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This is my original manuscript. The published version of the clip is available upon request, but has some unfortunate editing and layout problems.

## *The Science of Sleep*

*Researchers are slowly unraveling the mysteries of sleep – how it affects your health and wellbeing, and why you often can't get enough of it*

(Part I of II parts)

By Hilda J. Brucker

Sleeping Beauty had a refreshingly long siesta before her handsome prince came along. Rip van Winkle easily dozed away 20 years. And citizens of ancient Greece had only to appeal to Hypnos, god of sleep, to guarantee blissful slumber. For the rest of us, however, getting a good night's sleep can be a frustratingly elusive goal: according to the National Sleep Foundation, 63 percent of Americans get less than the eight hours needed to function well, and 58 percent report having insomnia a couple of times a week.

The allure of uninterrupted, rejuvenating sleep is so strong that marketeers dangle it in front of us like the ultimate prize. Each night during prime time, TV commercials offer fatigued consumers everything from prescription sleeping pills to specialty mattresses. The Westin hotel chain has so successfully branded itself with its "Heavenly Bed" that its clients spend thousands to buy the whole setup and repeat the restful experience at home. Like sex, sleep sells. Even the British Cheese Board is trying to cash in. It recently reported, in a rather dubious study, that eating cheese at bedtime not only helps you sleep soundly, but also allows you to customize your dreams (eat Cheddar to dream of celebrities; Stilton for vivid and bizarre experiences.)

As it turns out, the medical community has also learned sleep is a commodity to be bought and sold. The red-letter day for sleep research came in 1987, when Medicare began paying for the treatment of sleep disorders. This newly expanded market ultimately led to better therapies for sleep-related maladies and to more skilled care, as sleep medicine became a board-accredited specialty. In today's healthcare system, America's quest for rest amounts to big business. There are over 700 accredited sleep medicine centers nationwide, including a dozen or so in the Atlanta metro area.

According to sleep specialist Dr. David Schulman of the Emory Clinic, a handful of sleep disorders are serious health hazards, linked to cardiovascular disease, high blood pressure, diabetes, obesity and stroke. Yet even occasional bouts of sleeplessness can be a

vexing ordeal, like coping with a recurring cough or cold. The bad news is, insomnia may be just as inevitable as catching cold. Stress, jet travel, lack of exercise, shift work, and the late night lure of TiVo or the Internet can all conspire against you when the clock says bedtime – or when the alarm jangles you back into reluctant consciousness.

So what's the answer? Schulman believes many people can attain better rest by practicing good sleep hygiene – those tips, tricks and behaviors that will put your body back in sync with its internal clock. Today, it seems, sleep is both a science and an art.

## Setting the internal clock

Long before our ancestors walked out of Africa, human beings functioned in accord with the natural cycles of darkness and light. We didn't evolve to be a nocturnal species; we don't have particularly good night vision and are largely vulnerable in the dark. Yet at the flip of a switch, we can now manipulate our environment and reach across time zones. "We're a 24-hour society now. Lighting and electricity have allowed us to do things that hundreds of years ago couldn't be done at night," said Schulman. This ability to work and play long after sunset has come with consequences, however. It has disrupted biological rhythms that were millions of years in the making, causing many of us to drag through the day with drooping eyelids.

The human sleep cycle operates roughly in sync with the 24-hour cycle of the earth's rotation and is regulated by exposure to light – this is known as the circadian rhythm. But there's also what scientists call a *homeostatic* component to the sleep cycle; it refers to the natural balance your body maintains between states of sleepiness and wakefulness. Simply put, this means the longer you stay awake, the stronger the drive to sleep becomes. Conversely, if you have to catch a flight before dawn and decide to go to bed early, you may be unable to doze off at all, because the homeostatic sleep drive hasn't yet peaked. These two components – the circadian rhythm and the homeostatic sleep drive – work in tandem to determine when and how well you'll be able to sleep.

Here's how it all happens: within the brain, a group of cells called the suprachiasmatic nucleus (SCN) acts as the body's internal clock. In the morning, light travels down a nerve pathway from the retina to the brain, cueing the SCN to jumpstart certain functions that make us feel alert and wide awake. It raises our body temperature and releases energizing hormones like cortisol. It also suppresses other hormones like melatonin, which cause us to feel drowsy. In the evening, the SCN is cued by darkness to reverse the process so we begin to get sleepy again.

While the effects of the internal clock are most obvious in the morning and evening, the circadian cycle also rises and falls at other times of the day. What some people call getting their "second wind" in the evening is actually a natural peak in the circadian cycle – about two to three hours before bedtime, it's typical to feel alert and productive even though you've been up for hours. And in the afternoon, usually between 1:00 and 3:00 p.m., most people experience a circadian dip that leaves them feeling lazy and sluggish, in need of a nap. In Corporate America, there's a tendency to fight this natural urge with coffee, while the tradition in Mediterranean and tropical cultures is to take a siesta. (As it

turns out, sleep specialists agree a short nap is the better option, as stimulants like caffeine are not very effective at "re-setting" the internal clock at times when it's natural for circadian sleepiness to be increasing – though coffee can make you feel more alert in the morning when your internal clock is cycling toward wakefulness anyway.)

If you have trouble falling asleep or staying asleep, you may be fighting your biological rhythms. Try to time your bedtime to coincide with a natural dip in your circadian cycle – that is, a time in the evening when you're likely to experience a rapid increase in drowsiness. It may take a few weeks of record keeping to figure out when this is, especially if you keep irregular hours. Schulman advises keeping a sleep log to track total sleep time and patterns of sleepiness, as well as factors like caffeine and exercise that can affect how well you snooze. Sleeping well isn't just a quality-of-life issue; it's very likely the most important contribution you can make to your overall health.

## You can't live without it

For centuries, most people believed the sole function of sleep was to give the brain a much-needed rest. Then, in the 1950's, scientists performed the early sleep studies. By measuring brain wave activity with an electroencephalograph (EEG), they were able to observe the different stages of sleep. And they made a startling discovery: instead of being idle, the brain is busily processing information during a stage called the REM (rapid eye movement) stage of sleep. "It's just not interacting with the outside world, but it's very, very active," explained Schulman. "If you have someone who's in REM sleep and you shake them awake, you'll find that they are immediately functioning pretty well, because their brain was in a state that's almost identical to wakefulness."

Discoveries like these led scientists to hypothesize that sleep has physiological functions well beyond rest. Ultimately, they've amassed a huge body of evidence that demonstrates how profoundly sleep affects your appetite, immune system, hormone levels, memory, learning capacity, emotional stability, mental acuity, and overall metabolism. In other words, depriving yourself of sleep can mess up just about any bodily function you can think of.

In a series of classic experiments, researchers dramatically demonstrated the crucial role of sleep. Laboratory rats were kept awake continuously for two to three weeks. In the end, their metabolisms went completely haywire: despite eating a balanced diet, they developed nutritional imbalances and began wasting away, rapidly losing muscle mass. Their hair fell out, they developed skin lesions, their body temperatures plummeted and they died.

Scientists now know that growth hormone is released during the deepest stages of sleep, facilitating normal development in children and cellular repair in grownups. Sleep appears to affect the balance of many other hormones as well. Healthy men participating in a weeklong study were limited to four hours of sleep per night; at the end of that time they had a 30 percent drop in their bodies' ability to secrete and respond to insulin. This condition, known as insulin resistance, is often a precursor to diabetes. Recent research also links sleep to the hormones that play a role in weight management. Study volunteers

restricted to four hours of sleep per night had a 20 percent drop in leptin (a hormone that suppresses appetite), plus a 20 percent rise in ghrelin (a hormone that stimulates appetite). A correlating study shows adults who sleep less than seven hours a night have higher body mass indexes – and are more likely to be obese – than those who get more sleep.

Besides making you healthier, research also suggests sleep can make you more productive and proficient. Studies show that motor skills learned during the day – playing piano, performing card tricks – actually improve after a good night's rest, without any additional practice. REM sleep in particular is associated with memory and learning: while we're asleep the brain consolidates the day's memories and experiences and burns them into its hard drive. Because children soak up knowledge like a sponge, "they have profoundly high percentages of REM sleep," Schulman said. "Roughly 50 or 60 percent is REM sleep, where adults have closer to 20 or 25." Schulman also offers the example of a college student who stays up all night cramming for an exam. She may pass the test, but without sleep, her brain is less able to transfer the facts she learned from short term to long-term memory. In a situation that calls for critical thinking, it's the stores of knowledge residing in your long-term memory that you're likely to draw from– so when in doubt, you may want to heed that age-old advice to "sleep on it."

## Sleeping in stages

While sleep might seem like a steady state, it's actually a dynamic process. During the night, your body treks through five distinct stages of sleep that cycle over and over again – four stages collectively known as non-REM (non-rapid eye movement) sleep, during which the brain gets progressively less active; and a fifth stage of REM sleep, where dreams occur. One complete cycle lasts 90 to 110 minutes and you're likely to have four or five cycles overnight.

Scientists classify sleep stages by the frequency and amplitude of their characteristic brain waves, which are named for the letters of the Greek alphabet and appear on an EEG as wavy or jagged lines. And they believe the stages have different functions, which work together to influence your overall state of health. "It is thought that your REM sleep is important more for psychological wellbeing, and the other stages more for your physical wellbeing," explained Dr. David Westerman, medical director of the Atlanta Pulmonary Group Center for Sleep Disorders, located in Dunwoody.

Stage one is a period of drowsing that ideally lasts just a few minutes. Your eyes are closed, but you can easily be aroused by noise or light (and would probably feel as if you hadn't been asleep at all). Your heart rate and breathing begin to slow. You may have a hypnic jerk – that sudden sensation of falling that makes you twitch or flail involuntarily. Interestingly enough, a handful of people experience a different type of "sleep start," as these occurrences are collectively known. Instead of waking from a twitch, they're roused by a loud snapping noise or blinding flash of light that seems to come from inside their heads. Though these sensations may be frightening, they're harmless.

Stage two puts you in a state of light snoozing. Your body temperature drops and your

heart slows a little more, but your muscles still twitch occasionally and your brain waves are dramatic peaks and valleys on an EEG. You'll spend most of the night, about 45 percent, in this phase, which can be compared to a good nap – you're asleep and oblivious to small distractions, but if you woke up now you'd feel relatively alert rather than groggy.

Stage three is a phase of deep sleep. Your respiration and heart rates reach their lowest levels. Your brain is working at a leisurely pace now – between 20 and 50 percent of its activity shows up as the large, slow waves known as delta waves. The restorative effects of sleep occur mainly during the phases of slow wave, or delta, sleep. Unfortunately, the amount of time you spend in delta sleep begins to decline in middle age. By age 60 or 70, you'll find that you wake more often during the night and need frequent catnaps during the day, because of diminished delta sleep.

Stage four finds you slumbering *very* deeply. It's taken you about an hour to reach this phase from the time you entered stage one. Your brain is in its most inactive state, predominantly producing delta waves now; your breathing is slow and rhythmic; and your muscles are very relaxed. If the alarm clock goes off during stage four, you'll wake up feeling groggy and slow, wanting to hit the snooze bar and catch 40 more winks. (This feeling of sleep inertia, as it's called, typically lasts between 15 and 30 minutes – longer if you're chronically sleep deprived. Taking a shower or drinking a cup of coffee may help you cut through the fog.)

After stage four, the fifth stage of sleep doesn't begin immediately. First, you'll backtrack a little, drifting through the lighter stages of sleep in reverse, before entering a period of REM sleep. During the REM stage, your brain is very active, putting out bursts of the same fast beta waves it produces while you're awake. Your eyes move rapidly under your eyelids, your fingers twitch, and your heart rate and respiration speed up and become irregular – all as if your mind were responding to outside stimuli. As you enter the landscape of vivid dreams, however, your brain blocks signals to your major muscle groups so you won't hurt yourself by trying to act out your dreams.

And that's it – after about ten minutes of REM sleep, you've finished your first cycle and are ready to do it all over again. In successive cycles, REM stages will get progressively longer, so as the night goes on, you'll dream for longer periods. At the same time, your stages of delta sleep will become shorter in length, making it more likely you'll awake from a lighter sleep stage in the morning, feeling refreshed and ready to face the day.

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## SIDEBAR: Practicing Good Sleep Hygiene

Despite the associations that come to mind, sleep hygiene has nothing to do with laundering your sheets. Instead, the phrase refers to the constellation of personal habits and environmental factors that influence the quantity and quality of your sleep. According to the National Sleep Foundation, improved sleep hygiene should be the first

line of defense for anyone plagued by frequent insomnia. The non-profit association compiled the ten tips below.

1. *Stick to a regular sleep schedule, even on weekends.* While the NSF contends this is necessary to keep your internal clock consistent, it may not be entirely practical. According to Emory's Dr. Schulman, it's probably okay to sleep in a little on the weekend, as long as you don't let your schedule fluctuate wildly.

2. *Establish a relaxing bedtime routine.* Reading a good book, taking a bubble bath or sipping chamomile tea are all better sleepy-time rituals than paying your bills or vacuuming. Finish up with tedious or stressful tasks a couple of hours before you turn in.

3. *Create a setting that's dark, quiet and cool.* Remember, bright light or a rise in body temperature will send wake-up signals to your internal clock, so set up your bedroom accordingly. Dr. Westerman points out that even a clock can be an unwelcome distraction – lying awake and watching the minutes go by can make you more and more anxious about your inability to fall asleep. "If you need it for the alarm, just help yourself by turning it around, or put it under the bed," he advised.

4. *Sleep on a comfortable mattress and pillow.* The lifespan of the average mattress is only 8 to ten years. After that, lumps and saggy spots can cause you to toss and turn.

5. *Use the bedroom – or the bed – only for sleep and sex.* According to the NSF, activities like watching TV under the covers will only weaken your association between bed and sleep. And if you find yourself wide awake during the night, Westerman recommends getting out of bed until you start to feel sleepy. "I think what you want to do is break that routine of anger and tossing and turning and frustration," he said. "But what you don't want to do is start working on the computer, and paying bills, and watching horror movies. You've got to do something boring. People start ironing and doing housework and then expect to go back to sleep – you can't do that."

6. *Limit fluids and finish eating two to three hours before bedtime.* You'll avoid blood sugar swings, heartburn and frequent trips to the bathroom.

7. *Exercise regularly but finish workouts at least three hours before bedtime.* "A surprising number of people exercise in the evening," said Schulman. "And the problem is that ramping up your metabolism and putting epinephrine in your blood are not things that are conducive to falling asleep."

8. *Avoid caffeine in the evening.* This stimulant stays in the body for three to five hours, but some sensitive individuals are affected up to 12 hours later, according

the NSF. Schulman concurs: "If you can drink a Coke and go to sleep, that's fine. But if you're an insomniac, I would say no caffeine after two p.m."

9. *Avoid nicotine close to bedtime.* It's also a stimulant.

10. *Avoid alcohol within a few hours of bedtime.* Although it may initially make you sleepy, it can cause sleep disturbances once your body metabolizes it.

## SIDEBAR: Power Napping

Whether you call it a siesta, a power nap, or a "stage two limited nap," the idea is the same – to catch a few ZZZs during the day, when you're starting to drag. Daytime naps can actually increase your productivity because you're working *with* your natural circadian rhythms instead of fighting them. And no matter what your boss may think about catnapping on the job, the sleep experts are in favor of it. "Power napping has clearly been shown to improve function; it clearly works," said Dr. Schulman of the Emory Clinic.

When you feel circadian sleepiness coming on in the afternoon, it's an excellent time for a power nap. Here's where knowledge of the five sleep stages really helps: remember, stage one and stage two are light sleep phases and you can wake from them easily without feeling groggy. As long as you don't make the transition into deep, slow wave, sleep (stages three and four) you can expect to reap the restorative benefits of napping. The average person enters deep sleep about 45 minutes after closing his eyes, so daytime naps should never exceed that. If you're waking up groggy, you're napping too long (you also may be throwing your internal clock out of whack, making it harder to sleep at night.) Shorten your nap time, and either set an alarm or have someone wake you. Many people find that 20 minutes is the ideal length for a power nap, recharging them more effectively than gulping down coffee or cola.

However, cautions Schulman, if you consistently short-change yourself on sleep, daytime naps may not work for you at all, because your body may enter slow wave sleep in just a few minutes. "There are people who say 'I can't nap during the day, because if I sleep twenty minutes, I feel horrible.' So you need to know what your body needs," stressed Schulman. "If you wake up during the wrong stage of sleep, you will be very poor to interact with, and you're very unable to interact with the outside world."

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Next month, Part II –
***Sleep disorders:*** *When lifestyle changes and good sleep habits don't resolve the problem, it's time to seek medical advice*