COMMENTARY

Getting to the Heart of Sleep Deprivation

Commentary on Robillard et al. Sleep deprivation increases blood pressure in healthy normotensive elderly and attenuates the blood pressure response to orthostatic challenge. SLEEP 2011;34:335-339.

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Cardiovascular disease is the number one killer of Americans, yet 15% to 20% of patients with coronary artery disease have no traditional risk factors, and over half have only a single risk factor.[1] Even hypertension, the most common cardiovascular risk factor,[2] has no identifiable cause in 95% of those affected.[3] Growing evidence suggests a relationship between short sleep duration and hypertension.[4,5] The elderly overwhelmingly bear the burden of hypertension and cardiovascular disease. Aging involves alterations in both sleep and cardiovascular physiology, some of which may be interrelated,[6] raising the question of whether changes in sleep may promote cardiovascular disease, and hypertension in particular. The identification of factors that promote hypertension in the elderly has both mechanistic and public health implications, and it is conceivable that short sleep duration may be a common, and preventable, cardiovascular risk factor in this population.

In this issue of *SLEEP*, Robillard and colleagues[7] present a study that sought to determine the effect of a night of sleep deprivation on blood pressure and blood pressure response to an orthostatic challenge in a group of young (20-28 years old) and elderly (60-69 years old) subjects. Subjects underwent a crossover trial of habitual sleep and total sleep deprivation lasting 24.5 hours. Blood pressure was measured in the semi-recumbent position and after standing upright. In the habitual sleep condition, systolic blood pressure dropped slightly as expected upon transitioning from semi-recumbent to standing, but this effect was attenuated in both young and elderly subjects after a night of sleep deprivation, and in half of subjects was replaced with a hypertensive response. In the semi-recumbent position, young subjects showed no significant change in blood pressure, while the elderly group showed a striking increase in blood pressure (11.7 mm Hg systolic and 5.9 mm Hg diastolic), and 25% of the previously normotensive elderly subjects were left with frank systolic hypertension (> 140 mm Hg). Population-based studies have shown sustained systolic blood pressures of this magnitude to be associated with a significant increase in risk of cardiovascular events and stroke.[8] Whether the results of this short-term experiment can be extrapolated to longer-term cardiovascular risk remains to be seen, but the possibility and its ramifications raises a number of important questions about this study and future research in this domain.

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Models of Sleep Deprivation

Observational studies that report a relationship with cardiovascular disease suffer from many potential limitations: Is self-reported sleep duration accurate, and does "short" indicate true sleep curtailment, underlying medical illness, a primary sleep disorder, or just a normal variant—so-called "short sleepers"? However, experimental studies aren't automatically more informative. Perhaps the biggest challenge in experimental sleep deprivation research is understanding how to mimic the real-world experience of short sleep duration in a laboratory setting that allows for a rigorous assessment of outcomes. Much of our current understanding of sleep deprivation come from very short-term models of total sleep deprivation (including the current report by Robillard et al. in this issue). Whether 24-48 hours of total sleep deprivation mimics the real-life experience of sleep loss, or the effects of more chronic, low-grade sleep deprivation, is unclear. Furthermore, it is debatable if studies should control for, or include the effects from circadian misalignment that frequently occurs when sleep is restricted.

Studies of Young and Old

For a variety of practical reasons, it tends to be easiest to conduct sleep deprivation studies in the young. While inclusion of only young subjects can be scientifically advantageous because it may help avoid the potential confounders of aging, medication exposure, underlying sleep disorders, and preexisting occult cardiovascular disorders, this approach ignores what may be important age-related changes in cardiovascular and sleep physiology. As pointed out by Robillard et al., the hypertensive response to sleep deprivation may be more pronounced, or even exclusive to the elderly. On the other hand, observational studies have not consistently seen an association between sleep duration and hypertension in the elderly.[4,9] When the average age of those with prevalent hypertension in the US is nearly 60 years,[10] and cardiovascular events related to hypertension disproportionately affect the elderly, it would seem appropriate to focus more study on this group.

Cardiovascular Measurements

A major strength of the study by Robillard et al. is that the main outcome reported, blood pressure, is clearly linked to cardiovascular outcomes. While a number of potential mechanisms have been proposed to explain the link between sleep deprivation and elevated blood pressure, including endothelial dysfunction, sympathetic activation, baroreflex changes, and inflammation,[11] none have been clearly shown to dominate, and no mechanistic finding has suggested a specific intervention.

Time Course of Effects

The basic "kinetics" of the cardiovascular effects of sleep curtailment are unknown. For example, how soon are the cardiovascular effects of total sleep deprivation seen, how much sleep loss in a partial deprivation model is required to produce cardiovascular effects, and how long do they persist? Furthermore, what is the role of sleep deprivation in dysregulation of nighttime blood pressure and the normal blood pressure dip during the sleeping hours, which may be a more powerful predictor of cardiovascular outcomes than daytime blood pressure?[12] A better understanding of the time course of effects will help put research like that of Robillard et al.[7] into perspective: If the negative cardiovascular effects begin early or with minimal sleep loss, and only resolve after many days of adequate sleep, the public health impact could be far-reaching.

CONCLUSIONS

Studies of sleep deprivation relative to cardiovascular health are in their infancy, but a growing body of evidence suggests that sleep loss has cardiovascular effects. Whether these effects translate into clinically important outcomes, and whether interventions can be designed to prevent these outcomes, remain to be seen. Applying short-term results of studies like Robillard et al.[7] to real-world models, bolstered by further mechanistic studies, will serve to advance our understanding of the interplay between sleep and cardiovascular disease.

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DISCLOSURE STATEMENT

The authors have indicated no financial conflicts of interest.

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