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Abstract for Review

Effects of reduced rest and early start on crew sleep and fatigue in French regional airlines

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Problem [82 words]

The new European regulation on Flight and Duty Time Limitations (AIR-OPS) requires any airline requesting a deviation from a prescriptive limitation to evaluate the impact of such a deviation on crew sleep and fatigue. In this context, the French regional airline HOP has been granted an exemption to apply reduced rests to a minimum of 7h30 instead of the standard 10 hours. This paper describes the scientific research carried out to evaluate the impact of this deviation on crew sleep and fatigue.

Method [205 words]

The study has compared two specific types of roster pattern:

- **Reduced Rest** rosters (RR) composed of 5 or 3 sectors/Reduced Rests/3 sectors. During a working sequence, up to two Reduced Rests can be programmed with one normal night in between.
- **Early Start** rosters (ES): sequences of up to three consecutive early starts can be programmed. Duties starting before 07:00 (local time) which are not associated with a reduced rest were considered as “early start” in the study.

Two types of data have been collected:

- Sleep duration by the means of a sleep diary where aircrews were asked to report their sleep timings and sleep quality;
- In-flight alertness levels on the Samn Perelli scale (from 1 to 7). Crews were required to rate their alertness before the Top of Descent (TOD). Scores higher than 5 are generally considered to be associated with decrement in human performance.

For each crew, sleep data were collected over a sequence of 6 days starting by two days off followed by four duty days. The TOD survey was collected on all sectors during these four duty days. The study was based on voluntary participation; an internal communication letter was distributed to the crews to request their participation.

Results [250 words]

A total number of 229 questionnaires have been collected. A total of 431 duties were extracted from these questionnaires and allocated to either the reduced rest (RR) or early start (ES) groups. Both groups were equivalent regarding individual sleep needs (around 8 hours).

- Sleep duration

Overall, cabin crews slept less (RR: 05:33; ES: 06:02) than pilots (RR: 05:44; ES: 06:11). In order to take into account individual variability in sleep needs, sleep durations were expressed as a percentage of the individual sleep need. A slightly higher but statistically significant sleep deprivation is observed for RR as compared to ES for both flight and cabin crews.

Figure 1 shows the cumulative sleep deprivation, determined by summing all sleep deprivations over consecutive days. After three consecutive ES, a total of -69% of sleep deprivation is observed and a total of -44% after a RR sequence. This difference is mainly due to the recuperative effect of the « normal night » occurring on day 2, between the two RR.

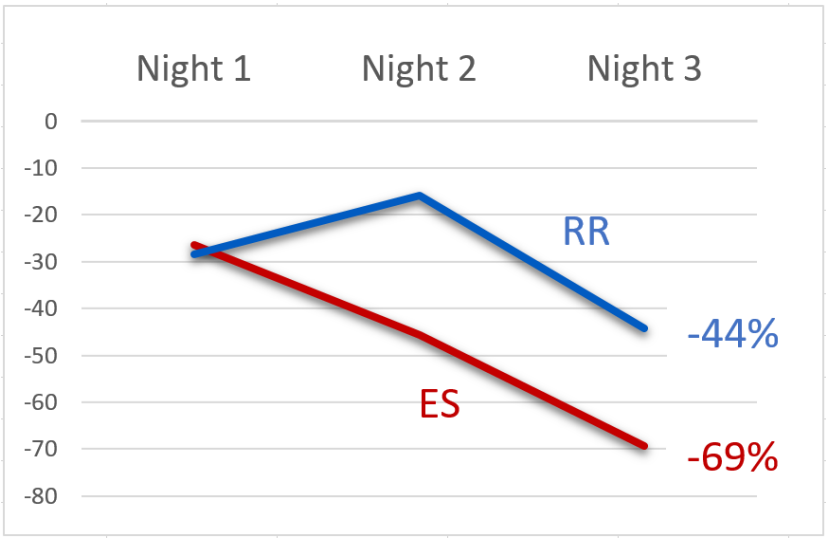

Figure 1- Comparison of cumulative sleep deprivation (%) during RR and ES sequences

- Alertness levels

Overall, all mean values were lower than 4. In average crews had a significantly higher mean alertness score for RR compared to ES but only on the first sector of the duty day. This difference is not significant for the last flight. When adjusted for differences in sleep debts, a significant difference between alertness levels during the first ES and during the first RR is still observed.

Discussion [249 words]

Results on sleep durations were closed to those reported in previous research (Spencer et al, 2002). Both ES and RR produced a sleep deprivation. However, when expressed as a percentage of individual sleep needs, sleep deprivation is only 5% higher for RR compared to ES. This slight difference reflects

the effects of the “forbidden zone” for sleep in the late afternoon that makes difficult to fall asleep earlier in the evening, even if rest time is not reduced as in the case of ES.
A higher cumulative sleep deprivation is observed for the ES sequence compared to the RR sequence, due to the “normal night” between the first and the second RR which prevents the accumulation of sleep debt. This result is important as it has been shown that cumulative sleep debt could be more critical than acute sleep deprivation as individuals tend to underestimate the effects of cumulative sleep debt (Van Dongen et al, 2003).
Mean alertness levels were lower than the “critical” level of 5. These results are similar to those reported in other studies on short-haul flights (Spencer et al, 2002; Powell et al, 2007). The mean alertness level is significantly higher for RR on the first sector, not on the last sector. This result could be explained by earlier duty start times for RR compared to ES, considering the combined effects of early time and sleep inertia. From these results, the airline has decided to implement a systematic monitoring of the effects of these rosters.

Summary [150 words]

This research aims to evaluate the impact on crew sleep and fatigue of a reduced rest pattern compared to a sequence of consecutive early starts. The method was based on sleep log and « Top of Descent » fatigue data. The results show that sleep deprivation produced by reduced rest is close to the one induced by consecutive early start. Paradoxically, the ES sequence produces a higher sleep deprivation than the reduced rest sequence. This is due to the effect of the normal night included between 2 reduced rests that allows the crew to recover. The mean levels of in-flight alertness are significantly higher for reduced rests only on the first sector. This difference is mainly due to earlier duty start times for RR compared to ES. From these results, the airline has decided to launch a systematic monitoring of fatigue and sleep to monitor the effects of these rosters.