth Score normal (i.e. <11) in 64.9% of cases with a mean score of 8.5+/-4.7
- Severe OSAS in 65.4% of cases (otherwise it was moderate) with a mean AHI at 36.2+/-19.2/h
- Treatment: CPAP in 87% of cases, or a mandibular advancement device in 8.7% of cases

The Aeromedical evaluation after the treatment:

- The ESS was normal in 93% of cases with a mean score of 4.2+/-3.4
- The mean AHI was 4.1+/-4 with 87.4% of cases having an AHI<10.
- The compliance was good with a mean use of the CPAP of 6.4+/-1.3h/night and 88.2% of nights with the device.

Among our population, 82 AM (59.4%) performed **MWT**, all of them were treated with CPAP. This test was normal with no sleep during each 40-minutes periods for 85.4% of them. However, **12 of them had an abnormal test**, with the following results:



We compared those 12 AM to others with normal MWT in order to find risk factors. We note differences concerning post treatment ESS (p<0.01) and compliance (p<0.01). Nevertheless, 7 AM out of 12 had a normal ESS with an abnormal MWT.

	AM with MWT<40min n= 12	AM with MWT=40min n=70	p
BMI (kg/m²)	31.7 ± 4.6	30.6 ± 5.2	NS
Pretreatment ESS	11.7 ± 4.5	8.3 ± 4.8	NS
Pre Treatment ESS>11 (n, %)	4 (57.1%)	12 (34.3%)	NS
Pre Treatment AHI (event/h)	41.0 ± 23.1	40.3 ± 16.8	NS
Post Treatment ESS	7.9 ± 5.9	3.4 ± 2.2	<0.02
Post Treatment ESS>11 (n, %)	5 (41.7%)	0	<0.01
Post Treatment AHI (event/h)	4.1 ± 7	3.9 ± 3.5	NS
CIPAP Compliance (h/night)	6.1 ± 1.4	6.4 ± 1.3	NS
CIPAP Compliance (% of nights)	86.4 ± 14.6	90.1 ± 9.6	NS
Unsatisfactory CIPAP compliance (n,%)	4 (30%)	4 (5.7%)	<0.01

Comparison between AM with normal MWT and those with abnormal MWT
BMI=body mass index, ESS=Epworth Sleepiness Score, AHI=Apnea hypopnea Index, CIPAP : continuous positive airway pressure device, unsatisfactory CIPAP compliance is defined as a use less than 6 hours per night and/or less than 80% of nights.

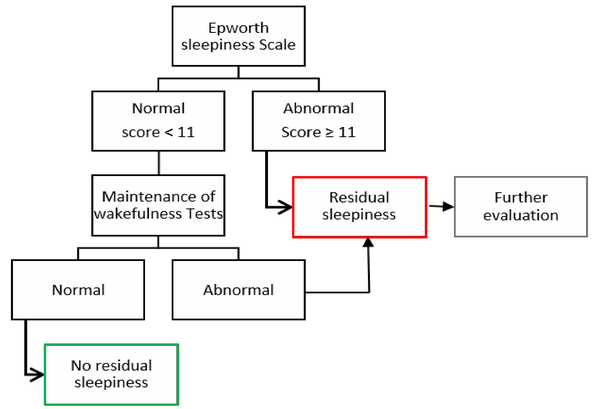
Including 2 AM with an abnormal post treatment ESS who didn't perform MWT, **10.1% of our population (14 AM) had a residual excessive sleepiness**. After further evaluations in a sleep medicine department, this residual sleepiness was due to a bad tolerance/compliance to CPAP in 4 cases (28.6%), an associated mood disorder in 2 cases (14.3%), and was considered as a sequellar residual sleepiness in 7 cases (50%).

Fitness assessment:

After the presentation to the licensing authority or to the military commission, **83.3% of AM were declared fit**, with limitations in 96.5% of cases. If the most frequent limitation is a time limitation, 53% of pilots had a multi pilot limitation.
Concerning the unfit group (16.7% of AM), 43.5% of them were declared unfit because of an associated psychiatric disease, 30.4% because of residual sleepiness, 17.4% because of an associated somatic disease, and 2 AM because they didn't perform a required test (private pilots who didn't want to perform MWT).

Discussion

Thus, among our population, **14 AM (10.1%) had residual sleepiness**, which underlines the need for assessing sleepiness in AM with OSAS. This result is comparable to those of the literature, such as Pepin or Gasa who found respectively 12% and 13% of residual sleepiness in OSAS patients treated with CPAP.
It is interesting to note that the first cause of residual sleepiness in our population is not a defect in the compliance and tolerance of the treatment, as it is in the general population. Indeed, Gasa showed a diminution in the number of hours per night of CPAP use in case of residual sleepiness (p<0.0001), which was not seen in our study. However, we must confess that the power of our study with a residual sleepiness group of 14 AM should limit these differences.
In Aircrew members, in case of treated OSAS, the evaluation of sleepiness could be managed as described in the following figure:



This procedure for assessing sleepiness therefore seems to be quite easy. However, this study reminds us the difficulty to evaluate the sleepiness. As the use of MWT is not mandatory in regulations, it could be absent of the evaluation. But we have seen that the mean sleep latency could be very low even with a normal ESS and a satisfactory compliance.

The choice of the appropriate MWT limit in aviation medicine

The Philip study described previously did not show any difference in driving performance between control subjects and those with a sleep latency between 34 and 40 minutes. But this does not mean, in our opinion, that we can declare fit a solo pilot who would have an mean sleep latency of 34 minutes on 4 tests. Indeed, this study was performed on a small population, and we will probably not have the same level of requirement for a pilot as for another patient.
Thus, the American Academy of Sleep Medicine specifies in its 2005 recommendations that **40-minute MWT remain the strongest objective data to assert a person's ability to stay awake**. In addition, we can read that it is an appropriate expectation for individuals requiring the highest level of safety, which in our opinion, includes aircrews.

Which aircrew members should perform MWT?

It does not seem necessary to discuss the interest of these tests in a solo pilot: a complete sleepiness evaluation has to be done.
Is this test necessary for a multi-pilot, such as an airline pilot? To answer this difficult question, it may be easier to take it the other way around. Are there cases where a pilot would be declared unfit, even in case of multi-pilot, because of sleepiness on MWT? We have to keep in mind that in our study, 5 aircrews had an average sleep latency between 0 and 19 minutes on MWT, with a normal Epworth score for 2 of them. In particular, there was the case of a 44-year-old airline pilot, with a severe OSAS (apnea-hypopnea index=35/h), treated by CPAP with excellent compliance, a residual apnea-hypopnea index at 4/h and an Epworth score of 8. MWT were performed, showing a mean sleep latency of 11 minutes on the 4 tests, i.e. severe sleepiness. The patient was referred to a sleep department, and was finally treated with wake-promoting agents. It seems obvious here that such a situation is not compatible with flight safety, even in multi-pilot.
MWT are therefore important tests for all pilots with treated OSAS, but also by extension for other specialties (Air traffic controllers for example).

Conclusion

The evaluation of residual sleepiness in aircrew with a history of OSAS is an important step in its rehabilitation. This study reminds us that residual sleepiness in AM with OSAS is not rare, and that it could be diagnosed even in patients with a normal Epworth score. In this context, MWT are an interesting tool, in association with the Epworth score and the CPAP efficiency and compliance evaluation, to be sure of the absence of sleepiness. By reading various studies and recommendations on this topic, MWT showing no sleepiness, at 40 minutes, seem to be an appropriate expectation to maintain flight safety at a high level. In our opinion, these tests are also necessary even in case of multi pilot to ensure the absence of severe sleepiness.
Finally, it is important to keep in mind that the sleepiness evaluation is only one part of the OSAS evaluation. This condition is a cardiovascular risk factor and should be explored with a complete cardiological evaluation.

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