Pitt research shows NASA sleep-wake scheduling guide may need to be changed

December 6 2004

New research from the University of Pittsburgh shows the human body has difficulty adjusting to dramatic time changes such as those experienced by working shifts or traveling across time zones.
The NASA-funded study, detailed in this month's Aviation, Space and Environmental Medicine, was designed to examine the protocols the space agency uses to assign sleep-wake schedules that ensure astronauts are always able to handle their demanding tasks at peak performance.
The findings suggest changes should be made in the way NASA schedules sleep periods on missions, but also have meaning for anyone who has had to deal with a significant time change and still function.

"Many of us find that we have to change our sleep schedule, perhaps to accommodate work or school start times, or a change in our commute time," said Timothy H. Monk, Ph.D., professor of psychiatry at the University of Pittsburgh School of Medicine and lead author. "We often wonder if we should make the change all at once, or more gradually over several days or weeks. This research has the eventual aim of helping us make that decision in the best way possible."

According to Dr. Monk, early in the history of manned space flight, NASA realized that it had to have a method for assigning sleep periods to correspond to astronauts' biological clock rhythms if they were to get enough rest to do their assignments. "If they scheduled sleep for the wrong time, an astronaut could end up having disrupted and unrefreshing sleep, leaving them feeling tired and irritable, and perhaps more apt to make mistakes."

Getting the right amount of sleep at the right time is more complicated in space than it is on Earth. On Earth, people are used to having time cues tell their bodies when it is time to sleep or to wake up. The strongest of these is the 24-hour day-night cycle, which comes from the fact that we live and have evolved on a planet with a 24-hour rotation. Like most animals we have a biological clock in our head, which is able to keep time, getting us ready for sleep at night and wakefulness during the day using rhythms with a period of about 24 hours – referred to as circadian rhythms. In orbit, the sunrise-sunset cycle lasts for a mere 90 minutes, and after the absence of the natural 24-hour cycle for three months or more, the biological clock starts to weaken. When the biological clock gets thrown off balance, sleep and alertness suffer.

Complicating the issue is the need for astronauts to be awake and alert to undertake sensitive mission goals – say docking with another vessel – at specific times that may fall during a time at which they are normally asleep.

To reconcile an astronaut's need for sleep with their busy schedules, NASA originally developed guidelines referred to as "Appendix K." These guidelines specified how much time had to be set aside for sleep and for the transitions to and from it. It also specified by how much an astronaut's bedtime could change from one day to the next. It favored "trickling in" changes rather gradually, using phase delays to later bedtimes (by up to 2 hours) wherever possible.

The concept is similar to the terrestrial example of the common traveler's advice to move one's bedtime ahead or back a little at a time in the week before an overseas trip to help minimize jet lag.

"The thought was that mission schedulers could trickle in a series of two-hour phase delays without incurring any negative consequences as far as sleep quality and alertness," said Dr. Monk. "However, based on the findings from this experiment, that assumption might be quite wrong."

The researchers observed participants, who volunteered to spend 16 days on a "mission" at the University of Pittsburgh's time isolation facilities, and tested them for alertness, mood and core body temperature – the best standard for assessing circadian rhythms. At the same time they recorded their sleep to assess its duration and quality. The experiment involved a series of nine repeated two-hour delays in bedtime.

During the study Dr. Monk and his colleagues found that the circadian pacemaker did adjust itself – but only by about one hour per night rather than the two hours required by NASA's protocol. Because of that, subjects eventually experienced a massive flattening in the amplitude of their circadian temperature rhythm indicating that the biological clock was not doing its job properly. This led to significant disruptions in sleep and lowered alertness while awake.

More research needs to be done before scientists can advise NASA on how to change its guidelines.

"There is always some cost to performing tasks when we expect to be asleep, but by the end of the series of experiments, of which this is the first part, we shall be able to advise NASA which approach – gradual delays, gradual advances, all at once – will lead to the least disruption of an astronaut's sleep and alertness," said Dr. Monk.

Co-authors include Daniel J. Buysse, M.D., Bart D. Billy, M.S. and Jean M. DeGrazia, M.Ed. The National Institute on Aging provided additional research support.

Source: University of Pittsburgh Medical Center