Healthcare-Related Regret among Nurses and Physicians Is Associated with Self-Rated Insomnia Severity: A Cross-Sectional Study

The Harvard community has made this article openly available. Please share how this access benefits you. Your story matters.

Citation
Schmidt, Ralph E., Stephane Cullati, Elizabeth Mostofsky, Guy Haller, Thomas Agoritsas, Murray A. Mittleman, Thomas V. Perneger, and Delphine S. Courvoisier. 2015. “Healthcare-Related Regret among Nurses and Physicians Is Associated with Self-Rated Insomnia Severity: A Cross-Sectional Study.” PLoS ONE 10 (10): e0139770. doi:10.1371/journal.pone.0139770. http://dx.doi.org/10.1371/journal.pone.0139770.

Published Version
doi:10.1371/journal.pone.0139770

Citable link
http://nrs.harvard.edu/urn-3:HUL.InstRepos:23474137

Terms of Use
This article was downloaded from Harvard University’s DASH repository, and is made available under the terms and conditions applicable to Other Posted Material, as set forth at http://nrs.harvard.edu/urn-3:HUL.InstRepos:dash.current.terms-of-use#LAA
RESEARCH ARTICLE

Healthcare-Related Regret among Nurses and Physicians Is Associated with Self-Rated Insomnia Severity: A Cross-Sectional Study

Ralph E. Schmidt¹, Stephane Cullati², Elizabeth Mostofsky³,⁴, Guy Haller⁵, Thomas Agoritsas⁶, Murray A. Mittleman³,⁴, Thomas V. Perneger⁷, Delphine S. Courvoisier²,⁴*

¹ Department of psychology, University of Geneva, Geneva, Switzerland, ² Quality of Care Unit, University Hospitals of Geneva, Geneva, Switzerland, ³ Cardiovascular Epidemiology Research Unit, Department of Medicine, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, Massachusetts, United States of America, ⁴ Department of Epidemiology, Harvard School of Public Health, Boston, Massachusetts, United States of America, ⁵ Department of Anesthesiology, Pharmacology, Intensive Care, Geneva University Hospitals, Geneva, Switzerland, ⁶ Department of Clinical Epidemiology and Biostatistics, McMaster University, Hamilton, Ontario, Canada, ⁷ Division of Clinical Epidemiology, University Hospitals of Geneva, Geneva, Switzerland

* Delphine.courvoisier1@gmail.com

Abstract

To examine the association between healthcare-related regrets and sleep difficulties among nurses and physicians, we surveyed 240 nurses and 220 physicians at the University Hospitals of Geneva. Regret intensity and regret coping were measured using validated scales. Sleep difficulties were measured using the Insomnia Severity Index (ISI), and an additional question assessed the frequency of sleeping pill use. After controlling for sex, profession, years of experience, rate of employment, and depression as well as for all other regret-related variables, the following variables remained significantly associated with self-rated severity of insomnia: regret intensity (slope = 1.32, p = 0.007, 95%CI: [0.36; 2.29], std. coefficient = 0.16) and maladaptive (e.g., rumination) emotion-focused coping (slope = 1.57, p = 0.002, 95%CI: [0.60; 2.55], std. coefficient = 0.17) remained significant predictors of self-rated insomnia severity. If these cross-sectional associations represent causal effects, the development of regret-management programs may represent a promising approach to mitigating sleep difficulties of healthcare professionals.

Introduction

Sleep difficulties and sleep loss among healthcare providers [1–8] reduce their cognitive abilities [3, 5, 6], and psychomotor performance [4], which can cause medical errors [7]. This empirical evidence concurs with healthcare providers’ self-perception that poor sleep may lead to critical errors at work. In a survey of 150 nurses, 63.5% reported concerns that sleepiness would result in mistakes, and 58.1% worried that sleepiness would cause them to miss changes in patients’ condition [9].
Furthermore, sleep problems are frequent among hospital nurses and physicians. Several studies using the Pittsburgh Sleep Quality Index (PSQI) have shown that around 70% of nurses [9, 10] and 70% of physicians with burnout report poor sleep [11]. Using DSM-IV criteria, one study reported that 18.8% of physicians suffered from insomnia [9, 11].

While sleep is an important problem among healthcare providers [12], the specific causes of poor sleep in this population are complex. Indeed, they are likely numerous and inter-related. Often cited causes of poor sleep among healthcare professionals include night shift work and number of hours worked [2, 9, 13–16]. The associations of sleep problems with healthcare professionals’ psychological and emotional state [9] and with work environment and job strain [17, 18] have also been investigated.

However, to the best of our knowledge, no study has as yet evaluated whether common (non pathological) emotional reactions in healthcare settings, such as regrets, may impact sleep difficulties. Regret may be defined as an affective, cognitive and physiological state following an experience in which one feels that an outcome would have been better if one had acted differently [19]. This emotion is especially likely to occur in medical settings, where healthcare professionals are often required to make speedy and critical decisions on the basis of complex, uncertain, and abundant information [20, 21]. Upon reflection, healthcare decisions and actions are sometimes perceived as inappropriate [22]. Since healthcare professionals are obliged to make a large number of decisions on a daily basis, they are prone to experiencing more regrets than members of other professions. Thus, examining the association between regrets and sleep in healthcare professions is particularly relevant.

The intensity of regret and the strategies used to regulate regret have been associated with poor sleep in both young [23], and older adults [24], and experimental activation of regret has been shown to delay sleep onset [25]. Courvoisier, Merglen [26] proposed that three distinct aspects of regret may influence sleep among healthcare professionals: the intensity of the most important regret, the accumulation of small regrets, and regret regulation strategies.

The aim of the present study was to investigate the association of healthcare-related regret intensity and regret regulation strategies with sleep quality among physicians and nurses. We hypothesized that (a) the intensity of the most important healthcare-related regret, (b) the number of recently experienced regrets, and (c) the use of maladaptive regret regulation strategies (e.g., self-blame) would be associated with sleep problems.

**Methods**

**Study design**

We conducted a cross-sectional study of physicians and nurses working at the University Hospitals of Geneva, a Swiss public teaching hospital network including acute and primary care, psychiatric and geriatric facilities with approximately 1900 beds. In 2011, we mailed a paper questionnaire to 1650 randomly selected healthcare professionals (825 nurses and 825 physicians), with up to 3 reminders. Questionnaires were anonymous and sent back by postal mail with no return address. The questionnaire included measures of regret, depression, and insomnia severity, as well as questions about demographics and job characteristics. Exclusion criteria were (a) not working with patients for the last 5 years, (b) recent retirement, or (c) not being a physician or a nurse. The study was approved by the Research Ethics Committee of the University Hospitals of Geneva.

**Instruments and measures**

**Regret.** Healthcare-related regret intensity was assessed with the 10-item regret intensity scale (RIS–10) [27]. The RIS–10 examines the intensity of regret at the moment of measurement
for an event that occurred up to five years in the past using a five-point Likert scale ranging from 'not at all' to 'absolutely'. Respondents are instructed to choose this event based on the intensity of regret at the time of measurement. Healthcare-related regret regulation was assessed with the 15-item regret coping scale (RCS-HCP)[28]. Using a four-point Likert scale ('never or almost never', 'sometimes', 'often', and 'always or almost always'), the RCS-HCP measures how frequently the respondent uses three types of regret regulation strategies: problem-focused strategies (e.g., talking to colleagues in order to change practices), and emotion-focused strategies, which can be either adaptive (e.g., acceptance of one’s limitations) or maladaptive (e.g., self-blame). The RIS–10 and the RCS-HCP show good psychometric properties, with internal consistency $>0.85$ (Cronbach alpha) and test-retest reliability $>0.70$ (Intra-class correlation 2). The validity of these two scales was considered good since the scales were developed based on a qualitative study of physicians and nurses [29], and a panel of experts, including psychologists, one sociologist, and physicians, ascertained that the scales covered all major aspects of regret intensity and regret coping.

We included additional questions about different aspects of the regret-inducing event:

- "How responsible do you feel of this situation?": answer options ranged from 0 (no responsibility) to 10 (very high responsibility).
- "Did the regret-inducing event imply an error on your part?": yes or no.
- "How much support did you receive from your superior?": Answers options ranged from 0 (none) to 10 (high).

In addition, accumulation of regrets was measured using two questions:

- Regret frequency during the last month: “Within these last 30 days, how many situations with patients have you regretted?”
- Regret intensity during the last month: “What is the mean intensity you would give to these situations within the last 30 days?” Answers ranged from 0 (no intensity) to 10 (highest intensity).

Sleep. We assessed sleep problems using the Insomnia Severity Index (ISI), which consists of 7 items rated from 0 (none) to 4 (very much), and yields a total score ranging from 0 to 28. This measure is an index of sleep problems (difficulties initiating and maintaining sleep, early awakenings, satisfaction with current sleep patterns) and the consequences of these problems (interference with daytime functioning, noticeability of impairment to significant others, level of distress caused by the sleep problems) over a one-month interval [30, 31]. The internal consistency of the ISI is at least 0.90 in both a clinical and community samples [32]. Concurrent validity of the ISI has also been demonstrated with other-administered versions of this instrument, polysomnography, and cardiovascular measures [32, 33]. Using a cutoff score of 10 to classify individuals in a community sample as having insomnia (as evaluated by a clinical interview), the ISI has a sensitivity of 86.1% and a specificity of 87.7% [32]. In addition to the ISI, one question examined the frequency of sleeping pill use on a four-point Likert scale (0- ‘not within the last month’, 1- ‘less than once a week’, 2- ‘once or twice per week’, and 3- ‘3 or 4 times a week or more’). Answers were dichotomized (not within the last month vs. once or more often per month).

Depression. Depressive symptoms over the last 7 days were measured using the Center for Epidemiologic Studies Depression Scale (CESD–10), a 10-item scale for measuring depressive symptoms in the general population. The measure has been shown to possess good internal consistency ($\alpha = 0.85$) [34, 35].
Since regret and sleep may be related to professional and demographic characteristics, we also collected information on factors that may act as confounding variables, including sex, profession, years of experience, and rate of employment.

Analyses

Sample size. To accurately estimate regression coefficients, there should be at least 5 times more events (in this study sleeping pill use) than predictors [36], yielding a minimum of 50 events for our 10 predictors (regret variables and confounders included). Based on an expected proportion of healthcare professionals using sleeping pills of 12%, the required sample size is 417 (50/0.12).

Statistical analysis. We used multiple linear regression to estimate slopes and 95% confidence intervals for the association between aspects of regret and insomnia severity as assessed by the continuous ISI score. We used multivariable logistic regression to estimate the odds ratios and 95% confidence intervals for the association between aspects of regret and sleeping pill use. For each aspect of regret, we present the results of uni- and multivariate models adjusting for sex, profession, years of experience, rate of employment, and CES-D score. The covariates used for adjustment were chosen to control for confounding effects. For instance, depression could cause sleep problems and change strategies of regret coping, resulting in a biased estimation of the association between regret and sleep. In addition, we constructed a multivariate linear regression model including all aspects of regret and the covariates listed above. The importance of the influence of the regret variables over and above the covariates was estimated with the R² change coefficient of determination statistic.

Since, in our previous analysis, regret intensity and regret coping were on average similar across professions [27, 28], we analyzed the association between regret and sleep for the whole sample. However, as a sensitivity analysis, we also ran the analyses separately for each profession (i.e., not adjusting for profession in the model). Results were very similar across nurses and physicians (data not shown).

We plotted the proportion of respondents reporting sleeping pill use more than once in the past month according to the score for regret intensity and the score for maladaptive coping strategies. Statistical analyses were performed using R (v 3.0.1) (R Core Team, 2013).

Results

Overall, 240 nurses and 220 physicians returned the survey (31.2% of the 1474 eligible participants). Respondents were on average 39.5 (SD 9.1) years old, and 69.3% were female. Compared to the physicians who participated in the study, the nurses tended to be older and reported more sleep problems and also more frequent use of sleeping pills (Table 1). Among the respondents, 19 (4.1%) did not answer the sleep, regret or depression scales, and were excluded from the analysis.

Insomnia Severity Index

A one-unit increase in the intensity of the most important regret in the last five years (range: 1–5) was associated with almost 3 more points in self-rated insomnia severity (ISI range: 0–28) (Table 2). This corresponds to a standardized coefficient of 0.33 (not shown in Table 2). The number of regret-inducing events and the score for maladaptive regret coping strategies were also associated with higher scores of insomnia severity (Table 2). Conversely, higher scores for problem-focused and adaptive regret coping were associated with lower scores of insomnia severity (standardized coefficient of -0.13 and -0.12 respectively). These associations remained significant and of similar strength even after adjusting for depression and socio-professional
variables (Table 2). Both regret intensity and the use of maladaptive strategies showed a substantial association with insomnia severity, as the R² change (between a model with only the covariates and a model with the regret variable and the covariates) for regret intensity was 5.1%, and the R² change for maladaptive strategies was 4.7% (Table 2). Feeling supported by one’s superior when the regretted event occurred was associated with lower insomnia severity, but feeling responsible for a regret-eliciting event or reporting that this event was related to a medical error were not.

In a multivariable model including all aspects of regret (i.e. regret intensity, the three regret coping strategies, number and average intensity of regrets in the last month, responsibility, evaluation of the event as an error and superior support), as well as the potential confounders added in the previous multivariable model (i.e., depression, demographics, and job characteristics), only regret intensity (slope = 1.32, p = 0.007, 95%CI: [0.36; 2.29], standardized coefficient = 0.16) and maladaptive regret coping strategies (slope = 1.57, p = 0.002, 95%CI: [0.60; 2.55], standardized coefficient = 0.17) remained statistically significant predictors of insomnia severity.

Table 1. Baseline characteristics of 460 healthcare providers at University Hospitals of Geneva, Switzerland, 2011.

| Characteristics            | Categories | Nurse                                | Physician                           |
|----------------------------|------------|--------------------------------------|-------------------------------------|
|                            |            | N = 240                              | N = 220                             |
|                            | N         | %                                    | N         | %                                    |
| **Socio-professional**     |           |                                      |                                      |
| Sex                        | Male       | 45                                   | 18.8     | 96                                   | 43.6     |
|                            | Female     | 195                                  | 81.2     | 124                                  | 56.4     |
| Age                        | <30        | 25                                   | 10.4     | 28                                   | 12.8     |
|                            | 30–39      | 84                                   | 35.0     | 126                                  | 57.8     |
|                            | 40–49      | 76                                   | 31.7     | 45                                   | 20.6     |
|                            | >50        | 55                                   | 22.9     | 19                                   | 8.7      |
| Professional status        | Nurse / resident | 217 | 91.6 | 106 | 48.4 |
|                            | Head nurse / Board certified | 20 | 8.4 | 113 | 51.6 |
| Rate of employment         | 0–50%      | 12                                   | 5.0      | 10                                   | 4.6      |
|                            | 51–80%     | 100                                  | 41.7     | 27                                   | 12.4     |
|                            | 81–100%    | 128                                  | 53.3     | 180                                  | 82.9     |
| Years of experience        | <3         | 15                                   | 6.3      | 20                                   | 9.3      |
|                            | 3–5        | 8                                    | 3.3      | 54                                   | 25.1     |
|                            | 6–10       | 50                                   | 20.9     | 73                                   | 33.9     |
|                            | 11–20      | 67                                   | 28.0     | 44                                   | 20.5     |
|                            | >20        | 99                                   | 41.4     | 24                                   | 11.2     |
| **Regret**                 | Mean       | 1.74                                 | 0.65     | 1.70                                 | 0.73     |
|                            | SD         |                                      |          |                                      |          |
| Regret intensity (RIS–10)  | Problem-focused | 2.92 | 0.60 | 2.94 | 0.59 |
| (RCS-HCP)                  | Maladaptive | 1.83 | 0.57 | 1.86 | 0.70 |
|                            | Adaptive   | 2.64                                 | 0.51     | 2.76                                 | 0.59     |
| Depression                 | 1.88                                 | 0.48     | 1.84                                 | 0.39     |
| Insomnia severity index (ISI) | 8.60 | 6.03 | 5.66 | 5.33 |
|                            | N         | %                                    | N         | %                                    |
| ISI ≥ 10                   | 102 | 43.6 | 48 | 22.4 |
| Sleeping pill use ≥ once/month | 44 | 18.3 | 30 | 13.6 |

doi:10.1371/journal.pone.0139770.t001
Sleeping Pill Use

As expected, respondents who reported using sleeping pills at least once in the prior month also reported more sleep problems (mean ISI score for people using sleeping pills more than once a month: 13.0 (SD = 5.8), mean ISI for people using sleeping pills less than once a month: 6.1 (SD = 5.2), p < 0.001).

We observed a strong association between dimensions of regret and whether the healthcare professional used sleeping pills at least once in the prior month (Table 3). For every one unit increase in the regret intensity score, the odds of reporting sleeping pill use was 2.14 times higher (Fig 1); for every one unit increase in the maladaptive regret coping score, the odds of reporting sleeping pill use was 2.25 times higher (Fig 2). These results remained statistically significant event after adjusting for depression, demographics and job characteristics (Table 3).

Table 2. Parameter Estimates and 95% Confidence Intervals from Linear Regression Models to Evaluate the Association Between Measures of Regret and Insomnia Severity Index Score.  

|                  | Univariable | Adjusted* |
|------------------|-------------|-----------|
|                  | slope       | p         | 95% CI    | slope       | p         | 95% CI     | ΔR²        |
| Regret intensity | 2.79        | <0.001    | 2.03;3.56 | 2.05        | <0.001    | 1.31;2.78  | 5.1        |
| Regret coping    |             |           |           |             |           |           |            |
| Problem-focused  | -1.31       | 0.005     | -2.24;-0.39 | -1.28       | <0.001    | -2.14;-0.42 | 0.5        |
| Adaptive         | -1.32       | 0.009     | -2.32;-0.33 | -0.98       | 0.04      | -1.89;-0.06 | 0.1        |
| Maladaptive      | 2.94        | <0.001    | 2.12;3.76  | 2.36        | <0.001    | 1.56;3.17  | 4.7        |
| Number of regrets in the last month | 0.37 | 0.002 | 0.13;0.61 | 0.25 | 0.02 | 0.03;0.47 | 0.1 |
| Mean intensity of regrets in the last month | 0.48 | <0.001 | 0.27;0.69 | 0.33 | <0.001 | 0.14;0.52 | 1.3 |
| Responsibility   | 0.06        | 0.54      | -0.13;0.25 | 0.10        | 0.25      | -0.07;0.28 | 0.0        |
| Error            | -1.00       | 0.10      | -2.20;0.19 | -0.06       | 0.92      | -1.20;1.08 | 0.0        |
| Superior support | -0.26       | 0.001     | -0.41;-0.10 | -0.15       | 0.04      | -0.29;-0.01 | 0.1 |
| Profession (ref: nurse) | -2.94 | <0.001 | -4.00;-1.88 | -2.06 | <0.001 | -3.20;-0.92 | — |

*Adjusted for profession (nurse or physician), sex, years of experience, rate of employment, and CES-D depression score.

doi:10.1371/journal.pone.0139770.t002

Table 3. Odds Ratios and 95% Confidence Intervals from Logistic Regression Models to Evaluate the Association Between Measures of Regret and Sleeping Pill Use.  

|                  | Univariable | Adjusted* |
|------------------|-------------|-----------|
|                  | OR          | p         | 95% CI     | OR          | p         | 95% CI     |
| Regret intensity | 2.14        | <0.001    | 1.55;2.97  | 2.06        | <0.001    | 1.45;2.94  |
| Regret regulation |             |           |           |             |           |           |            |
| Problem-focused  | 0.85        | 0.44      | 0.56;1.29  | 0.76        | 0.21      | 0.49;1.17  |
| Adaptive         | 0.75        | 0.23      | 0.47;1.19  | 0.78        | 0.31      | 0.49;1.25  |
| Maladaptive      | 2.25        | <0.001    | 1.57;3.25  | 2.10        | <0.001    | 1.41;3.14  |
| Number of regrets in the last month | 1.16 | 0.006 | 1.05;1.30 | 1.14 | 0.02 | 1.03;1.28 |
| Mean intensity of regrets in the last month | 1.07 | 0.25 | 0.96;1.20 | 1.01 | 0.85 | 0.90;1.14 |
| Responsibility   | 1.06        | 0.21      | 0.97;1.15  | 1.06        | 0.22      | 0.97;1.16  |
| Error            | 0.99        | 0.96      | 0.56;1.69  | 1.21        | 0.52      | 0.66;2.17  |
| Superior support | 1.00        | 0.93      | 0.93;1.08  | 1.02        | 0.64      | 0.94;1.09  |

*Adjusted for profession (nurse or physician), sex, number of years of experience, rate of employment, and CES-D depression score.

doi:10.1371/journal.pone.0139770.t003
There was no statistically significant association between the use of problem-focused and adaptive strategies and sleeping pill use.

In multivariate analyses including all aspects of regret, depression, demographics and job characteristics, there was a 1.76 (95%CI: 1.08; 2.92) times higher odds of sleeping pill use associated with a one unit increase in regret intensity and a 1.14 (95%CI 1.01; 1.29) times higher odds of sleeping pill use associated with a one unit increase in the number of regret-inducing events or episodes of regret in the prior month.

**Discussion**

In this cross-sectional study of 460 physicians and nurses, healthcare-related regret was associated with higher self-rated insomnia severity and sleeping pill use. The intensity of the most important regret in the past five years, the number of regrets, and the use of maladaptive regret regulation strategies were associated with higher levels of self-reported insomnia severity and higher odds of sleeping pill use. These associations remained statistically significant after adjusting for depression, demographics, and job characteristics. However, neither feeling personally responsible for the regret-eliciting event nor connecting this event to a medical error were associated with sleep problems or sleeping pill use, suggesting that the scope of regrets...
stretches beyond individual mistakes in medical decisions. In accordance with our proposed theoretical model [26] and our previous qualitative study [29], these results suggest that regret intensity and coping are associated with sleep quality among physicians and nurses. In addition, the findings are consistent with studies indicating that the use of dysfunctional strategies of thought control (e.g., thought suppression) and emotion regulation (e.g., self-blame) may contribute to a state of sleep-interfering cognitive and affective arousal [37]. Other dysfunctional strategies, such as rumination, have been associated with insomnia and more generally with neuroticism [38, 39], which is often higher among individuals with sleep difficulties.

Whereas shiftwork in healthcare settings and its consequences on sleep have been studied extensively [e.g., 2], and pathological emotional states (e.g., burnout [11], anxiety [14]) have also been the focus of much research, there is limited research in recent years on psychological (non pathological) factors associated with sleep in this population. This study suggests that emotion regulation may be strongly associated with healthcare professionals’ sleep, though additional studies are necessary to determine the directionality of the link between regret regulation and sleep. Further research to identify psychological factors and methods of mitigating
their adverse consequences are warranted because, unlike work-schedule constraints, they represent a more modifiable risk factor for sleep quality. Modifying work-schedule constraints, for instance to introduce aviation industry work-hour restrictions in the medical system, was estimated at more than $1,000,000 per patient life-year saved [40]. The introduction of such restrictions would also entail an increase of 71% in the US physician workforce and a 174% increase in the number of residents [40].

A promising avenue for future research will be to design interventions that encourage the use of functional regret regulation strategies (i.e., problem-focused strategies; adaptive emotion-focused strategies) and to explore their efficacy in randomized-controlled trials. Regarding the especially maladaptive strategy of self-blame or self-attacking, it has previously been suggested [24] that fostering self-compassion [41] and self-forgiveness [42] might be particularly helpful intervention strategies.

Given the cross-sectional design of this study, causal inferences regarding the effects of regret intensity and regulation on sleep remain speculative. It is not clear whether regret impacts sleep or sleep impacts feelings of regret. For instance, sleep problems could lead to more time for ruminations. However, as mentioned earlier, a recent randomized trial found that experimental activation of regrets at bedtime delays sleep onset [25]. But there is also evidence that sleep loss may in turn undermine emotion regulation: For instance, a longitudinal study of 78 medical residents found that sleep loss intensified negative emotions following daytime disruptive events [43]. Taken together, these different lines of research suggest that the relations between sleep and emotion regulation may best be conceptualized as bi-directional [44]. Specifically, the experience of regrets may interfere with sleep and the resulting sleep loss may increase regret intensity and decrease resources needed to regulate regrets in adaptive ways. Moreover, sleep loss may decrease attentional resources [45], thereby increasing the risk of errors.

Finally, two other limitations of our study warrant discussion. First, only 31.2% of the eligible healthcare professionals responded to the survey, potentially due to the sensitive topic of regrettable behavior in healthcare settings [46]. Therefore, there may be selection bias if survey response was related to sleep habits and regrets. However, similar associations have previously been found in a sample of university students who were obliged to return their questionnaires in fulfillment of a course requirement [23]. It is also of note that response rate did not differ by profession. Second, we did not collect data on anxiety. It is difficult to disentangle the fact that people with higher levels of anxiety may be more likely to experience regret and may also be more likely to experience sleep difficulties. Therefore, anxiety may either confound or mediate the association between regret and sleep quality. However, in our analyses, we adjusted for depressive symptoms, an affective state that is more closely related to regret than anxiety [33,47], and the associations between regret intensity, maladaptive regret regulation, and sleep problems remained statistically significant. Note that depression may also be part of the potential causal pathway between regret and sleep. The associations reported here may thus be underestimated.

In conclusion, we have shown that regret intensity and the use of maladaptive regret regulation strategies are cross-sectionally associated with sleep problems among health care professionals. Whether regret management can be acted upon, so as to limit its impact on sleep and other negative consequences, is an issue worth exploring.

**Supporting Information**

**S1 Data. Codebook for the data.** ID. Provides a unique and anonymous ID. SEX: 1 = male, 2 = female. PROF: nurse or physician. EMPLOYLEV: Rate of employment, 1 = 0–50%, 2 = 50–
80%, 3 = 80%-100%. Expcat: Categories of work experience, 1 = <3 years, 2 = 3–5 years, 3 = 6–10 years, 4 = 11–20 years, 5 = >20 years. RIS10: regret intensity scale score. PF: problem-focused regret coping strategy score. MA: maladaptive regret coping strategy score. A: adaptive regret coping strategy score. Depression: CES-D score. ISI: insomnia severity index score. Pill: Frequency of pill use in the last month, 0 = <1/month, 1 = /C21. RMONTH: number of regret in the last month. RINTEN.MONTH: average intensity of regrets in the last month. RRESPON: “How responsible do you feel of this situation?”, 0 = no responsibility to 10 = very high responsibility. RERROR: “Did the regret-inducing event imply an error on your part?”, 1 = no, 2 = yes. RSUPPORT: “How much support did you receive from your superior?”, 0 = no support to 10 high support.

Author Contributions
Conceived and designed the experiments: DC SC TP TA RS GH. Performed the experiments: DC SC TP TA GH. Analyzed the data: DC SC TP EM MM. Wrote the paper: RS SC EM GH TA MM TP DC.

References
1. Dorrian J, Lamond N, van den Heuvel C, Pincombe J, Rogers AE, Dawson D. A pilot study of the safety implications of Australian nurses’ sleep and work hours. Chronobiol Int. 2006; 23(6):1149–63. Epub 2006/12/28. doi:10.1080/07420520601059615 PMID: 17190702.
2. Geiger-Brown J, Rogers VE, Trinkoff AM, Kane RL, Bausell RB, Scharf SM. Sleep, sleepiness, fatigue, and performance of 12-hour-shift nurses. Chronobiol Int. 2012; 29(2):211–9. Epub 2012/02/14. doi: 10.3109/07420528.2011.645752 PMID: 22324559.
3. Jacques CH, Lynch JC, Samkoff JS. The effects of sleep loss on cognitive performance of resident physicians. J Fam Pract. 1990; 30(2):223–9. Epub 1990/02/01. PMID: 2299318.
4. Johnson AL, Brown K, Weaver MT. Sleep deprivation and psychomotor performance among night-shift nurses. AAOHN J. 2010; 58(4):147–54; quiz 55–6. Epub 2010/04/27. PMID: 20415342.
5. Thomas F, Hopkins RO, Han drahan DL, Walker J, Carpenter J. Sleep and cognitive performance of flight nurses after 12-hour evening versus 18-hour shifts. Air Med J. 2006; 25(3):216–25. Epub 2006/08/30. doi: 10.1016/j.amj.2006.06.005 PMID: 16938635.
6. Wesnes KA, Walker MB, Walker LG, Heys SD, White L, Warren R, et al. Cognitive performance and mood after a weekend on call in a surgical unit. Br J Surg. 1997; 84(4):493–5. PMID: 9112899.
7. Arimura M, Imai M, Okawa M, Fujimura T, Yamada N. Sleep, mental health status, and medical errors among hospital nurses in Japan. Ind Health. 2010; 48(6):811–7. Epub 2010/07/10. PMID: 20616466.
8. Philipbert I. Sleep loss and performance in residents and nonphysicians: a meta-analytic examination. Sleep. 2005; 28(11):1392–402. Epub 2005/12/13. PMID: 16335329.
9. Bjorvatn B, Dale S, Hogstad-Erikstein R, Fiske E, Pallesen S, Waage S. Self-reported sleep and health among Norwegian hospital nurses in intensive care units. Nurs Crit Care. 2012; 17(4):180–8. Epub 2012/06/16. doi: 10.1111/j.1478-5153.2012.00504.x PMID: 22698160.
10. Ruggiero JS. Correlates of fatigue in critical care nurses. Res Nurs Health. 2003; 26(6):434–44. Epub 2003/12/23. doi: 10.1002/nur.10106 PMID: 14689460.
11. Vela-Bueno A, Moreno-Jimenez B, Rodriguez-Munoz A, Olavarrieta-Bernardino S, Fernandez-Mendoza J, De la Cruz-Troca JJ, et al. Insomnia and sleep quality among primary care physicians with low and high burnout levels. J Psychosom Res. 2008; 64(4):435–42. Epub 2008/04/01. doi: 10.1016/j.jpsychores.2007.10.014 PMID: 18374744.
12. Owens JA. Sleep loss and fatigue in healthcare professionals. J Perinat Neonatal Nurs. 2007; 21 (2):92–100; quiz 1–2. PMID: 17505227.
13. Geiger-Brown J, Trinkoff A, Rogers VE. The impact of work schedules, home, and work demands on self-reported sleep in registered nurses. J Occup Environ Med. 2011; 53(3):303–7. Epub 2011/02/25. PMID: 21346638.
14. Hsieh ML, Li YM, Chang ET, Lai HL, Wang WH, Wang SC. Sleep disorder in Taiwanese nurses: a random sample survey. Nurs Health Sci. 2011; 13(4):468–74. Epub 2011/10/21. doi: 10.1111/j.1442-2018.2011.00641.x PMID: 22011090.
30. Bastien CH, Vallieres A, Morin CM. Validation of the Insomnia Severity Index as an outcome measure.

29. Courvoisier DS, Agoritsas T, Perneger TV, Schmidt RE, Cullati S. Regrets associated with providing suboptimal care among European and Israeli intensive care unit nurses and physicians. JAMA. 2011; 306(24):2694–703. Epub 2011/12/29. doi: 10.1001/jama.2011.1888 PMID: 22203538.

28. Schmidt RE, Combescure C, Agoritsas T, Perneger TV. Performance of logistic regression modeling: beyond the number of events per variable, the role of data structure. J Clin Epidemiol. 2011; 64(9):993–1000. doi: 10.1016/j.jclinepi.2010.11.012 PMID: 21411281.

27. Courvoisier DS, Cullati S, Ouchi R, Schmidt RE, Haller G, Chopard P, et al. Validation of a 15-item care-related regret intensity scale (RIS–15) for healthcare professionals. Med Care. 2013; 51(3):285–91. PMID: 23295580.

26. Courvoisier DS, Cullati S, Haller C, Haller G, Schmidt RE, Agoritsas T, et al. Validation of a 10-item care-related regret intensity scale (RIS–10) for healthcare professionals. Med Care. 2013; 51(3):285–91. PMID: 23295580.

25. Schmidt RE, Renaud O, van der Linden M. Nocturnal regrets and insomnia in elderly people. Int J Aging Hum Dev. 2011; 73(4):371–93. Epub 2011/01/01. PMID: 22474917.

24. Schmidt RE, Van der Linden M. Feeling too regretful to fall asleep: Experimental activation of regret delays sleep onset. Cog Therapy Res. 2013; 37:820–72. doi: 10.1007/s10608-012-9367-1.

23. Schmidt RE, Van der Linden M. The aftermath of rash action: sleep-interfering counterfactual thoughts and emotions. Emotion. 2009; 9(4):549–53. Epub 2009/08/06. doi: 10.1037/a0015856 PMID: 19653778.

22. Scott IA. Errors in clinical reasoning: causes and remedial strategies. BMJ. 2009; 338(jun08_2):b1860. doi: 10.1136/bmj.b1860.

21. Scott IA. Errors in clinical reasoning: causes and remedial strategies. BMJ. 2009; 338(jun08_2):b1860. doi: 10.1136/bmj.b1860.

20. Donchin Y, Gopher D, Olin M, Badihi Y, Biesky M, Sprung CL, et al. A look into the nature and causes of human errors in the intensive care unit. Qual Saf Health Care. 2003; 12(2):143–7. doi: 10.1136/qhc.12.2.143 PMID: 12679512.

19. Zeelenberg M, Pieters R. A theory of regret regulation 1.0. J Consum Psychol. 2007; 17(1):3–18.

18. Schmidt RE, Richter M, Gendolla GH, Van der Linden M. Young poor sleepers mobilize extra effort in response to sleep-restricting conditions: evidence from cardiovascular measures. J Sleep Res. 2010; 19(3):487–95. Epub 2010/04/23. doi: 10.1111/j.1365-2869.2010.00834.x PMID: 20408924.

17. Eriksen W, Bjorvatn B, Bruusgaard D, Knardahl S. Work factors as predictors of poor sleep in nurses’ aides. Int Arch Occup Environ Health. 2008; 81(3):301–10. Epub 2007/07/03. doi: 10.1007/s00420-007-0214-z PMID: 17650531.

16. Courvoisier DS, Merglen A, Agoritsas T. Experiencing regrets in clinical practice. Lancet. 2013; 382(9904):1553–4. Epub 2013/11/12. doi: 10.1016/S0140-6736(13)62325-9 PMID: 24209827.

15. Lin PC, Chen CH, Pan SM, Pan CH, Chen CJ, Chen YM, et al. Atypical work schedules are associated with poor sleep quality and mental health in Taiwan female nurses. Int Arch Occup Environ Health. 2012; 85(8):877–84. Epub 2011/12/31. doi: 10.1007/s00420-011-0730-8 PMID: 22207296.

14. Andresen EM, Malmgren JA, Carter WB, Patrick DL. Screening for Depression in Well Older Adults for Depression in Well Older Adults: Evaluation of a Short-Form of the CES-D. Am J Prev Med. 1994; 10(3):49–57. Epub 1994/10/06. PMID: 7975928.

13. Fuhrer R, Rouillon F. La version française de l’échelle CES-D (Center for Epidemiological Studies Depression): Description et traduction de l’échelle d’auto-évaluation [French version of the CES-D scale] (Center for Epidemiological Studies Depression: Description and translation of the self-reported scale). Psychiatrerie et psychobiologie. 1989; 4:1099–800. doi: 19653778.

12. Schmidt RE, Richter M, Gendolla GH, Van der Linden M. Young poor sleepers mobilize extra effort in response to sleep-restricting conditions: evidence from cardiovascular measures. J Sleep Res. 2010; 19(3):487–95. Epub 2010/04/23. doi: 10.1111/j.1365-2869.2010.00834.x PMID: 20408924.

11. Fuhrer R, Rouillon F. La version française de l’échelle CES-D (Center for Epidemiological Studies Depression): Description et traduction de l’échelle d’auto-évaluation [French version of the CES-D scale] (Center for Epidemiological Studies Depression: Description and translation of the self-reported scale). Psychiatrerie et psychobiologie. 1989; 4:1099–800. doi: 10.1037/a0015856 PMID: 19653778.

10. Courvoisier DS, Cullati S, Ouchi R, Schmidt RE, Haller G, Chopard P, et al. Validation of a 15-item care-related regret coping scale for health-care professionals (RCS-HCP). J Occup Health. 2014; 56(6):430–3. doi: 10.1539/joh.14-0060-OA PMID: 25214189.

9. Donchin Y, Gopher D, Olin M, Badihi Y, Biesky M, Sprung CL, et al. A look into the nature and causes of human errors in the intensive care unit. Qual Saf Health Care. 2003; 12(2):143–7. doi: 10.1136/qhc.12.2.143 PMID: 12679512.

8. Zeelenberg M, Pieters R. A theory of regret regulation 1.0. J Consum Psychol. 2007; 17(1):3–18.

7. Schmidt RE, Renaud O, van der Linden M. Nocturnal regrets and insomnia in elderly people. Int J Aging Hum Dev. 2011; 73(4):371–93. Epub 2011/01/01. PMID: 22474917.

6. Schmidt RE, Van der Linden M. Feeling too regretful to fall asleep: Experimental activation of regret delays sleep onset. Cog Therapy Res. 2013; 37:820–72. doi: 10.1007/s10608-012-9367-1.

5. Schmidt RE, Van der Linden M. Feeling too regretful to fall asleep: Experimental activation of regret delays sleep onset. Cog Therapy Res. 2013; 37:820–72. doi: 10.1007/s10608-012-9367-1.

4. Courvoisier DS, Merglen A, Agoritsas T. Experiencing regrets in clinical practice. Lancet. 2013; 382(9904):1553–4. Epub 2013/11/12. doi: 10.1016/S0140-6736(13)62325-9 PMID: 24209827.

3. Courvoisier DS, Cullati S, Haller C, Haller G, Schmidt RE, Agoritsas T, et al. Validation of a 10-item care-related regret intensity scale (RIS–10) for healthcare professionals. Med Care. 2013; 51(3):285–91. PMID: 23295580.

2. Schmidt RE, Cullati S, Ouchi R, Schmidt RE, Haller G, Chopard P, et al. Validation of a 15-item care-related regret coping scale for health-care professionals (RCS-HCP). J Occup Health. 2014; 56(6):430–4. doi: 10.1539/joh.14-0060-OA PMID: 25214189.

1. Schmidt RE, Richter M, Gendolla GH, Van der Linden M. Young poor sleepers mobilize extra effort in an easy memory task: evidence from cardiovascular measures. J Sleep Res. 2010; 19(3):487–95. Epub 2010/04/23. doi: 10.1111/j.1365-2869.2010.00834.x PMID: 20408924.
37. Schmidt RE, Harvey AG, Van der Linden M. Cognitive and affective control in insomnia. Front Psychol. 2011; 2:349. Epub 2011/12/14. doi: 10.3389/fpsyg.2011.00349 PMID: 22162971; PubMed Central PMCID: PMC3232458.

38. Carney CE, Harris AL, Moss TG, Edinger JD. Distinguishing rumination from worry in clinical insomnia. Behav Res Ther. 2010; 48(6):540–6. doi: 10.1016/j.brat.2010.03.004 PMID: 20362977; PubMed Central PMCID: PMC2871974.

39. Roelofs J, Huibers M, Peeters F, Amtz A, van Os J. Rumination and worrying as possible mediators in the relation between neuroticism and symptoms of depression and anxiety in clinically depressed individuals. Behav Res Ther. 2008; 46(12):1283–9. doi: 10.1016/j.brat.2008.10.002 PMID: 19006785.

40. Payette M, Chatterjee A, Weeks WB. Cost and workforce implications of subjecting all physicians to aviation industry work-hour restrictions. Am J Surg. 2009; 197(6):820–5; discussion 6–7. Epub 2009/04/21. doi: 10.1016/j.amjsurg.2008.05.013 PMID: 19375063.

41. Gilbert P, Procter S. Compassionate mind training for people with high shame and self-criticism: Overview and pilot study of a group therapy approach. Clin Psychol Psychot. 2006; 13(6):353–79. doi: 10.1002/Cpp.507 ISI:000243418500001.

42. Ingersoll-Dayton B, Krause N. Self-forgiveness—A component of mental health in later life. Res Aging. 2005; 27(3):267–89. doi: 10.1177/0164027504274122 ISI:000228442800001.

43. Zohar D, Tzischinsky O, Epstein R, Lavie P. The effects of sleep loss on medical residents' emotional reactions to work events: a cognitive-energy model. Sleep. 2005; 28(1):47–54. PMID: 15700720

44. Walker MP, Harvey AG. Obligate symbiosis: Sleep and affect. Sleep Med Rev. 2010; 14(4):215–7. doi: 10.1016/J.Smrv.2010.02.003 PMID: 20427211

45. Killgore WDS. Effects of sleep deprivation on cognition. Prog Brain Res. 2010; 185:105–29. doi: 10.1016/B978-0-444-53702-7.00007-5 ISI:000287853800008. PMID: 21075236

46. Perneger TV, Cullati S, Rudaz S, Agoritsas T, Schmidt RE, Combescure C, et al. Effect of numbering of return envelopes on participation, explicit refusals, and bias: experiment and meta-analysis. BMC Med Res Methodol. 2014; 14(1):6.

47. Roese NJ, Epstude K, Fessel F, Morrison M, Smallman R, Summerville A, et al. Repetitive Regret, Depression, and Anxiety: Findings from a Nationally Representative Survey. J Soc Clin Psychol. 2009; 28(6):671–88. ISI:000267496400001.