Laparoscopic Skills and Cognitive Function are not Affected in Surgeons During a Night Shift

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OBJECTIVE: To monitor surgeons' performance and cognition during night shifts.

DESIGN: Surgeons were monitored before call and on call (17-hour shift). Psychomotor performance was assessed by laparoscopic simulation and cognition by the d2 test of attention. The surgeons performed the laparoscopic simulation and the d2 test of attention at 8 a.m. before call and at 4 a.m. on call. Sleep was measured by wrist actigraphy and sleepiness by the Karolinska sleepiness scale.

SETTING: Department of Surgery at Herlev Hospital, Denmark.

PARTICIPANTS: Overall, 30 interns, residents, and attending surgeons were included and completed the study. One participant was subsequently excluded owing to myxedema.

RESULTS: The surgeons slept significantly less on call than before call. There was increasing sleepiness on call; however, no significant differences were found in the precall laparoscopic simulation values compared with on-call values. The d2 test of attention showed significantly improved values on call compared with before call.

CONCLUSION: Sleep deprivation during a 17-hour night shift did not impair surgeons' psychomotor or cognitive performance. (J Surg 71:543-550. © 2014 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: surgeons, sleep deprivation, night shifts, d2 test of attention, laparoscopic simulation, actigraphy

COMPETENCIES: Patient Care, Practice-Based Learning and Improvement, Systems-Based Practice

INTRODUCTION

There is increasing focus on patient safety and adverse events causing patient harm, because of medical errors in hospitals. In the United States of America, it was estimated that 23% of all in-hospital deaths could be related to a preventable adverse event.[1] In a systematic review from 2008 based on 12 studies on medical records, the median overall incidence of in-hospital adverse events was 9.2%,[2] and the median percentage of preventability was found to be 43.5%. More than half of the adverse events resulted in no or minor disability (56.3%); however, 7.4% of the adverse events were classified as lethal. Most adverse events were related to surgery (39.6%) or medication (15.1%). There is increasing concern that sleep deprivation in physicians owing to night shifts may cause some of these adverse events and patient harm during admission.[3]

Surgeons' psychomotor and cognitive skills are worse after call compared with before call owing to sleep deprivation.[4-7] An 83% increased complication rate was shown in surgeons who slept less than 6 hours on night shifts and performed elective surgery after call during daytime.[8,9] This started a debate on how doctors should handle postcall fatigue and elective surgery.[9] It was suggested that surgeons should obtain informed consent, or that the operation should be postponed, or a different surgeon should be requested.[9] Furthermore, it was proposed that surgeons have ethical obligations in sleeping and being well rested to be capable of performing safe surgery.[10] Some countries typically run 24-hour shift for surgical residents, some run 17-hour shifts, and some only 8-hour shifts. There are, however, no data to support one schedule for another regarding residents' work hours. The focus of sleep deprivations' effect on surgeons' performance has so far been after call, yet information on how surgeons perform during night shifts is lacking. It appears highly relevant to assess surgeons' performance during night shifts, as emergent surgery often is performed during the night and in the early morning hours, when little or no sleep has been achieved in the preceding 20 to 24 hours.

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The aim of this study was to monitor surgeons' performance during night shifts by laparoscopic simulation and cognitive tests to assess surgeons' psychomotor performance, dexterity, and cognition.

METHOD

Design

Overall, 30 surgeons, of 43 possible, were included in a prospective monitoring study in an academic surgical department. The surgeons were recruited by e-mail and by written and oral information at the handover between shifts. The surgeons who wished to participate were included if they met the inclusion criteria. The surgeons were monitored for 2 days. The monitoring period started on the first day before call at 8 a.m., and on the subsequent day, they were followed during a 17-hour night shift from 3.30 p.m. to 8.30 a.m. The surgeons did not perform clinical work on the morning before the 17-hour night shift as they were off duty. The night shift began with a handover at 3.30 p.m. The surgeons were allowed to sleep on call if given the opportunity. The subsequent day after call, the surgeons would have the day off to rest and would leave the hospital. The doctors worked for approximately 37 to 48 hours per week, which is standard in Scandinavia. The European Union maximum work hour limit is 48 hours.

Subjects

Male and female interns, residents, and attending surgeons were included. All gave written informed consent before inclusion. The exclusion criteria were night shifts within 72 hours of the beginning of the study to avoid preexisting sleep deprivation. The surgeons were instructed to get their habitual amount of night sleep during this period. Furthermore, subjects in medical treatment owing to known endocrine, autoimmune, or heart diseases were excluded, as were subjects previously diagnosed with a sleep disorder. Pregnant or breast-feeding women were not included. The consumption of alcohol 24 hours before the beginning of the study and during the study was not allowed. The intake of caffeine was not controlled.

Psychomotor Performance

The doctors' psychomotor performance was tested with laparoscopic simulation (LapSimGyn virtual reality simulator, Surgical Science, Gothenburg, Sweden). The ectopic pregnancy procedural module was used, as it previously has been validated as a reliable tool for both the assessment and improvement of technical skills.[11-13]

The primary effect parameter was total time in performing the ectopic pregnancy module. Other parameters were blood loss as an estimate of error, instrument path length and instrument angular path (for both left and right hand) as a measure of dexterity and psychomotor performance.[13] All surgeons were trained in the ectopic pregnancy procedural module between 1 and 7 days before the precall day. This was done to ensure that the surgeons would reach a plateau in simulation, known as a predefined proficiency level.[11,14] As described previously, we trained the surgeons in the ectopic pregnancy module, until a proficiency level was achieved, by passing twice within 5 consecutive repetitions.[14] The doctors would repeat the ectopic pregnancy procedural module for 30 minutes at 8.00 a.m. on the precall day and again at 4.00 a.m. on the subsequent day on call, which equaled 7-10 repetitions. The median of the surgeons' last 3 repetitions of the ectopic pregnancy module was used as representative data for the 30-minute long simulation.

Karolinska Sleepiness Scale

The Karolinska sleepiness scale (KSS) is a 9-grade Likert scale, where 1: very alert, 3: alert, 5: neither alert nor sleepy, 7: sleepy (but not fighting sleep), and 9: very sleepy (fighting sleep). The KSS was filled out at 8.00 a.m. on the precall day, and on the subsequent day on call, it was filled out from 4.00 p.m. and every second hour till 8.00 a.m. the following morning. If the surgeons were asleep, or were in the operating room, they were not expected to fill out the Karolinska sleepiness scale. KSS is a validated scale for the assessment of sleepiness.[15,16] A score of 7 to 9 is reflected in electroencephalographic activity as alpha and theta activity and slow eye movement electrooculographic activity under the condition of open eyes.[16,17]

Cognitive Function

We used the d2 test of attention to measure attention and concentration at 8.00 a.m. on the precall day and again at 4.00 a.m. on call. The d2 test of attention is a validated test for attention and concentration.[18] The test has 14 printed lines, each with 47 characters for 658 items. The items are letters ***d*** and ***p*** marked with 1 to 4 dashes arranged singularly or in pairs and upward or downward signs. The task is to cancel out all target characters; a ***d*** with 2 dashes placed above and/or below, hence ***d2***, in 14 successive timed trials.

Scoring of the d2 test included the following: (1) total number of items processed (TN), which is a quantitative measure of performance on all items processed; (2) errors of omission (E1); (3) errors of commission (E2); (4) total number of errors (E), which is the sum of E1 + E2; (5) percentage of errors (E%), which is (Ex100)/TN, and reflects performance accuracy; (6) total number of items processed minus errors (TN-E), which measures the quantity of work completed after a correction for errors providing an indication of attention and the relationship between accuracy and speed performance; (7) concentration performance, which is the total number of items canceled out correctly minus the items canceled out incorrectly (E2), and represents performance speed and accuracy in the overall test; and (8) fluctuation rate (FR), which is the maximum amount of items processed minus the minimum amount of

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