

Our Job and Our Health as Crewmembers

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Researching the effects of diurnal and circadian disruption on the human hormonal system raises some important questions for the aviation community. The effect is serious and needs to be understood if we are going to try to mitigate the negative impact on our lives. This piece is research based on references throughout. However, I have also had to make connections and correlations that have not been studied and therefore are anecdotal, based on actual experience and interviews. Research defining the scope and impact of hormonal disruption has increased exponentially during the last 15 years. This piece merely scratches the surface and is not meant to be comprehensive. It is a starting point from which you can begin your own research and explore current information relative to your own experience.

First, all of us react and respond differently to stressors. Some people may seem to tolerate our lifestyles better than others. Diurnal (working at night) and circadian (time zone changes) effects are very similar in that they are very stressful to the body and cause release of cortisol, an adrenal hormone, resulting in high chronic cortisol levels. Cortisol is damaging, by itself, to certain parts of the brain, but is also an immune system suppressor. If we are working at night or in another part of the world and are awake when we should be sleeping, we do not release other hormones that are necessary for health, such as growth hormone (responsible for healthy replacement cell growth and general organ health), and melatonin, a serotonin-releasing hormone, which is also tied to the health and function of our thymus gland. The thymus is the organ that produces cancer-fighting cells (T-cells), and empowers our immune system. We are inducing damage through our lifestyles, the result of which is a weakened immune system with which to fight the damage, and a weakened hormonal system unable to repair or rebuild that damage. To make it worse, all those systems begin to decline naturally in our 50s. We often impede the body's ability to maintain normal health far beyond that of normal aging. The acceleration of decline after age 50 becomes exponential rather than linear.

Additionally, there have been many recent studies that definitively show a correlation between circadian disruption and increased growth rates in cancer. With a weakened immune system and increased cancer potential, pilots are often in an environment that accelerates cancer growth!

Pilots are goal-oriented and often place financial or family goals above personal comfort. They will just press on and believe they can hack it. If they were aware of the actual health implications, perhaps many would make different choices.

This article should raise awareness and help define the questions you should ask yourself, your company, and your doctor (probably not your FAA doc) about how to stay healthy and increase your potential for longevity. Much of what is presented is based on research of individual aspects of how our body operates in response to varying situations. As you read this, try to get a feeling for the potential cumulative impact of the different areas discussed based on your lifestyle.

Our physical strength is expressed through our muscles and skeleton, our function and performance rely on our brain-driven nervous system, but our vitality and health are driven by our endocrine system (hormones). Our endocrine system is a complex overlapping system of hormone release and inhibition that manages our body temperature, energy use, blood glucose level management, cell growth and replacement, and immune system function, among many other things. The impact of crew lifestyles and schedules can be devastating to these systems. Some of this may be a bit technical, however I think by the end of the article the importance of this information will be clear.

My research began some 15 years ago. Since that time much more information has become available.

In November 1998, *The Journal of Occupational and Environmental Medicine* reported, “The airline industry may be an occupational setting with specific health risks. Pilots tend to experience debilitating effects of erratic time changes resulting from jet lag due to international flying and radical shift changes of domestic flights. Other factors to be considered” the article continued, “are circadian disruption and conditions specific to air travel, such as noise, vibration, mild hypoxia, reduced atmospheric pressure, low humidity, and air quality.” Another article published in *Nature Neuroscience* (June 2001), states, “The long term repeated disturbance of synchronization between the two timing systems [pattern of light and dark and endogenous circadian rhythms] impairs physiological and psychological health and induces stress.”

The same article in *The Journal of Occupational and Environmental Medicine* found that “U.S. pilots and navigators have experienced significantly increased mortality due to cancer of the kidney and renal pelvis, motor neuron disease, and external causes. In addition, increased mortality due to prostate cancer, brain cancer, colon cancer, and cancer of the lip, buccal cavity [mouth], and pharynx was suggested.”

While these studies clearly found a connection between our career and health risks, unfortunately, nowhere was there any cause-and-effect relationship. Since these studies were printed there have been several studies, including the “Nurses’ Health Study,” that have now shown a clear connection between circadian/diurnal disruption and increased cancer rates as well as increased cancer growth rates during exposure to disruptive schedules.

There is now increasing research into the impact of chronic fatigue. This early study clearly identifies potential health risks: “Chronic sleep debt has been linked with the disruption of numerous modulators of immune function including SNS hormones, HPA hormones, and cytokines [Vgontzas and Chrousos, 2002]. However, the potential role of immunosuppression associated with chronic sleep debt has received little attention.” *S. Sephton, D. Spiegel/Brain, Behavior, and Immunity* (2003)

Stress has also been identified as a major contributor to decreased health. Stress is not always something we can control, and it is not always bad. Stress from increased mental challenge has been found to be beneficial. Most physical and emotional stress generates negative responses. Our bodies are stressed by and react to noise, low oxygen environments, circadian disruption, diurnal disruption, fatigue, poor diet, and many other factors that we may not be able to control.

An article in the *Nature Neuroscience* June 2001 issue presented a starting point for research. This study, done by the University of Bristol Medical School, looked at flight attendants over a five-year period. The group with five days or less between trips with transmeridian flights had high chronic cortisol levels and suffered temporal lobe atrophy and related cognitive deficits. In layman's terms, it means that chronic jet lag appeared to cause stress, which elevated cortisol levels (an adrenal hormone), which damaged a portion of the brain that manages memory and cognitive function. Crews who fly international trips know they're stressing their body. But they really don't know how or why it's so bad. To better understand, let's look a little closer at the role of cortisol.

Cortisol is a hormone produced in the adrenal glands. It is part of the hypothalamic-pituitary-adrenal (HPA) axis. What that means is that the cortisol can't be understood outside of the interrelationship of the three glands. In identifying cortisol, other related hormones are brought into focus. Some of those that are potentially impacted by what we do are melatonin, growth hormone, IGF-1 (insulin-like growth factor 1), DHEA (dehydroepiandrosterone), and DHEAS (DHEA sulfate). The common link to all is their involvement in immune system function.

Cortisol is an important and necessary adrenal hormone. Too much, however, and for too long, can have devastating effects on our health. Cortisol is released as a response to stress. Under normal conditions, once the stressful event is concluded messaging hormones are sent to stop the production of cortisol. In a continuous stress environment, that message isn't sent. Not only that, but there is growing evidence that chronically high cortisol levels damage the hippocampus portion of the brain resulting in the inability to shut down the cortisol production during normal events. This becomes a vicious cycle that results in more and more damage. The hippocampus is also an area of the brain needed for learning and memory. Remember the temporal lobe damage mentioned above?

One of the most insidious aspects of excess cortisol is the suppression of the immune system. In a fight or flight crisis you want all your body's energies and capabilities available for survival. At some point though you want them back to fight disease and cancer! Significantly, a connection has been made in several studies to the inhibition of the cytotoxic (cell killing) activity of n-killer cells by cortisol. In one study of women with metastatic breast cancer, those with flat patterns of cortisol levels had earlier mortality than those with normal circadian/diurnal cortisol rhythms. This was directly related to low counts and suppressed n-killer cell activity.

Most of us have heard about melatonin and its help in producing sleep due to its impact on serotonin levels. What is more important for us is that the thymus gland has the highest number of melatonin receptors of any organ in the body. The thymus gland takes immature white blood cells and matures them into a variety of specialized immune cells called T-cells. One particular cell of note is the n-killer cell. This cell's job is to identify and kill cancers. Melatonin is released during the dark, at night, by the pineal gland. Exposure to light during the night can have a negative impact on the amount of melatonin produced. Reduced melatonin production may have a detrimental effect on the ability of the thymus gland to produce proper numbers of n-killer cells among other T-cells. Melatonin is normally on an inverse diurnal rhythm as compared to cortisol. It is usually available to the body in a low-cortisol environment, at night during sleep. High chronic cortisol levels may have a negative impact here as well. The expectation of facing prostate cancer at some point in the ageing process is very high in all of the male population. There are now links to the suppressive effects of melatonin on prostate cancer. Recent studies have identified melatonin as one of the most powerful antioxidants available in our bodies. It appears to have great value in cell protection in addition to all the above-mentioned properties.

Growth hormone (GH) is released usually at night during deep sleep. Disruption of sleep patterns on a regular schedule can have a significant impact on reducing the release of GH. This hormone circulates in the body for only about 15 to 18 minutes after release. The individual cells throughout the body use GH for cellular growth and replication. It has been identified as an integral part of immune system maintenance due to its support of the associated organs. It also plays a major role in the health and availability of replacement cells throughout your body. In patients with pituitary damage, one sign of loss of GH release is early aging. Once GH has been circulated to the individual cells in the body, the rest is scavenged out of the blood by the liver.

The liver then produces a subhormone called IGF-1, which it releases into the blood throughout the day. IGF-1 acts like insulin in reducing blood sugar levels. Insulin stores the sugar; IGF-1 drives it into cells for use in energy production and regeneration. Loss of IGF-1 causes an imbalance in the blood sugar management by the pancreas and may cause difficulties in weight control among other medical impacts. On their [webpage](#), the Pituitary Society states: "In adults, GH deficiency may cause a decrease in energy and physical activity, change in body composition [increased fat, decreased muscle mass], a tendency toward increased cardiovascular risk factors/diseases and decreased quality of life [including an increased sense of social isolation]." Resistance exercise (weight training) can help stimulate production of GH and mitigate some of the effects of loss of sleep.

DHEA is important for many reasons. Low levels of DHEA and DHEAS have been linked to depression, prostate cancer, and may identify the pending failure of the adrenals due to chronic over activation. Significantly it is the ratio and relationship between cortisol and DHEA that we must pay attention to. This is usually a 10:1 ratio DHEA to cortisol. Part of what makes this work is that DHEA has a very low circadian variance where cortisol has a wide variance. Cortisol peaks in the morning and declines late in the day. DHEA remains relatively constant providing a buffer to some of the damaging

effects of cortisol. If operating in a stressful environment with excess cortisol production, it may be beneficial to have counterbalancing levels of DHEA. One specific benefit is the reported stimulation of the immune system through increasing IL-2 and n-killer cell activity and overcoming the immuno-suppressive effects of cortisol on T-cell function. This benefit helps directly with the body's ability to fight disease and cancer. DHEA is also thought to be a precursor that is converted to testosterone and estrogen, and as such beneficially impacts other hormone levels. DHEA is an adrenal hormone that naturally reduces with age. Tests are available and level should be checked by a healthcare professional prior to considering supplementation.

It is also important to realize that the impact of circadian disruption is not a linear problem. After several days, depending on the individual, we seem recovered. The reality is that almost every different organ has its own recovery rate. For example, the liver can take up to two weeks to recover from jet lag. What happens if you are doing week on/week off international flying? Your liver is in a constant state of flux. With its prominent role in so many areas of your health and health maintenance, that can't be good. The day/night disruption and change in dietary patterns impacts your body's digestive processing and blood sugar levels. All these things create stresses that cause decrements to our health.

Hopefully, what you have gleaned from the above discussion is that there is more to the effects of circadian and diurnal disruption than just fatigue. Those are just two forms of stress to the body that we face. Chronic stress causes increased cortisol levels, potentially reduced melatonin, GH, and IGF-1. This may result in severely compromised immune system function as well as actual damage to memory and cognitive ability. There are tests available to check these levels. It is also possible to have your bloodwork checked for immune system health and specifically for T-cell availability. **Hormone supplementation can be dangerous and should never be considered without the advice of a health-care professional. Even just taking supplements at the wrong time of day can shut down your natural system and do irreparable damage.**

Much of this is even more complicated for women when factoring in monthly cycles, pregnancy, and aging. There are issues with stress and cortisol and the fertility process that need to be researched, as well as issues with prolonged noise, vibration, and low oxygen exposure. Menopausal impact can be aggravated by many of the issues discussed. Know also that the immune system impact is not gender-specific. Women who work on rotating night shifts with at least three nights per month, in addition to days and evenings in that month, appear to have a moderately increased risk of breast cancer after extended periods of working rotating night shifts. **(Schernhammer E S, et al)**

Right now, pilots should maintain a good diet (balanced) that is not overly dependent on carbohydrates, which break down into simple sugars. Eating smaller amounts more times a day minimizes the body's energy fluctuations and may stabilize your insulin responses. Do your own research and see if you feel vitamin or mineral supplementation is appropriate. Exercise is a requirement! Just walking for 30 minutes to one hour three to five times a week at a brisk pace can have tremendous impact on all areas of health. It is

resistance training, however, that provides GH stimulation as well as bone density improvement. And again, if you have not been exercising regularly, see your health-care provider to ensure a safe approach to exercise is initiated.

Sleep when you can—those who have done the hub turn/redeye to a deadhead home trick must now realize that you are doing real damage. Any sleep during the beginning, middle, or end of the night is better than sleep during the day. You may feel worse for a short time but there is a clear benefit of a 30-minute nap (no longer). Lastly, the obvious, sleep at night as much as possible, keep long breaks between international trips and rest when you can. Will that stop the damage? No, but until we have more definitive studies and can change our scheduling practices to include these considerations more aggressively, you must do what you can.

Finally, there have been studies of people who seem to do well doing shift work. Their bodies seem to make some adaptation, so not everyone is impacted at the same rate or severity. While they may seem less affected daily, there is no correlating information as to longevity.

That brings me to one last point to consider. There has been much discussion over the years as to the reduced longevity of pilots. An FAA study of pilots who retired between 1968 and 1993 claims, “The expectancy for lowered life expectancy for airline cockpit crews was not supported by the results of this particular data set.” I would agree, since the comparative used in the study was the general population based on the 1980 census and they eliminated everyone who didn’t make it to age 60. They placed us at the statistical average age for mortality. We should be compared to highly educated individuals who are at the very top of fitness (on average) when starting their career. It is my supposition that we should be at the high end of the mortality curve dragging it upward, not buried in the middle.

On a positive note, we are more health aware now than ever before. We must accept that there are health implications in the career we have chosen. By understanding what is happening to us, we can minimize and mitigate the negative impact, improve our health, and live to enjoy the retirement we have worked so hard to secure. We can bid in ways that are consistent with our individual health needs and make educated assessments regarding the risk/benefit of upgrades vs seniority loss. We must drive scheduling improvements and contracts based on science and safety. Safety, not just for our passengers, crewmembers, and company bottom line—but for our families and our own lives!

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Additional references:

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Circadian disruption in cancer: a neuroendocrine-immune pathway from stress to disease? Sandra Sephtona,* and David Spiegelb 2003

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“Night-shift work and risk of colorectal cancer in the nurses’ health study.” These data suggest that working a rotating night shift at least three nights per month for 15 or more years may increase the risk of colorectal cancer in women.

Female cabin attendants had a significant 1.9-fold incidence of breast cancer and a 15-fold incidence of bone cancer compared with the national average *BMJ* 1995;311:649-652 (9 September) Incidence of cancer among Finnish airline cabin attendants, 1967-92 Eero Pukkala, researcher,^a Anssi Auvinen, senior scientist,^b Gunilla Wahlberg

As early as 1990 studies were beginning to show increases in cancer among airline pilots. These were relatively small groups and the research was focusing on radiation not endocrine related causes. The significance is that there were increased levels of cancer identified, and that this information has been available for some time. Band P R; Spinelli J J; Ng V T; Moody J; Gallagher R P *Aviation, space, and environmental medicine*, (1990 Apr) Vol. 61, No. 4, pp. 299-302. Journal code: 7501714. ISSN: 0095-6562. Report No.: NASA-90253344. English.

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HPA dysregulation has been associated with increased risk for a number of other human illnesses, including type 2 diabetes, stroke, and cardiovascular disease (Rosmond and Bjorntorp, 2000).