Why is Sleep Important?

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Science is still working out the details of the biological purpose of sleep. However, through observing what goes on physiologically in sleep and what happens when we are deprived of sleep, we can deduce a number of important functions. In general, sleep is when we heal and recover from day-to-day wear and tear. It is when we "recharge our batteries". Lack of sleep quality or quantity can eventually result in accumulating wear and tear until we develop symptoms of disease and fatigue.

To begin with, some of our most important healing hormones are released primarily during deep, slow wave sleep. This includes hormones such as growth hormone and testosterone which not only help children grow, but they also both help children and adults heal injuries. These hormones are essential for building stronger muscles, bones and ligaments in response to exercise. Reduced sleep quality and quantity can lead to a reduction in these anabolic hormones resulting in impaired growth in children as well interfering with the healing response to injury in adults. In this way poor sleep may contribute to wear and tear type conditions such as osteoarthritis, repetitive strain injury, and fibromyalgia.

A reduction in growth hormone and testosterone from reduced deep sleep also has effects on our metabolism and weight. An hour of exercise may burn 300 – 500 calories depending on how vigorous you exercise and how fit you are. The calories you burn during exercise are not the most important factor contributing to the weight loss associated with exercise. In addition, you can re-acquire those calories very easily with a poor dietary choice such as a hamburger or piece of chocolate cake. One of the main benefits from exercise is when it stimulates the building of more muscle mass. Pound per pound, muscle burns more than twice the calories per hour than fat, even at rest. Therefore, increasing your muscle mass will increase your metabolism 24 hours per day, even when you sleep. However, in order to build that muscle mass, you need to get enough good, deep sleep. You not only need enough sleep to recover from day-to-day wear and tear, but you also need additional sleep to recover from the additional wear and tear of exercise. Otherwise, that wear and tear from exercise will just accumulate and break you down. The anabolic hormones, growth hormone and testosterone, which encourage the growth of muscles and ligaments, are released primarily during deep, slow wave sleep. Without enough deep sleep, exercise is just burning a few hundred calories but is not doing much to improve your overall metabolism.

Leptin is a more recently discovered hormone that helps us feel full when we eat and helps us burn fat for energy. It is released predominantly during deep, slow wave sleep. Sleep deprivation leads to reduced leptin and causes increased resistance to the effects of leptin. This results in a tendency to eat more before we feel full and to burning less fat for energy. Sleep deprivation also leads to an increase in the hormone, Ghrelin. This hormone tends to increase appetite, especially for higher fat and carbohydrate foods, thus increasing the inclination to overeating and obesity.

Sleep has other important effects on metabolism. Sleep deprivation causes increased resistance to the effects of insulin. As a result, the body must produce more insulin to control blood sugar. This increases the risk of type II diabetes. Increased insulin levels also encourage the cells of the body to turn more sugar into fat, contributing to obesity as well.

Erythropoietin is a hormone that stimulates the production of red blood cells. It is produced by the kidney primarily during deep, slow wave sleep. A deficiency of deep sleep can lead to a reduction of erythropoietin. A reduction of this hormone can lead to an anemia that can look a lot like iron deficiency anemia because it causes the red blood cells to become smaller, paler and fewer. Hematologists describe the look under the microscope as "microcytic hypochromic" anemia. This anemia is sometimes called "anemia of chronic disease" as it is seen in many chronic conditions such as kidney disease, chronic arthritis and cancer. Serum iron levels may be low or normal in anemia of chronic disease. What differentiates anemia of chronic disease from iron deficiency anemia is normal iron stores as measured by serum ferritin. Thus, even though it may look a lot like iron deficiency anemia, anemia of chronic disease does not respond to the increased intake of iron because the levels are not low.

Trying to function when you are sleep deprived is stressful. You must push yourself to get up in the morning and to get through your day. This results in stimulation of the sympathetic nervous system with the "fight or flight" response. Increased levels of "adrenalin" and "cortisol" contribute to elevated blood pressure heart rate, and blood glucose levels. This increases the risk of hypertension, heart disease, and diabetes.

Beta-amyloid is a type of protein “waste” that increases in the neurons of the brain when you are awake and decreases when you sleep. Lack of sleep has been shown to result in increased levels of this waste protein in the brain. This protein is found in abnormally large quantities in the brain of patients with Alzheimer’s disease. It is thought that this protein

may “clog up” the neurons and interfere with their function. It has also been found that patients with Alzheimer’s are more likely to suffer from sleep disorders such as insomnia and obstructive sleep apnea than other people of similar age.

As we all know from personal experience, reduced sleep quality and quantity can result in fatigue and sleepiness. Fatigue and sleepiness are different. Fatigue or "feeling tired" means you do not have the energy to do something, but you are not necessarily falling asleep. Sleepiness means you are struggling to stay awake. Fatigue can make it hard to concentrate on tasks, remember things, and cope with stress. Mistakes are more common due to inattention or even "microsleeps” which last only a few seconds so that you may or may not be aware of them.

To give you an idea of the impact of sleep deprivation, being awake for 22 hours can result in an impairment equivalent to being legally drunk with a 0.08 blood alcohol! Four hours of sleep per night for 2 weeks can result in a reduction in performance equivalent to no sleep for 3 days.

Fatigue and sleepiness can lead to reduced productivity and a significant increase in the risk of errors, accidents, injury and death. Being on call, working shiftwork, and caring for infant children are some of the many common causes of insufficient sleep. Even people who feel they get enough hours of sleep may be affected by an underlying sleep disorder such as Obstructive Sleep Apnea or Periodic Limb Movement Disorder. Most people are unaware they have a sleep disorder because the condition is occurring when they sleep. Many people with underlying sleep disorders think they are “champion sleepers” because they can sleep easily or anywhere. What they often do not realize is that the reason why they feel they are such good sleepers is because they have an underlying sleep disorder making them abnormally sleepy.

Whether it is medication errors in a hospital, mistakes on the assembly line, single vehicles accidents in the middle of the night, commuter train derailments, or "friendly fire" incidents on the battlefield, sleep deprivation is often a significant or primary contributing factor. Major catastrophes like Three Mile Island, Chernobyl and the Exxon Valdez are examples of accidents that were most likely precipitated by sleep deprivation. The cost to both industry and society from reduced productivity, mistakes and accidents runs into millions of dollars and countless lives per year.

With regards to “recharging our batteries”, there are a number of biochemical changes that occur in our body when we are awake that lead to fatigue and sleepiness, that are reversed when we sleep.

During the day our bodies break down food into glucose and other sugars that are converted into energy filled molecules called ATP (adenosine triphosphate). ATP is used to provide energy to muscles, nerves, enzyme reactions and other processes that enable the body to function. The ATP is broken down into ADP (adenosine diphosphate), AMP (adenosine monophosphate) and ultimately results in a build up of adenosine. Adenosine binds to adenosine receptors in the brain that inhibit wake promoting neurons leading to increased sleepiness. Incidentally, these adenosine receptors can be blocked by caffeine and thus help

prolong wakefulness. During sleep the adenosine is metabolized, turned back into ATP and cleared away allowing wakefulness to gradually return.

There are several other sleep regulating substances (SRS) such as Factor S, interleukin-1 (IL-1), and tumor necrosis factor (TNF) that have complicated origins and functions in the body. In general, these substances increase during the day, contributing to fatigue and sleepiness along with other metabolic effects on health and healing, and are reduced during sleep. Thus, sleep serves the function of reducing these sleep-inducing substances enabling us to be alert and healthier the next day.

Not only is getting enough quality sleep critical for health and healing, the timing of sleep and light exposure is important too. We live in a 24-hour world but our biological clock averages about 24 hours and 10 minutes in most people although may be longer in young people and shorter in the elderly. Imagine living on the East Coast and having a watch that was 10 minutes slow. If you did not reset it everyday, in a few weeks it would be on West Coast time. What resets our biological clock is bright light first thing in the morning within one hour of our normal wake up time. Every day you sleep in and do not get the light within an hour of your normal wake time, your biological clock can drift 10 minutes.

For most people who must get up at regular times to go to work or school, this does not usually run into a problem. For young people, whose clocks may be longer and may sleep-in daily for a few weeks at a time over winter or summer holidays, it can become a significant problem. When it is time to go to bed at 10 pm the night before school restarts, the biological clock feels like 7 pm and they have trouble falling asleep. When it is time to get up at 7 am it feels like 4 am and they have trouble getting up. This can lead to a quite common type of insomnia in young people called *Delayed Sleep Phase Syndrome*.

Your circadian rhythm not only influences your ability to sleep well, about 50% of your genes are governed by your circadian clock. This fact has many ramifications. For example, people who tend to go to sleep later and get up later may find that calories eaten after 8 pm are more likely to lead to weight gain than the same number of calories eaten earlier. Chemotherapy for cancer can be more effective and cause less side effects when given at certain times of the day. People with circadian dysregulation, such as occurs in some shift-workers have a greater risk of cancer, cardiovascular disease and overall mortality.

Good sleep is critical to optimum health.