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FATIGUE AND USE OF GO/NOGO PILLS IN F-16 PILOTS SUBJECTED TO EXTRAORDINARILY LONG COMBAT SORTIES

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Introduction: We lack knowledge of real world pilot fatigue and use of GO/NOGO pills. To analyze this, a forward-deployed flight surgeon studied fighter pilots subjected to combat sorties often longer than 8 hours in duration. **Methods:** A 49-question survey on fatigue and GO/NOGO (USAF terms for stimulants/ sleep aids) use was distributed to 19 deployed/two permanent party fighter pilots during the end of a 3-month deployment. The data was analyzed at the USAF Warfighter Fatigue Countermeasures Research Laboratory. **Results:** The pilots flew an average of 149.0 hours over 3-months. To enhance crew rest, the flight surgeon made the sleep aids zolpidem (Ambien) and temazepam (Restoril) readily available to pilots. Fifteen pilots reported using zolpidem. Sleep aids were reported as being effective, but pilots had varied perceptions about their relative effectiveness. There was a statistically significant negative trend for sleep aid use frequency as a function of pilot age. Dextroamphetamine was available for pilot use during long sorties (longer than 8 hours). Pilots each flew an average of 4.3 long sorties per month. Sixteen pilots reported using dextroamphetamine and all used it when returning to base and/or prior to landing. Overall, the alertness aid was perceived as being effective. Seven of 16 dextroamphetamine users reported difficulty sleeping after their use. **Conclusions/Recommendations:** Fatigue is a significant safety threat in sustained fighter combat operations. Proper use of GO/NOGO pills can help mitigate this risk.

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PREFACE

This report was prepared by Dr. Darlene Schultz with the assistance of Dr. James Miller. It has not been published elsewhere.

The report was reviewed and approved for publication by Public Affairs at Eielson AFB, AK and the Congressional Public Affairs Office at the Pentagon, Washington, D.C.

The authors would like to thank Captain Graham Wallace for his help in writing and editing the pilot survey, and the staff of the Warfighter Fatigue Countermeasures R&D Program, Air Force Research Laboratory (AFRL/HEPM-WFC), who performed the statistical analyses.

SUMMARY

Introduction: We lack knowledge of real world pilot fatigue and use of GO/NOGO pills. To analyze this, a forward-deployed flight surgeon studied fighter pilots subjected to combat sorties often longer than 8 hours in duration.

Methods: A 49-question survey on fatigue and GO/NOGO (USAF terms for stimulants/ sleep aids) use was distributed to 19 deployed/two permanent party fighter pilots during the end of a 3-month deployment. The data was analyzed at the USAF Warfighter Fatigue Countermeasures Research Laboratory.

Results: The pilots flew an average of 149.0 hours over 3-months. To enhance crew rest, the flight surgeon made the sleep aids zolpidem (Ambien) and temazepam (Restoril) readily available to pilots. Fifteen pilots reported using zolpidem. Sleep aids were reported as being effective, but pilots had varied perceptions about their relative effectiveness. There was a statistically significant negative trend for sleep aid use frequency as a function of pilot age. Dextroamphetamine was available for pilot use during long sorties (longer than 8 hours). Pilots each flew an average of 4.3 long sorties per month. Sixteen pilots reported using dextroamphetamine and all used it when returning to base and/or prior to landing. Overall, the alertness aid was perceived as being effective. Seven of 16 dextroamphetamine users reported difficulty sleeping after their use.

Conclusions/Recommendations: Fatigue is a significant safety threat in sustained fighter combat operations. Proper use of GO/NOGO pills can help mitigate this risk.

FATIGUE AND USE OF GO/NOGO PILLS IN F-16 PILOTS SUBJECTED TO EXTRAORDINARILY LONG COMBAT SORTIES

INTRODUCTION

We lack knowledge concerning the interactions between real-world pilot fatigue and their use of GO/NOGO pills (2; Cornum KG. Personal Communication; 1992). Thus, a forward-deployed, USAF flight surgeon (DS) designed a survey to analyze real-world pilot fatigue and associated use of GO/NOGO pills in F-16 pilots subjected to extraordinarily long (greater than 8 hours) combat sorties and high operations tempo in dual support of Operations Southern Watch (OSW) and Enduring Freedom (OEF). GO/NOGO are terms used by the USAF pilots for stimulants (GO) and sleep aids (NOGO). The USAF currently has approved dexamphetamine for use as an aircrew stimulant. Approved aircrew sleep aids include zolpidem (Ambien), temazepam (Restoril), and zaleplon (Sonata). All aircrew are tested for side effects on the medications before being allowed to use them operationally.

METHODS

A 49-question survey was distributed to 19 pilots in the deployed unit and two permanent party pilots at the deployed location. Two pilots opted not to complete the survey. Two pilots returned from the deployment early and did not receive the survey. The survey, developed by the squadron's deployed flight surgeon, was conducted during the last week of a 3-month deployment. All but two survey questions were of either nominal or interval scaling properties. Two questions, one on stress level change and one on appetite change, were structured as 3-level ordinal scales (Increased, Decreased, Same). Due to size constraints, the entire survey is not contained in the article. Pertinent questions and answers are shown throughout the Results section. Since the survey was intended as a non-generalizable, medical snapshot of real-world operations, there was no review conducted relevant to the protection of human subjects in research. The data were collected non-invasively during work that the participants would have undertaken had no survey existed. Since the work was not intended to be generalizable, it did not meet both components of the legal definition of "research," i.e., "a systematic investigation ...designed to develop or contribute to generalizable knowledge" and was thus not reviewed for human subject protection issues (Title 32, Code of Federal Regulations, Part 219.102 d). This was an ad hoc medical survey with no specific scientific validation. It was done because there was concern by all the deployed flight surgeons that these pilots were experiencing much more fatigue than at home. The results were sent for analysis to the Air Force Research Laboratory's Warfighter Fatigue Countermeasures Research and Development Program in San Antonio, Texas, USA.

RESULTS

PILOT TRAITS

Data were acquired from 19 male F-16 pilots for a response rate of 90.5%. Seventeen of these pilots were on a 3-month deployment to Southwest Asia in dual support of OEF and OSW and the other two pilots were permanent party at the deployed location. Although the

sample size was small, it reflects data from almost an entire deployed squadron and therefore a valuable snap shot of operational fatigue and use of GO/NOGO pills.

The pilots' ranks ranged from O-2 (First Lieutenant) to O-6 (Colonel; the median and mode were O-3, Captain) and their ages ranged from 25 to 41 yr (mean = 31.7 yr). Two of the pilots had over 2000 hr in the F-16 and three reported 1500-2000 hr; ten reported 500-1000 hr and four reported less than 500 hr. Six were qualified as instructor pilots, nine as flight leads, and four as wingmen. Overall, this was a sample of highly experienced F-16 pilots.

The survey also asked about pilot sleeping characteristics prior to the deployment. Pilot wake times ranged from 0600-0800 and bedtimes from 2200-0000. The total time in bed ranged from 7-9 hours (mean 7.96 hours) and total hours of sleep were between 6-8 hours (mean 7.6). Sixteen pilots denied difficulty falling asleep at home. Two pilots reported difficulty falling asleep at home, and another reported difficulty only once per month. The latter pilot and one other reported the use of over-the-counter sleep aids at home.

DEPLOYMENT

All of the respondents filled out the questionnaire in the last week of their 3-month desert rotation. During this deployment, the unit flew a total of 750 sorties and logged 2796.6 hours. During this period, the pilots reported having flown 100 to 250 hours (mean = 149.0 hours). The bulk of these hours were combat and the remainder were training time. Three pilots reported flying a total of 25 hr/wk, four reported 20 hr/wk, four reported 15 hr/wk, and eight reported 10 hr/wk (median = 15 hr/wk, mode = 10 hr/wk). These hours included 2 to 10 sorties per month that exceeded eight hours in length (mean = 4.3 long sorties/month).

The survey also looked at stress levels. Asked "How has your level of stress changed during this deployment?", four pilots chose "increased," ten chose "same," and five chose "decreased" (median and mode = "same"). Stress was attributed to "12- to 14-hr days," "no days off," "sleep cycle/scheduling stressful here and at home," and "7-day work week/long hours/flex schedule." Reduced stress was attributed by three pilots to "new environment," "experience," and "decisions for free time."

Though the deployment did not provide a general perception of increased stress, it was obvious to the squadron's flight surgeon that the amount of work demanded of the pilots was much greater than that demanded at home. The use of the word, "stress," may have been misleading for the pilots. Perhaps an assessment of "sleepiness" or "fatigue" might have produced a clearer picture. For example, about half-way through the deployment a flight lead asked the flight surgeon if it was normal to fall asleep immediately whenever you sat down or laid down on your bed—he was experiencing extreme fatigue. The flight surgeon's general observations suggested that the pilots displayed far more fatigue and stress than they were willing to admit in the survey. Additionally, the response to the stress questions might have been different if the survey had been administered at mid-rotation when fatigue and burn out were at their peak rather when the squadron was preparing to return home.

It was also noted that the pilots' sleep schedules were changed quite often. Nine of the pilots reported that their sleep cycles were switched, by the flying schedule, from day to night or

back on a weekly basis. The other ten pilots reported switching on a "daily" basis. Unfortunately, there was no response choice offered on the questionnaire between these two frequencies.

The shift work literature from Europe and the United States indicates that weekly rotations are worse than daily or monthly rotations in terms of causing circadian disruptions in metabolism, cognitive performance and health. This observation may have indicated a need for crew schedulers to be trained in better scheduling. However, the daily and weekly switching problem appeared to be driven primarily by a lack of understanding by higher headquarters about the effects of a daily change in the use of deployed assets. There were only enough pilots to fill a demanding schedule. It was difficult to get the proper mix of experience to fill the combat sortie schedule with the appropriate numbers of flight-lead pilots and wingmen; the daily Supervisor of Flying (SOF) assignment (a pilot in the air traffic control tower who coordinated sortie launches); the daily Top3 assignment (a senior pilot who dealt generally with aircraft and pilot problems in the ground and air environments); and upgrade missions with the appropriate numbers of instructor pilots and upgrade pilots. Although stopping upgrade sorties when deployed is an option, it was viewed as having unacceptable, negative effects on the squadron's combat readiness and on pilot morale. The schedulers had to juggle pilot qualifications and make sure that they filled the schedule with pilots with adequate crew rest. With this high ratio of sorties (especially the 8-to-10-h sorties) it was quite difficult to make a schedule, let alone consider circadian rhythms. In addition, these schedule demands changed every day depending upon occurrences in Southwest Asia, and communication from higher headquarters was guarded. Thus, long-term schedule planning was nearly impossible.

SLEEP AIDS

Zolpidem (10 mg) and temazepam (15 mg) were available for pilot use through the squadron's flight surgeon as sleep aids for crew rest. Zalepon was not used because its use had recently been approved and none of the pilots had previously ground tested it. Command policy at the start of the deployment required a period of 12 hours from sleep aid ingestion to throttle. A policy letter sent out by the US Air Force Medical Operations Agency (AFMOA) to the Major Command (MAJCOM) changed this policy. The new policy changed the time from ingestion to throttle to 4 hours for zaleplon, 6 hours for zolpidem and 12 hours for temazepam. Although the policy change was done near the beginning of this deployment, the deployed flight surgeons were unaware of the change and enforced the 12 hour rule. Most of the pilots (15) reported using zolpidem during the deployment. One reported using no sleep aids and three reported using both zolpidem and temazepam. One of the pilots who used both reported that he changed from zolpidem to temazepam because zolpidem became ineffective for him after one month. Another pilot who reported a decreased effectiveness of zolpidem tested temazepam when not flying and found it affected him strongly for up to 12 hours. He did not change to temazepam because of his concern that he would be unable to wake up for his job.

The number of pills used per week ranged from 0 to 7 (mean = 3.6). There was a statistically significant negative trend for sleep aid use frequency as a function of pilot age (Figure 1; Pearson $r = -0.530$, $df = 16$, $p < 0.02$).

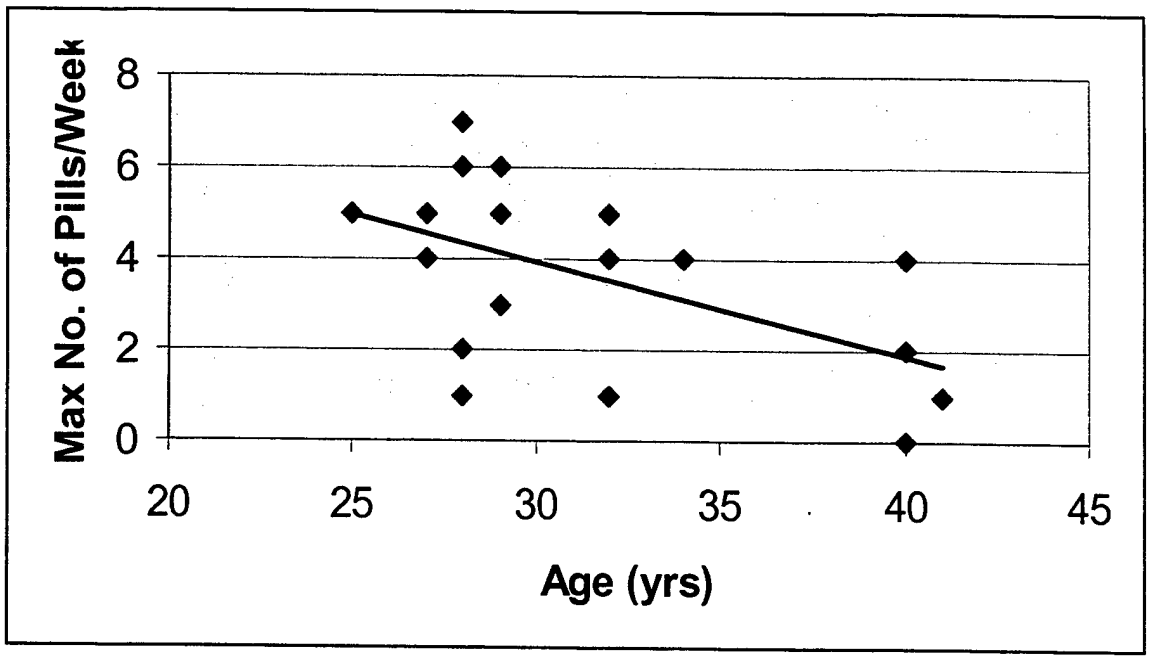

Figure 1. The statistically significant relationship between sleep aid use and pilot age (r = -0.530).

The pilots reported sleeping 6 to 8 hr/day during the deployment (mean = 6.9 hr). The mean of 6.9 hr represented a daily loss of 0.7 hr from the pre-deployment report. Although there was only a slight decrease in average sleep, a comment by one pilot suggested that the average sleep length was not the whole story. He noted that his sleep length was either 4 or 10 hours depending on the flying schedule. Clearly, launching with only 4 hours or sleep in the previous 24 hours is unacceptable, even if the sleep occurs near the beginning of the sortie. Several pilots noted interrupted sleep. Interestingly only one of these pilots classified himself as a light sleeper. Though the proportion of pilots reporting interrupted sleep was low, it is significant. These interruptions were probably due to inadequate sleeping arrangements--two pilots were assigned to a 1-room trailer. Often, one pilot's sleep was disturbed by the trailer mate being on a different schedule. Other sleep aid data are summarized in Table I at the end of this section.

None of the pilots reported side effects from the use of sleep aids. These data suggest that sleep aids were both used and perceived as being effective during the deployment.

When asked, "How many hours of sleep do you get on the NO-GO pill?", the responses ranged from 4 to 8 hours (mean = 5.6 hr). For the zolpidem-only users, the responses range was the same, but the mean was 5.3 hr.

Five zolpidem users reported that the effectiveness of their sleep aid "deteriorated" during the deployment. However, none of these five used both of the sleep aids that were available (zolpidem and temazepam); they were all zolpidem-only users. Additionally, since 14 of the pilots reported taking more than one pill per 24 hr, it is possible that the effects of the sleep

aids were deteriorating more than the answers to the deterioration question suggested. The flight surgeon also received anecdotal data supporting this view.

Senechal described dextroamphetamine use and the failure to use secobarbital by the F-111A crews involved in the 13-hour USAF bombing raid on Libya in April 1986 (6). He noted that the use of dextroamphetamine was a success. He then noted that the failure of the crews to use secobarbital for pre-mission crew rest was due, apparently, to their lack of confidence in their own reactions to the drug and their overestimations of their abilities to acquire pre-mission sleep. He recommended the use of a shorter-acting sleep aid and better education of crewmembers about the need for the use of sleep aids. Our data suggested that, while our aircrews were better educated than the F-111A crews about the need for the use of sleep aids, they would have benefited from further education that would allow them to judge and exploit their individual responses to the various sleep aids available to them.

Table 1. GO/NOGO Survey Data

Survey Question	**Response (number of pilots)**			
	Yes	**No**	**Sometimes**	**N/A (not used)**
"Have you ever taken more than one NOGO pill in a 24-hour period?"	14	4	0	1
"Was the NOGO pill helpful for you to fall asleep when you weren't tired?"	18	0	0	1
"When you wake up after taking a NOGO pill, do you feel well rested?"	17	0	1	1
"Over the course of the deployment have you noticed any deterioration in the effect of the effect the NOGO has on you?"	5	13	0	1
"If there were rules to the contrary would you ever want to take a NOGO pill less than 12 hours prior to flying?"	12	6	0	1
"Do GO pills help you stay alert on a long sortie?"	14	1	1	3
"Could you fly a long mission without using GO pills?"	16	3	0	
"Is it difficult to fall asleep naturally after taking GO pills?"	7	9		3

ALERTNESS AIDS

Dextroamphetamine (5 mg) was available for pilot use, through the flight surgeon, as an alertness aid for long sorties. A long sortie was defined by command policy as being longer

than 8 hours, and these pilots each flew an average of 4.3 long sorties/month. The pilots were allowed to take more than one GO pill per sortie. In fact, command policy suggested that once they started taking them, they were supposed to continue taking them, once every four hours until landing. The pilots were asked, "How many GO pills do you average on sorties greater than 8 hours?" The numbers ranged from 0 for three pilots to 4 pills for four pilots (mean = 1.9 pills). Overall, the alertness aid was used and perceived as being effective. The use and approval rate for our pilots was quite similar to those reported by Emonson and Vanderbeek for F-15 pilots during Desert Storm (3). The later part of the table above summarizes the data on GO pills.

The pilots were asked to report whether nighttime or daytime operations affected their use of the alertness aid differentially. Six of the 16 users reported no difference and the other 10 selected nighttime.

Command policy allowed pilots to take a second GO pill when the first 5mg dose failed to provide adequate alertness after 15 minutes. When asked, "How commonly do you take two GO pills at once?" nine responded "never," four responded "25%," two responded "50%," two responded "75%," and one responded "100%." (The one non-responder reported zero use on long sorties.) Interestingly, five of the nine non-never pilots were "wing it" responders. Apparently, no dose or a 5 mg dose was adequate for about half of the pilots all of the time and up to half the time for 84% of the pilots (16 of 19 pilots).

In response to a question about whether they planned their use of GO pills in advance or just "winged it," eleven chose the latter response, six reported planning ahead and two (who reported zero use on long sorties) did not answer. All of the 16 pilots who reported using the alertness aid on long sorties used it while returning to base (RTB) and/or prior to landing.

The pilots were asked, "How often have you taken a NO-GO pill to get to sleep after a sortie where you have taken a GO pill?" Six of the 16 answered "never," six answered once, and each the other four pilots answered "25%," "50%," "75%," and "100%," respectively. The latter three reported difficulty falling asleep after a GO-pill sortie, but the "25%" responder reported no difficulty. The latter pilot may have needed some medical advice about over-medication.

DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

Survey data were acquired from 19 male, highly-experienced fighter pilots during combat operations in Southwest Asia. The pilots flew an average of 149.0 h over a 3-month period. Generally, they were good sleepers at home, without obvious evidence of insomnia or other sleep pathologies and with some evidence of good sleep hygiene. Although the sample size was small, it reflects data from almost an entire deployed squadron and therefore is a valuable snap shot of operational fatigue and the use of GO/NOGO pills.

This survey was conducted by a field flight surgeon with no previous research experience. It therefore has multiple deficits. First, it was conducted without an Ethics Committee review. The flight surgeon was unaware of this review process. The flight surgeon only tried to

quantify the stress and fatigue issues seen while deployed. The flight surgeon's only purpose was to improve flight safety of future deployments. Secondly, due to lack of familiarity with the sleep literature and lack of resources in a remote environment, established sleep survey data were not used in the survey. The questions on the survey were developed by the flight surgeon based on her observations and she enlisted the help of other deployed flight surgeons. The data would be more accurate and reproducible if established sleep surveys were incorporated into the sleep survey. Finally the flight surgeon contacted the sleep lab at Brooks only after the data were collected. The author encourages early contact with experts in the field to avoid all the above shortcomings. Despite these set backs, important data were obtained.

The data showed daily and weekly schedule switching which did not allow proper sleep/circadian rhythm synchronization. Two issues contributed to this. First pilot schedulers were unaware of how to plan schedules to optimize fatigue issues. Second, higher headquarters dictated almost daily, last minute mission changes. Both these issues need to be combated have an impact on pilot fatigue. Schedulers could easily be educated on fatigue and then incorporate that knowledge into scheduling procedures. The USAF Warfighter Fatigue Countermeasures Research Laboratory is currently developing computer programs to aid schedulers. More importantly, educating higher headquarters about the inherent dangers of fatigue and the impact of last minute schedule changes on flight safety will allow them to make more informed decisions about balancing the needs of combat operations with flight safety.

There appeared to be substantial variability in pilots' perceptions about relative sleep aid effectiveness across the two choices, temazepam and zolpidem. Research may be needed to support efforts of flight surgeons to encourage pilots to try temazepam instead of zolpidem during a deployment when they perceive deteriorating zolpidem effectiveness.

There was a statistically significant negative trend for sleep aid use frequency as a function of pilot age. This finding was unexpected since insomnia risk generally increases with age. However, since this insomnia tends to be secondary to primary sleep pathologies and these were healthy pilots, it was unlikely that we would have seen a positive trend due to an increasing incidence of sleep pathology (1). In fact, the negative trend may have occurred because the older pilots had become, through experience or self-selection, better able to cope with psychological and psychosocial factors that might have caused insomnia and were thus less likely than younger pilots to use sleep aids.

Command policy prior to the deployment required a period of 12 hours from sleep aid ingestion to throttle. During the deployment this time requirement changed to 6 hours for zolpidem and 4 hours for zaleplon. The deployed flight surgeons were unaware of the policy change and therefore enforced the 12 hour time requirement. The primary observation from the pilots about sleep aids, elicited by this survey, was that pilots need to be able to take zolpidem later than 12 hours prior to flight. The survey data supports command decision to decrease the time from sleep aid ingestion to take-off and encourages expedient dissemination of policy changes to flight surgeons in the field.

Dextroamphetamine was available for pilot use as an alertness aid for long sorties (longer than 8 hours). All of the 16 pilots who reported using the alertness aid on long sorties used it while returning to base (RTB) and/or prior to landing. This may have happened because the flight surgeon emphasized the need to take the GO pills prior to landing. Considering that RTB is a common period for accidents (probably due, in part, to the "let down" of departing the combat zone), the RTB use was probably appropriate (5).

However, a low proportion of planned pill use (6 of 16 responding pilots is 37%) indicated a generally inadequate approach to operational risk management applied by the pilots to fatigue. We have the quantitative capability to plan pill use, and we should use it (4). Considering the insidious nature of fatigue, those pilots who make voluntary use of alertness aids should plan ahead before the sortie and not rely on real-time, fatigue-impaired, in-flight judgment to "wing it" on decisions about GO pill use. Thus, when fatigued during a sortie, they could fall back upon their own, written plan about GO pill use instead of elevating their risk of making an error of omission (not taking a needed GO pill) that could jeopardize them, their wingmen, the aircraft, and the mission. Seven of the 16 alertness aid users reported difficulty sleeping after their use. Perhaps the flight surgeon should advise pilots to take the pills at least 2 to 3 hours prior to landing to decrease this apparent effect of the alertness aid on post-sortie sleep.

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