Notice to CNE enrollees:
A closed-book, multiple-choice examination following this article tests your understanding of the following objectives:
1. Discuss the relationship between sleep disturbances and decision regret.
2. Discuss the consequences of sleep disturbances for critical care nurses and their patients.
3. List at least 3 ways to combat sleep disturbances.

To read this article and take the CNE test online, visit www.ajcconline.org and click “CNE Articles in This Issue.” No CNE test fee for AACN members.
The role of sleep loss and fatigue on cognitive performance has received increased attention recently. Impairments in higher level domains of executive function and decision making have been noted in health care providers who practice during extended and nighttime workshifts. Inadequate sleep increases the risk for errors and near-miss errors in judgment, the use of faulty decision algorithms, and poor patient outcomes. When faced with making decisions about patient care, a nurse may make the wrong decision, leading to adverse patient outcomes and causing decision regret for the nurse. Decision regret is a negative cognitive emotion that occurs when the actual outcome and the desired or expected outcome differ and reflects concerns that the wrong decision had been made. The amount of decision regret is proportional to the difference between the actual and desired outcomes. Although decision regret reflects previous decisions and adverse outcomes, it may also contribute to work-related stress and compromise patient safety in the future.

About the Authors

Linda D. Scott is associate dean for academic affairs and an associate professor, Health Systems Sciences, University of Illinois at Chicago College of Nursing. Cynthia Arslanian-Engoren is an associate professor of nursing, School of Nursing, and Milo C. Engoren is a clinical professor, Department of Anesthesiology, University of Michigan, Ann Arbor.

Corresponding author: Linda D. Scott, RN, PhD, NEA-BC, FAAN, Associate Dean for Academic Affairs, Associate Professor, Health Systems Sciences, University of Illinois at Chicago College of Nursing, 845 S Damen (MC 802), Chicago, IL 60612 (email: ldscott@uic.edu).

Inadequate sleep increases the risk for errors and poor outcomes for patients.
model has been used in previous studies on nurses’ fatigue and provides the framework for examining the human factors of sleep loss (sleep quality, duration, and fragmentation), fatigue and intershift recovery, and the effects of inadequate sleep, acute and chronic fatigue, and intershift recovery on clinical-decision self-efficacy (confidence, satisfaction, and decision regret). Decision regret was the primary outcome variable (Figure 1).

Methods
A nonexperimental, descriptive design was used to examine selected sleep variables, impairment due to fatigue, and clinical-decision regret among critical care nurses. A questionnaire was sent to a sample of nurses generated from the membership list of the American Association of Critical-Care Nurses.

Sample
With decision regret as the primary outcome variable, a power analysis was completed to determine the desired sample size. On the basis of previous research on health care providers’ decision regret, the assumption was that 40% of respondents would express regret. The goal was to find a difference between nurses who expressed regret and nurses who did not in the mean value of any continuous variable of 10%, when the standard deviation of that variable was 40% of the mean value. For a 2-tailed \( \alpha = .05 \) with 80% power, the study would require 530 nurses. If the assumed response rate to the mailing was 15%, the survey should be mailed to 3500 nurses.

Potential participants were recruited by using the membership list of full-time critical care nurses practicing as staff nurses. A list of 3500 nurses was randomly generated from approximately 14,000 full-time nurses (working at least 36 h/wk). Because staff nurses were the focus of the study, advanced practice nurses, nurse managers, and nurses in specialized roles such as discharge planning were not included. A total of 737 questionnaires were returned (21%) within the data collection period. However, 132 questionnaires were excluded because of late returns or because respondents did not meet the inclusion criteria (ie, no longer practicing in critical care or employed in a full-time position). Thus, a total of 605 questionnaire packets (17%) were available for analysis, a typical response rate for nonincentivized, mailed surveys among health care professionals.

Instruments
Self-reports on characteristics and questionnaires were used to collect information on personal and work-related data, sleep quality, daytime sleepiness, sleep quantity, and clinical-decision self-efficacy and decision regret.

Pittsburgh Sleep Quality Index. Subjective sleep quality was measured by using the Pittsburgh Sleep Quality Index. The index consists of 19 items that yield scores on 7 subscales (sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medications, and daytime dysfunction). The score for each item is from 0 to 3. Additionally, the subscale scores are used to compute a global score (0 to 21), with higher scores indicative of poor sleep quality. Computed global scores greater than 5 have a diagnostic sensitivity of 89.6% and a specificity of 86.5% to differentiate between good and poor sleepers and have been substantiated with polysomnographical sleep measures. Internal consistency coefficients of 0.69 to 0.81 (Cronbach \( \alpha \)) have been reported for various populations, including shift workers. The internal consistency coefficient in the study reported here was 0.76.

Epworth Sleepiness Scale. The severity of daytime sleepiness was evaluated by using the Epworth Sleepiness Scale. Nurses were asked to indicate if they...
The Pittsburgh Sleep Quality Index was used to measure subjective sleep quality.

The Clinical Decision Self-Efficacy. The Clinical Decision Self-Efficacy questionnaire combined brief open-ended questions with visual analogue scales (VAS) for nurses to rate their confidence in and satisfaction with their clinical decisions and to provide examples of clinical decisions made when alert and sleepy. In order to assess decision regret, they were asked, “Have you regretted a clinical decision that you made at work when sleepy?” (yes or no). Nurses were instructed to respond on the basis of the past 7 workdays before they had received the questionnaire packet.

A 100-mm horizontal VAS from 0 (no confidence) to 100 (total confidence) was used to measure perceptions of confidence in clinical decisions made when sleepy. A second 100-mm horizontal VAS with anchors of 0 (no satisfaction) to 100 (total satisfaction) was used to measure satisfaction in clinical decisions made when sleepy. Higher scores reflect greater clinical-decision self-efficacy. Because this questionnaire was developed specifically for this study, psychometric evaluation has not been performed. However, VAS scores are considered reliable, valid, and sensitive self-report measures of subjective experiences.46 In addition, because of their ease of completion and convenience, VASs are not burdensome for respondents to complete.49

Procedure

The critical care nurses in the random sample (N = 3500) were mailed a questionnaire packet with a letter of invitation to participate in the study. The cover letter explained the purpose of the study, the time commitment involved, and the voluntary nature of the study. No incentives for completing the questionnaire packet were provided. Potential participants were requested to return their completed questionnaires in a prepaid, self-addressed envelope within 30 days of the receipt date. Questionnaires returned after this date were not included in the analysis. This research protocol was approved by the human research review committee at Grand Valley State University, Grand Rapids, Michigan.

Data Management and Analysis

Graduate research assistants coded and entered data into a database created for the study. After an assessment for entry errors, all data were transferred into the SPSS 19.0 (IBM SPSS Statistics) for statistical analyses. Univariable comparisons were made by using t tests, the Fisher exact test, and χ² analysis as appropriate. Variables were first checked for multicollinearity by using linear regression. No pair of variables showed significant multicollinearity (max-
imum variance inflation factor <1.1) Then binary logistic regression with forward selection and backward selection was used to confirm the models’ variables; 3 separate models for predicting decision regret were constructed. The first model was constructed solely from the measures of sleep (perception of poor sleep quality, daytime sleepiness score, sleep debt, acute fatigue score, chronic fatigue score, and intershift recovery score; Figures 2A-2F). In order to assess the effect of nurses’ demographics and work and life characteristics, the second model was created by entering all the sleep-related variables and all of the nurses’ characteristics (Table 1). The final model consisted of the 2 previous sets of variables plus the nurses’ satisfaction and confidence in their decisions (Figures 2G and 2H). Results were considered significant if $P < .05$ and confidence intervals excluded 1. Discrimination of the models is presented as the $C$ statistic (the area under the receiver operating characteristic curve) with the standard error of the mean.

**Results**

**Characteristics of the Respondents**

A total of 605 full-time employed critical care nurses returned the survey. Of these, 546 (90%) answered the question on decision regret. Among these 546 nurses, 157 (29%) reported decision regret. Nurses who had decision regret were more likely to work nights and to work 12-hour shifts (Table 1) than were nurses without decision regret. Otherwise the personal and work-related characteristics of the nurses with and without decision regret were similar (eg, race, sex, age, family, and hospital unit). However, nurses with decision regret reported significantly more acute fatigue (regret: mean, 71.17; SD, 16; no regret: mean, 65.95; SD, 20) and daytime sleepiness (regret: mean, 10.00; SD, 4; no regret: mean, 8.39; SD, 4) and significantly less intershift recovery (regret: mean, 42.44; SD, 22; no regret: mean, 50.17; SD, 25) and poor sleep quality (regret: mean, 8.34; SD, 3; no regret: mean, 7.56; SD, 3) than did the nurses without decision regret (Figures 2A-2F).

When binary logistic regression was used to adjust for the several indicators of sleep, higher daytime sleepiness, less sleep deprivation, and lower amounts of recovery were independently associated with decision regret (Table 2). After the sleep indicators were combined with the nurses’ personal and work-related characteristics, intershift recovery and daytime sleepiness scores remained independently associated with decision regret. Male nurses were also more likely to express decision regret than were female nurses (Table 2).

The final regression model included the satisfaction and confidence variables (Table 2). The discrimination of the model improved from $C$ statistic $= 0.628$ (SE, 0.027) to $C$ statistic $= 0.719$ (SE, 0.024) with the addition of the satisfaction variable. Confidence was not significant as a predictor variable for decision regret. Nurses who were male, worked 12 hours or more, and were less satisfied in their decisions were more likely than other nurses to report decision regret.

**Discussion**

Registered nurses play a pivotal role as members of the health care team, but fatigued and sleep-deprived critical care nurses put their patients and themselves at serious risk. In our study, the majority of nurses reported moderately high fatigue, significant sleep deprivation, and daytime sleepiness, all of which affect their ability to be alert, vigilant, and safe. Furthermore, the nurses were not likely to sufficiently recover from their fatigue-related states during nonwork periods. Nurses with poorer intershift recovery (failure to recover from acute fatigue) are at greater risk than those with better recovery for becoming chronically fatigued; experiencing injuries, illnesses, and absenteeism; and making impaired decisions.

Acute and chronic sleep deprivation adversely affects cognitive function, most noticeably working memory, alertness, attention, vigilance, and decision making. The prefrontal cortex of the brain, the area responsible for complex cognitive processes, is thought to be especially vulnerable to the effects of sleep loss when planning, coordinating, and self-regulating behaviors are required. Further, sleep deprivation has a global effect on cognition, reducing response times, increasing risk-taking behaviors (possibly due to alterations in expected gains and losses), and altering normal affective processing. Detrimental effects of chronic sleep loss include deterioration in performance, especially during extended periods of wakefulness. This effect is especially a concern for critical care nurses who are providing care for seriously ill patients with compromised resilience and an inability to protect themselves from poor decisions of providers or from health care mishaps.

We used 3 separate models to evaluate the effects of sleep, nurses’ characteristics, and satisfaction and confidence on decision regret. Model 1 indicated that less intershift recovery, greater sleep debt, and
Figure 2  Box and whisker plots showing median, intraquartile range, 95% CIs, and outliers of sleep characteristics and decision making with decision regret. A, Perception of poor sleep quality (Pittsburgh Sleep Quality Instrument). B, Daytime sleepiness score (Epworth Sleepiness Scale). C, Sleep debt (Sleep Quantity Assessment). D, Acute fatigue score (Occupational Fatigue, Exhaustion, and Recovery Scale: Acute Subscale). E, Chronic fatigue score (Occupational Fatigue, Exhaustion, and Recovery Scale: Chronic Subscale). F, Intershift recovery score (Occupational Fatigue, Exhaustion, and Recovery Scale: Intershift Recovery Subscale). G, Degree of confidence in decision making (visual analogue scale). H, Degree of satisfaction with decision making (visual analogue scale).
When nurses' characteristics were added (model 2), daytime sleepiness and intershift recovery remained significantly associated with decision regret, but being male replaced sleep debt (Table 2). Possibly, this switch from sleep-related variables to personal and work-related characteristics was due to sex and professional socialization norms or to different reactions of male and female nurses to sleep debt.

Our final model, which showed good discrimination (C statistic, 0.719; SE, 0.024), being male, longer shifts (≥12 hours), and decreased satisfaction more daytime sleepiness were associated with greater decision regret (Table 2). Within a 5-day period, almost three-quarters of the study participants were sleep-deprived, losing at least a day (8 hours) or more of sleep during this time. Moreover, the likelihood for decision regret was significantly higher among those with sleep debt than among those without (Table 2). These findings are consistent with those of other studies4,7,8 in which persistent and chronic sleep debt was associated with devastating effects on performance and with adverse health and safety consequences.

Table 1
Characteristics of nurses who participated in the study

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Total</th>
<th>No.</th>
<th>Mean (SD)</th>
<th>No.</th>
<th>Mean (SD)</th>
<th>No.</th>
<th>Mean (SD)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decision regret</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>No.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>544</td>
<td>46</td>
<td>(10)</td>
<td>157</td>
<td>45</td>
<td>(10)</td>
<td>387</td>
<td>.84</td>
</tr>
<tr>
<td></td>
<td>546</td>
<td>20</td>
<td>(10)</td>
<td>157</td>
<td>20</td>
<td>(10)</td>
<td>389</td>
<td>.65</td>
</tr>
<tr>
<td></td>
<td>542</td>
<td>17</td>
<td>(9)</td>
<td>157</td>
<td>17</td>
<td>(9)</td>
<td>385</td>
<td>.29</td>
</tr>
<tr>
<td></td>
<td>544</td>
<td>28</td>
<td>(16)</td>
<td>157</td>
<td>29</td>
<td>(15)</td>
<td>387</td>
<td>.17</td>
</tr>
<tr>
<td></td>
<td>536</td>
<td>23</td>
<td>(4)</td>
<td>153</td>
<td>6</td>
<td>(4)</td>
<td>383</td>
<td>.13</td>
</tr>
<tr>
<td></td>
<td>546</td>
<td>135</td>
<td>(25)</td>
<td>157</td>
<td>43</td>
<td>(27)</td>
<td>389</td>
<td>.99</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>544</td>
<td>260</td>
<td>(48)</td>
<td>70</td>
<td>.13</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>546</td>
<td>127</td>
<td>(23)</td>
<td>36</td>
<td>.38</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>540</td>
<td>99</td>
<td>(18)</td>
<td>26</td>
<td>.38</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>536</td>
<td>56</td>
<td>(10)</td>
<td>25</td>
<td>.84</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>546</td>
<td>88</td>
<td>(16)</td>
<td>22</td>
<td>.99</td>
</tr>
<tr>
<td></td>
<td>546</td>
<td>150</td>
<td>(27)</td>
<td>157</td>
<td>41</td>
<td>(26)</td>
<td>109</td>
<td>.68</td>
</tr>
<tr>
<td></td>
<td>546</td>
<td>76</td>
<td>(14)</td>
<td>157</td>
<td>19</td>
<td>(12)</td>
<td>57</td>
<td>.06</td>
</tr>
<tr>
<td></td>
<td>546</td>
<td>73</td>
<td>(13)</td>
<td>157</td>
<td>26</td>
<td>(17)</td>
<td>47</td>
<td>.06</td>
</tr>
<tr>
<td></td>
<td>546</td>
<td>48</td>
<td>(9)</td>
<td>157</td>
<td>16</td>
<td>(10)</td>
<td>32</td>
<td>.13</td>
</tr>
<tr>
<td></td>
<td>546</td>
<td>36</td>
<td>(7)</td>
<td>157</td>
<td>11</td>
<td>(7)</td>
<td>25</td>
<td>.13</td>
</tr>
<tr>
<td></td>
<td>546</td>
<td>163</td>
<td>(30)</td>
<td>157</td>
<td>44</td>
<td>(28)</td>
<td>119</td>
<td>.99</td>
</tr>
<tr>
<td></td>
<td>544</td>
<td>475</td>
<td>(87)</td>
<td>157</td>
<td>144</td>
<td>(92)</td>
<td>331</td>
<td>.44</td>
</tr>
<tr>
<td></td>
<td>540</td>
<td>53</td>
<td>(10)</td>
<td>157</td>
<td>4</td>
<td>(2)</td>
<td>4</td>
<td>.01</td>
</tr>
<tr>
<td></td>
<td>540</td>
<td>16</td>
<td>(3)</td>
<td>157</td>
<td>9</td>
<td>(6)</td>
<td>54</td>
<td>.047</td>
</tr>
<tr>
<td></td>
<td>540</td>
<td>311</td>
<td>(58)</td>
<td>156</td>
<td>77</td>
<td>(49)</td>
<td>234</td>
<td>.047</td>
</tr>
<tr>
<td></td>
<td>540</td>
<td>156</td>
<td>(29)</td>
<td>156</td>
<td>55</td>
<td>(35)</td>
<td>101</td>
<td>.047</td>
</tr>
<tr>
<td></td>
<td>540</td>
<td>58</td>
<td>(11)</td>
<td>156</td>
<td>17</td>
<td>(11)</td>
<td>41</td>
<td>.047</td>
</tr>
<tr>
<td></td>
<td>540</td>
<td>15</td>
<td>(3)</td>
<td>156</td>
<td>7</td>
<td>(4)</td>
<td>8</td>
<td>.047</td>
</tr>
<tr>
<td></td>
<td>546</td>
<td>111</td>
<td>(21)</td>
<td>153</td>
<td>26</td>
<td>(17)</td>
<td>375</td>
<td>.16</td>
</tr>
</tbody>
</table>

*Not all participants answered all the questions, so some variables have fewer than 546 responses.
in clinical decision making were associated with increased decision regret (Table 2, model 3). A shift length of 12 hours or more may contribute to a variety of sleep disturbances, but the longer shifts, not the resultant sleep disturbances, are what lead to decision regret. Evaluation of the effects of naps during longer shifts is needed to determine how taking a nap affects sleep parameters, decision regret, and patients’ outcomes. Lower levels of satisfaction in making clinical decisions may reflect previous incorrect decisions leading to adverse outcomes. Although our findings can be a catalyst for further investigation, they also have implications for health care providers and the providers’ employers. Both critical care nurses and their employers must not only acknowledge the impact of fatigue, sleep deprivation, and excessive daytime sleepiness on clinical performance and patients’ outcomes but also engage in strategies to mitigate these impairments. Strategies at the individual level include practicing good sleep hygiene; taking naps to decrease the number of consecutive hours awake; and avoiding extended workshifts, excessive consecutive workdays, and shifts that interfere with circadian sleep cycles (eg, 3 AM to 3 PM) and the ability to recover between workshifts. Because sleep complaints are more common in middle-aged and older adults, particularly women, than in younger adults and children, proactive intervention is required to ensure that critical care nurses are fit for duty and can make decisions that are critical for patients’ safety.

Likewise, health care employers should implement scheduling models that maximize management of fatigue, ensure that support resources for clinical decisions are available, and encourage the use of relief staff to provide completely relieved work breaks and strategic naps. In addition, education on how to manage fatigue and incorporation of fatigue countermeasures should be routine practices in health care organizations. By working together to manage fatigue, critical care nurses and employers can ensure that patients receive care from alert, vigilant, and safe employees.

Limitations

We recognize that our instruments and sample size may limit the generalizability of our findings. Because self-report methods were used to collect data with a recall period of 5 to 30 days for selected sleep-related variables and clinical-decision regret, the subjective nature of the data is a potential limitation. However, the majority of the instruments used are extant measures with established psychometric properties, characteristics that enhance confidence in our results. Likewise, our sample size represents only 17% of the sampling frame and may not be representative of nurses who chose not to respond or who did not belong to the American Association of Critical-Care Nurses. We used a straightforward, rigorous study design to enhance the representativeness of the respondents. Although only 29% of respondents had decision regret, instead of our

### Table 2
Factors associated with decision regret

<table>
<thead>
<tr>
<th>Factor</th>
<th>Model 1&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Model 2&lt;sup&gt;d&lt;/sup&gt;</th>
<th>Model 3&lt;sup&gt;e&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>SE</td>
<td>Wald</td>
</tr>
<tr>
<td>Intershift recovery</td>
<td>-0.013</td>
<td>0.005</td>
<td>6.737</td>
</tr>
<tr>
<td>Daytime sleepiness</td>
<td>0.079</td>
<td>0.026</td>
<td>8.939</td>
</tr>
<tr>
<td>Sleep debt&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.337</td>
<td>0.141</td>
<td>5.705</td>
</tr>
<tr>
<td>Constant</td>
<td>-1.997</td>
<td>0.058</td>
<td>36.396</td>
</tr>
<tr>
<td>Sex (male)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shift length (12 h)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfaction</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> Degrees of freedom = 1 for all factor analyses.
<sup>b</sup> Decision regret analyzed with sleep variables only (C statistic, 0.628; SE, 0.027).
<sup>c</sup> Per 8-hour increments of debt in previous 5 days.
<sup>d</sup> Decision regret analyzed with sleep variables and critical care nurses’ characteristics (C statistic, 0.632; SE, 0.026).
<sup>e</sup> Decision regret analyzed with sleep variables, critical care nurses’ characteristics, and decision confidence and satisfaction (C statistic, 0.719; SE, 0.024).
estimated 40%, the study had sufficient statistical power, after all adjustments, to indicate 3 independent variables associated with decision regret. Future studies are needed to examine the association between sleep, decision regret, and adverse events, including patients’ mortality.

Conclusion

Several studies have indicated a link between adverse outcomes, fatigue, and sleep loss. We extended this work by adding the concept of clinical-decision self-efficacy (confidence, satisfaction, and decision regret) and used decision regret as the primary outcome variable. Critical care nurses who experience impairments due to fatigue, poor sleep, and inability to recover between shifts are more likely than unimpaired nurses to report clinical-decision regret. Decision regret was most common among nurses who are male, work 12-hour shifts, and have lower levels of satisfaction with their clinical decisions.

FINANCIAL DISCLOSURES
This research was funded in part by Kirkhof College of Nursing, Grand Valley State University, and the American Association of Critical Care Nurses.

eLetters
Now that you’ve read the article, create or contribute to an online discussion on this topic. Visit www.ajcconline.org and click “Responses” in the second column of either the full-text or PDF view of the article.

REFERENCES

2. Killgore WD. Effects of sleep deprivation on cognition. Prog Brain Res. 2010;185:105-129.
34. Johns MW. Sleepiness in different situations measured by the Epworth Sleepiness Scale. Sleep. 1994;17:703-710.

To purchase electronic or print reprints, contact The InnoVision Group, 101 Columbia, Aliso Viejo, CA 92656. Phone, (800) 899-1712 or (949) 362-2050 (ext 532); fax, (949) 362-2049; e-mail, reprints@aacn.org.