

The Ecology of Shiftwork in the United States Navy: A Comparison of Four Watchstanding Schedules from a human performance perspective

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Background

The naval environment is characterized by poor sleep and elevated fatigue levels. The daily work/rest schedule (or watchbill) for crewmembers varies from ship to ship. In the U.S. Navy, shift length typically varies from 3hrs to 6hrs. Depending on the number of qualified watchstanders, a given crewmember may stand watch from 6hrs to 12hrs each 24hr period. However, a common watchbill variant has watchstanders on-watch for 5hrs and off-watch for 10hrs or 15hrs—a *de facto* 15 or 20hr day that runs contrary to the naturally-occurring 24hr circadian day. In their off-watch period, crewmembers must fit in other ship duties and personal activities such as eating, hygiene and sleep. Unfortunately, this last category often gets short shrift and crewmembers suffer from chronic sleep deprivation. This work describes a multiyear effort to assess the impact of various watchstanding schedules used in the U.S. Navy from a human performance perspective. In this naturalistic experiments, we examined the sleep patterns and psychomotor vigilance performance of sailors on four different work/rest schedules.

Methods

Crewmembers were observed on a “3hrs-on/9hrs-off” (DDG-109, n=24), a “6hrs-on/6hrs-off” (DDG-109, n=9), a backward-rotating “6hrs-on/18hrs-off” (DDG-65, n=34), and on a “5hrs-on/10hrs-off” schedule (CNV-68, n=77). Each sailor wore an actigraph, completed an activity log, and performed a 3-minute psychomotor vigilance test (PVT) before and after standing watch. A between-subjects comparison assessed differences in daily sleep and PVT performance among the watchstanding schedules.

Results

Crewmembers on the 5hrs-on/10hrs-off received significantly more daily sleep ($6.88\text{hrs} \pm 0.89$) than those on the modified 6-on/18-off ($5.65\text{hrs} \pm 1.63$) and those on the 6hrs-on/6hrs-off ($5.90\text{hrs} \pm 0.90$) schedules (all comparisons, $p < 0.05$). Their sleep was comparable to sailors working the 3hrs-on/9hrs-off ($6.54\text{hrs} \pm 0.80$). However, sleep on the 5hrs-on/10hrs-off schedule occurs in irregular, circadian-misaligned times of the day. Over an entire 3-day rotation circle, a crewmember on the 5hrs-on/10hrs-off encounters two periods of 20-hours sustained wakefulness and one night of short sleep (≤ 4 hours). The 5hrs-on/10hrs-off schedule was associated with the worst PVT performance (mean reaction time and 355ms lapses) followed by the 6hrs-on/6hrs-off. The best performance was seen in the 3hrs-on/9hrs-off followed by the 6hrs-on/18hrs-off. PVT performance for both these schedules was significantly better than the 5hrs-on/10hrs-off ($p < 0.05$).

Conclusions

The 5hrs-on/10hrs-off results in lower quality sleep than other schedules. In particular, the 3hrs-on/9hrs-off schedule yielded better sleep hygiene and better performance. The

surface naval community should consider revising its watchstanding practices and implement policies to prevent using such unproductive watchbills. This study suggests that watchstanding schedules based on sound human performance and ergonomics principles may lead to better performance in the operational environment.

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