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Focus

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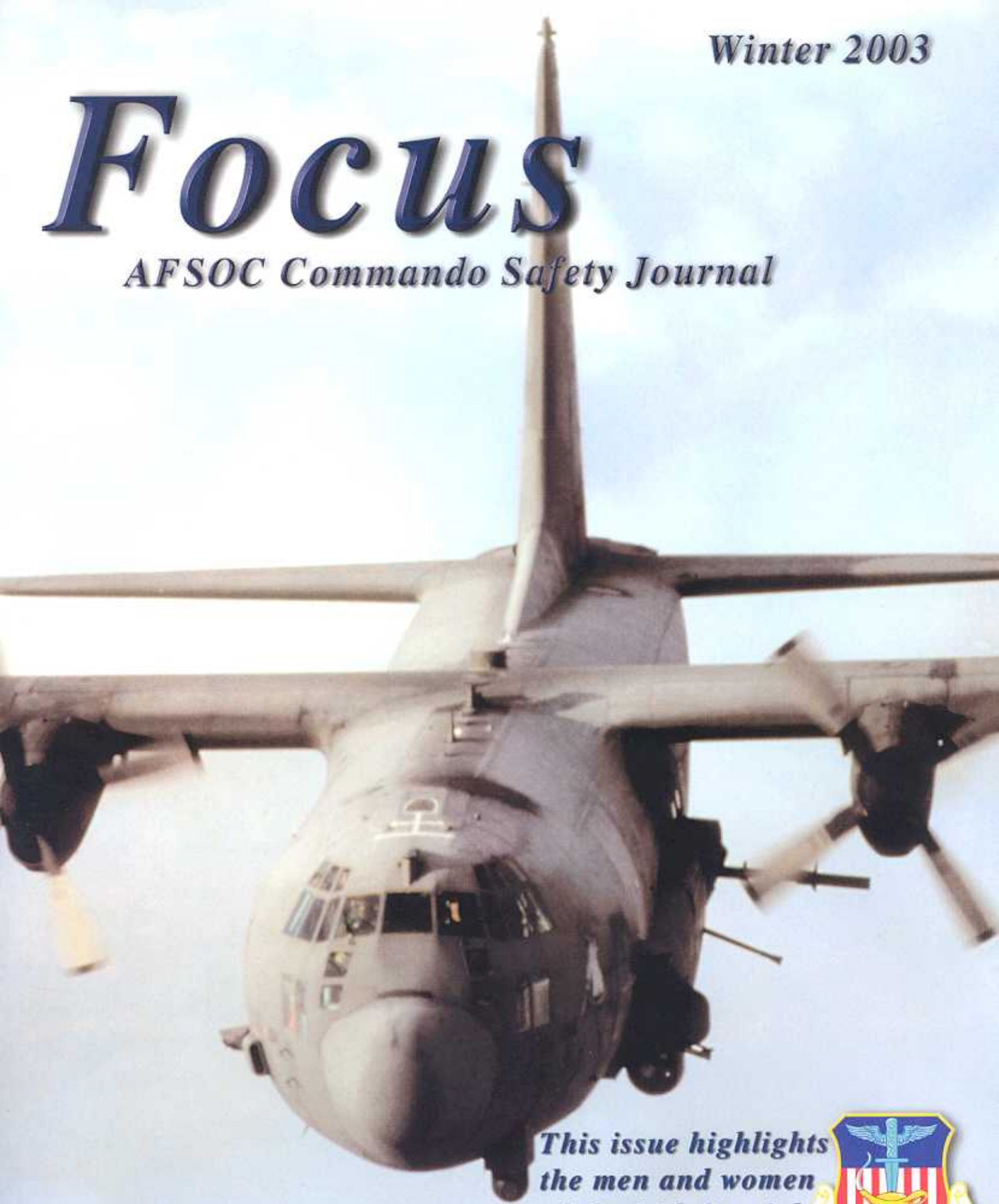

This issue highlights the men and women of the 16th Special Operations Wing

ANY TIME ANY PLACE

FATIGUE IN AVIATION SPECIAL OPERATIONS: UNDERSTANDING THE PROBLEM AND POSSIBLE WAYS TO FIX IT

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Fatigue in aviation operations is a safety hazard that prior to the early 1990's was largely underappreciated. However, after a DC-8 mishap in Guantanamo Bay was officially attributed in part to aircrew fatigue, the National Transportation Safety Bureau, the military safety centers, and even the general aviation community began to focus increasing amounts of attention on the risks posed by overly tired pilots. Now it seems that with each passing year, more and more is discovered about the number and sheer magnitude of fatigue-related mishaps in both military and civil aviation. In the Air Force alone, almost 8 percent of the reportable Class A mishaps over the past 20 years have been at least partially blamed on aircrew fatigue.

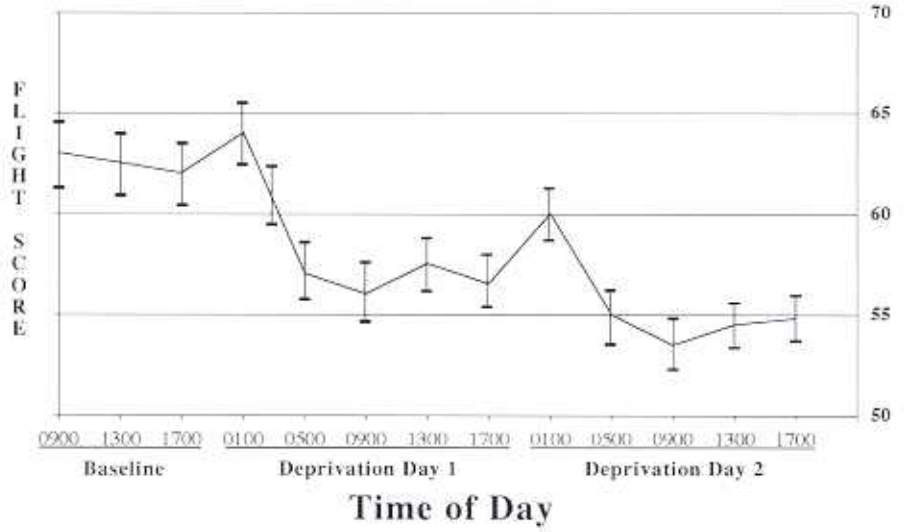
As one well-known researcher recently said, the problem of fatigue is insidious, widespread, and universal. In other words, fatigue is a sneaky and dangerous problem that almost every pilot in every aviation sector experiences on almost a daily basis. If you've been flying for very long, you don't need to be convinced that this is true! But regardless of the fact that fatigue has become a well-recognized operational hazard, many people remain unclear about the exact nature of the problem and what techniques are most likely to effectively counter it.

What is fatigue?

How many times have you struggled through a series of those seemingly endless days when the forces of nature, operational demands, and miserable schedules left you to wonder how in the world you would ever make it through the mission, much less through the trip back to base? How often have those scratchy eyes, those 'out-of-focus' instruments, the startling head-bobs, and those painfully heavy eyelids made it clear that the alertness of only a few hours ago was definitely a thing of the past? When was the last time that during an 0300 flight you caught yourself wondering whether you actually made that last radio call or whether you just thought you did? What about that last item on the checklist? Did you really check it, or was it accidentally skipped? If you're like most pilots, you've been face-to-face with all of these experiences more times than you can count, and your last "up close and personal" reminder about the insidious nature of fatigue wasn't all that long ago. Unfortunately, you're not alone. This kind of fatigue has always been a problem throughout aviation history, but it is especially problematic in Special Forces where rapid deployments, unpredictable schedules, and long hours are the norm rather than the exception. On top of all of that, the rapidly evolving technology of our modern world has further stressed human adaptive capability to the limit. How did we get in this boat to start with, and what are the root causes of our daily experiences with this phenomenon called fatigue?

For starters, the Air Force's conduct of sustained operations can be an open invitation to an unwanted escalation of pilot fatigue. Our sustained-operations doctrine is key to incapacitating the enemy in part by forcing them to continuously respond to tactical threats without the benefit of sufficient recovery sleep. Persistent and sustained operations, "24 hours a day, seven days a week" are now considered

essential to attaining U.S. victory in today's battlespace in part because of the damaging levels of fatigue they produce in the enemy. Unfortunately, this tactic can backfire unless we properly manage our own fatigue. Further, the 37.7 percent reduction in military personnel and corresponding 400 percent increase in contingency deployments has not helped in this regard. Thanks to personnel reductions, everybody is striving to "do more with less," and some experts claim the net effect has been diminished combat readiness, at least partially because of increased fatigue. Sleep-deprived people lose about 25-30 percent of their mental capabilities for every day that they remain continuously awake. There is evidence that even one night of sleep loss can lead to impairments similar to those seen with blood alcohol concentrations of 0.05 to 0.10 percent. As shown below, recent studies on pilots flying instrument maneuvers clearly show that lengthy duty periods without sufficient recovery sleep impair their ability to perform even the most well-practiced flight maneuvers. Note the decrements across 3 days without sleep. Not only is there a consistent worsening of performance throughout the entire



period, but at certain times of the day the problems are made even worse by low points in the body's natural rhythms.

Although 3 days (64 hours of continuous wakefulness) is the extreme, it is clear that even half that amount should raise serious concern. How many times have you and your buddies (or your subordinates) had to stay awake for 24-36 hours in combat? In fact, how many times have you stayed awake this long in peacetime just to rotate to a new work shift? Whenever you had these experiences, you came face to face with the primary component of the fatigue equation—insufficient day-to-day sleep.

Next, there are circadian rhythm problems, many of which stem from the fact that thanks to technology, we now have the capability to train and fight around the clock even though mother nature didn't intend things to be this way. Think about it, for thousands of years most humans lived their entire lives without traversing a single modern-day time-zone, and they lived their whole lives sleeping at night and staying awake during the day. However, in 1883 the invention of the electric light bulb enabled us to work at night, and starting in the 1950's, night vision technology enabled us to fight around-the-clock. Darkness was no longer a constraint, and because of this, the genetically-programmed biological clock was ignored. As a result, the unpleasant sensations of "shift lag" became all too common. To complicate things, high-speed air travel introduced the phenomenon we now call "jet lag." In 1913, it took 9 days to cross the 6 time zones between the U.S. and Europe, but today, this same crossing in a C-141B or a C-130 takes about 7 hours! So, in less than a hundred years, technology increased the speed with which troops could be deployed from a low of one time zone per day, to

today's rate of one time zone per hour. Meanwhile, *the rate at which humans can adapt to new time schedules has not changed.* It still takes us at least a day to adjust to each 1-hour change in work/rest schedule or time zone, and until adjustment occurs, we suffer from disrupted sleep, increased fatigue, gastrointestinal disturbances, and sleepiness on the job. And jet-lag or shift-lag related sleep loss of 2 or more hours per night can lead to significant performance and alertness decrements. This much sleep loss is almost a daily occurrence in today's military operations! How many times have you found yourself lying awake at 0300 after some overseas deployment because your body's internal clock was still running on U.S. time? Thanks to our slow rate of biological adaptation, every time-zone change and shift change offers a new "opportunity" to once again experience the joys of suffering through the haze of jet lag or shift lag! When was the last time you hit the flight line bleary-eyed before sunrise because your physiology was screaming that it was still time to be in bed asleep? These were the times when you encountered the second major component of fatigue—trying to work or sleep out of sync with the body's circadian rhythm.

What can be done to deal with fatigue?

Needless to say, if we could just avoid sleep loss, shift work, and time-zone changes, we could eliminate fatigue from every mission. However, given the nature of military operations, it's difficult to imagine that such a perfect world will ever exist unless we can figure out a way to use computers to fight all of the battles! Even then, we humans probably would still need to work long shifts at odd times just to keep tabs on the situation. So, what can be done to combat the deleterious effects of insufficient sleep and circadian disruptions both now and in the future? Well, there are in fact a variety of strategies for managing fatigue in operational settings, and these can generally be categorized as either nonpharmacological or pharmacological (nondrug versus drug).

Of course, the choice of one approach over the other depends on the exact nature of the situation as well as on the types of personnel involved; however, a well planned fatigue-management strategy can make the difference between success and failure, and even life and death, in the operational environment. Take a look at the overview presented below, and decide for yourself what will work best in your environment.

Nonpharmacological approaches

These non-drug techniques should be considered the "first line" defense against fatigue whenever they are feasible for the specific context. Obviously, some of these techniques are best for the home environment, whereas others will be most useful out in the field or otherwise when deployed.

Good sleep habits will maximize the benefits of every sleep period. As much as possible, make the sleep area cool, quiet, and dark, or use a sleep mask and ear plugs to minimize light and noise. Do your best not to take work into the sleep environment because this will have an alerting (and possibly stressful) effect. When possible (i.e., when at home or in a hotel), engage in a comforting pre-sleep ritual. Reading and/or taking a warm bath or shower before bedtime can promote sleep. When time permits, perform aerobic exercise 3 to 4 hours before lights out to improve sleep quality. Avoid nicotine, caffeine, and alcohol right before bed. Smoking within an hour of bedtime can lengthen the time it takes to go to sleep, and caffeine can have a stimulant effect for five or more hours (and caffeine tends to disrupt sleep quality more and more the older we get). Alcohol may increase sleepiness in the beginning of the sleep period, but it severely disrupts sleep quality later on, exacerbating fatigue the next day.

Proper work/rest management is absolutely essential to operational readiness because there is no better fatigue countermeasure than ensuring everyone is well rested prior to the mission. Whenever possible, ensure that all personnel have at least 10 hours off duty every 24 hours in order to accommodate 8 full hours of sleep. This is the minimum amount of daily sleep recommended by sleep specialists to maintain peak performance day in and day out. Remember that people need time to take care of personal business and travel to and from work, so allowing the extra 2 hours off (for a total of 10 hours per day) can make the difference between an 8-hour sleep period and one that ends up being only 5 or 6 hours long.

Strategic naps are a great way to avoid sleep-deprivation-related performance decrements whenever a full 8-hour sleep period simply isn't feasible. Naps work so well simply because they are brief periods of sleep, and sleep is the only really effective long-term way to minimize fatigue. Napping as late as possible *before* a period of sustained operations can minimize the amount of fatigue during the subsequent extended period of wakefulness, and naps *during* sustained operations can arrest the fatigue-related decline in performance. When planning a napping strategy, it is best to place the naps early rather than later in the period of sleep loss, to make the naps as long as possible (naps ranging from 30 minutes to 2 hours have been proven highly beneficial), and to place them at times that are naturally optimal for sleep (i.e., between 1300-1500, and 0100-0600). Of course, it is best to provide a napping environment that is as quiet, cool, and dark as possible, just like the environment recommended for regular restful sleep. Also, remember to allow at least 20 minutes of "wakeup time" to shake off post-sleep grogginess before returning to work after any nap or any other sleep period.

Rest or activity breaks are very helpful for temporarily boosting alertness in a variety of settings. Even breaks of only 7 minutes have proven beneficial for long-haul pilots, and several studies have documented the positive impact of rest breaks in industrial contexts. Although precise break schedules have not been developed, it is clear that more frequent breaks are needed in monotonous settings than in more mentally stimulating ones. Rest breaks will produce a noticeable increase in alertness for approximately 20-40 minutes.

Brief periods of exercise also can offer some benefit in situations where fatigue has become problematic, but, like activity breaks, this strategy only temporarily reduces the impact of sleep loss. Unlike breaks, exercise can have the drawback of ultimately impairing performance once the immediate effects wear off because intense physical activity can make people more tired in the long run. Thus, exercise should be used with caution in settings where sleep deprivation is present.

Computerized scheduling tools can help to identify periods of time when naps, breaks, or other fatigue countermeasures are needed the most. Also, they can help plan the best times for sleep in a variety of settings.

The Fatigue Avoidance Scheduling Tool (FAST™) is one tool that estimates performance effectiveness based on day-to-day patterns of sleep and wakefulness. FAST™ is a Windows™ program that allows planners and schedulers to quantify the effects of various schedules on human performance, and it provides an easy-to-read graphic output of the performance levels that can be anticipated in light of any given operational schedule.

The top non-pharmacological fatigue countermeasures are:
Good Sleep Habits
Proper Work/Rest Management
Strategic Naps
Rest/Activity Breaks
Brief Periods of Exercise
Scheduling Tools can be helpful

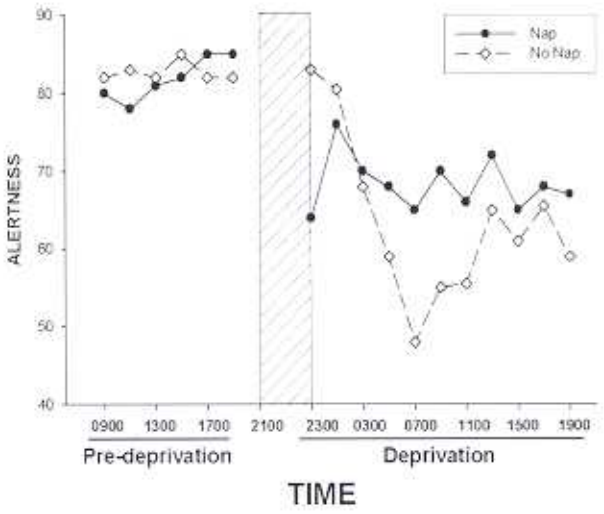
Pharmacological fatigue countermeasures

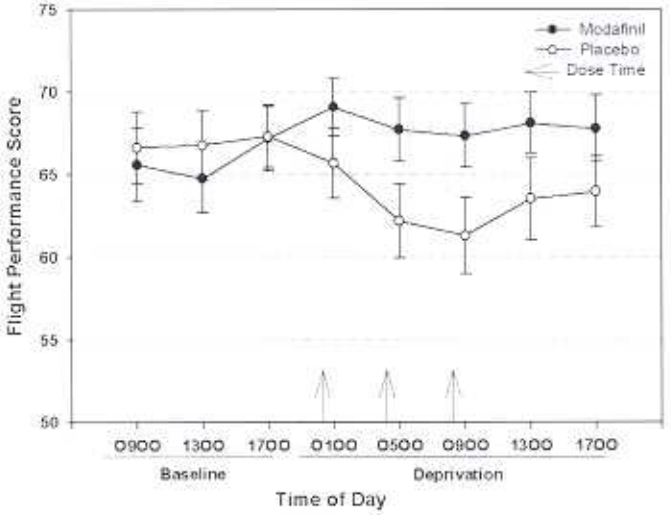
When none of the nonpharmacological approaches seem to be enough to maintain performance at safe and effective levels, anti-fatigue drugs can be a short-term solution. Although drugs should never be used in place of good crew-rest planning, there are situations in which "alertness-enhancing compounds" are the most reliable method for maintaining the performance of personnel who are deprived of adequate sleep opportunities. Such compounds are effective and easy to use, and their feasibility is

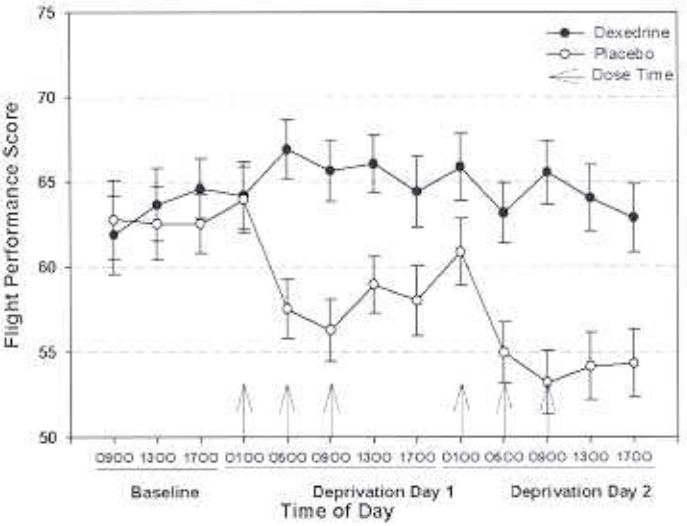
not dependent upon environmental manipulations or scheduling modifications. This explains why pharmacological compounds such as amphetamines have been used extensively in several military conflicts. At present, there are essentially three choices that deserve serious consideration—caffeine, modafinil, and dextroamphetamine.

Caffeine is easy to acquire and socially acceptable, and it appears suitable for sustaining alertness in relatively short (i.e., 37 hour) rather than long (i.e., 64 hour) periods of continuous wakefulness. The effectiveness of caffeine may be less than optimal in individuals who normally consume moderate to high amounts in coffee, soft drinks, nutritional supplements, and/or food products. For instance, it is known that tolerance to the sleep-disrupting effects of caffeine can occur in as little as 7 days in individuals given high doses (1200 mgs per day), and although the majority of adults consume far less than 1200 mgs per day, it is estimated that about 80 percent of the U.S. adult population regularly consumes a behaviorally active dose of caffeine on a daily basis. All of this not withstanding, it has been established that caffeine generally will significantly improve the performance of sleep-deprived people who do not normally consume high doses of this compound. Doses of 200 mgs, administered at 2-hour intervals, have been shown to sustain high levels of cognitive performance throughout a night of work without sleep. This is about the amount of caffeine available in a strong cup of coffee (or in a dose of NoDoz™ or Vivarin™).

Modafinil is a new alertness-enhancing compound that is useful for overcoming sleep loss in military contexts. The one aviator performance study that exists (with 600 mg modafinil given in three divided 200 mg doses) indicates modafinil sustained simulator flight performance at near-rested levels despite over 30 hours without sleep; however, there were anecdotal







reports that modafinil was associated with side effects such as nausea, vertigo, and dizziness. Other studies have found that modafinil reduced the frequency of involuntary sleep lapses and maintained cognitive performance during 60 continuous hours of wakefulness, and a Walter Reed Army Institute of Research study indicated that 400 mg of modafinil was similar to 600 mg caffeine for restoring performance that had degraded after 41.5 hours without sleep. With these promising effects, modafinil was recently approved by the Air Force for limited use in managing aircrew fatigue.

Amphetamines have long been known to maintain the performance of sleep-deprived people at or near nondeprived levels. The Air Force authorized the use of amphetamines to sustain the performance of sleep-deprived pilots as early as 1961, and dextroamphetamine continues to be authorized under Air Force policy for certain situations today. Multiple 10-mg doses of dextroamphetamine are known to sustain the performance of pilots throughout more than 55 hours of total sleep deprivation without producing side effects other than modest blood-pressure and heart-rate increases that are of little or no consequence in the pilot population. In addition, the preponderance of research indicates that dextroamphetamine does not increase risk-taking behaviors or cause overestimation of performance capabilities. The existing data, and approved Air Force policy, indicates that 10-mg doses of dextroamphetamine safely provide operationally-relevant resistance to the effects of sleep deprivation in aviation contexts.

The top pharmacological fatigue countermeasures are:
Caffeine
Dextroamphetamine
Modafinil (may be a future option)

What's the bottom line?

Fatigue will always be a problem in Special Operations because of the intensity and unpredictability of the missions undertaken. The best way to prevent fatigue on the job is to ensure that everyone gets enough sleep before the mission even starts. Sleep experts recommend 8 hours of sleep per day to maintain top-notch performance. However, if a full 8-hour sleep period is not possible, naps, breaks, and exercise should be considered, and a computerized scheduling tool such as FAST™ can show the times at which these are needed the most. Contact the Warfighter Fatigue Countermeasures Program at Brooks City-Base for information about how you can acquire a scheduling tool to use on your laptop or office computer.

When sleep deprivation becomes severe, alertness enhancing drugs may be the only realistic way to fight fatigue. Stimulants can't replace the need for sleep, but they can temporarily postpone it, and this can fight off the involuntary lapses into sleep that will occur once sleepiness becomes severe. Caffeine, taken in the form of drinks or food products, can be used freely by aviation personnel. Dextroamphetamine is a more powerful stimulant that can be utilized once the chain of command and the flight surgeon make a decision that this is the best course of action. Realizing that no alertness-enhancing drug is a perfect, 100-percent solution, the use of these compounds certainly beats falling asleep at the controls!

The bottom line is that improperly managed fatigue is an ever-present threat to operational safety and effectiveness. We all must be on constant guard against this insidious enemy and be prepared to implement effective countermeasures at the first sign of trouble. Optimal alertness on the job is the key to sustaining *Global Vigilance, Reach, and Power* that is the hallmark of today's Air Force.◆

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