

Impact of Volume and Type of Overnight Pages on Resident Sleep During Home Call

Adam E. Ludvigson, MD
Stephen T. Ryan, MD
Christina R. Gentile, MPH

Gregory J. Mills, BA
Graham T. VerLee, MD
Moritz H. Hansen, MD

ABSTRACT

Background Little research exists regarding factors that contribute to resident fatigue during home call.

Objective We objectively tracked the number and type of pages received, as well as residents' sleep time, during home call. We then examined the relationship between paging volume, resident sleep, and resident fatigue.

Methods A total of 4 of 4 urology residents (100%) at a single institution wore a FitBit Charge HR device from July 2015 to July 2016 to track sleep. Between January and July 2016, pages received by the on-call resident were counted as either *floor* (urology inpatient unit), *clinic* (after-hours answering service), or *other*. Postcall residents were defined as *fatigued* and excused at noon if they reported they were too tired to safely perform clinical duties.

Results Residents slept an average of 408 minutes per night while not on call, versus 368 minutes while on call but not fatigued, and 181 minutes while on call and fatigued ($P < .05$). The most senior resident received fewer pages per night on average than the most junior resident. Each page was associated with 4.71 fewer minutes asleep on average for all residents. Pages in the *other* category were associated with 7.74 fewer minutes asleep per page for all residents, but only the most junior resident had significantly less sleep, 9.02 minutes, per *floor* page.

Conclusions Objective sleep data correlate with subjective assessment of resident fatigue and with volume and type of pages received. Senior residents spent less time awake per page and received fewer pages.

Introduction

The Accreditation Council for Graduate Medical Education sets work hour requirements to ensure resident physicians are rested enough to safely perform their duties.^{1,2} No guidance is provided to residency programs that use home call (a system in which residents deliver clinical coverage from home, providing phone consults and/or returning to the institution as needed).³ Published studies are limited by a lack of baseline sleep data⁴ or a reliance on self-reporting to identify the number and acuity of overnight events.⁵

To fill this gap, we collected all pages received by residents, and we also tracked sleep continuously using activity monitors. These devices have been shown to have accuracy comparable to commercial actigraphy systems.^{6,7} We hypothesized that residents get less sleep on call nights, and even less on nights when they subsequently report they feel too fatigued to perform their duties safely. We also hypothesized that residents would sleep less with increasing call volume, and that the difference would be larger for pages about unfamiliar patients.

Methods

Sleep Tracking

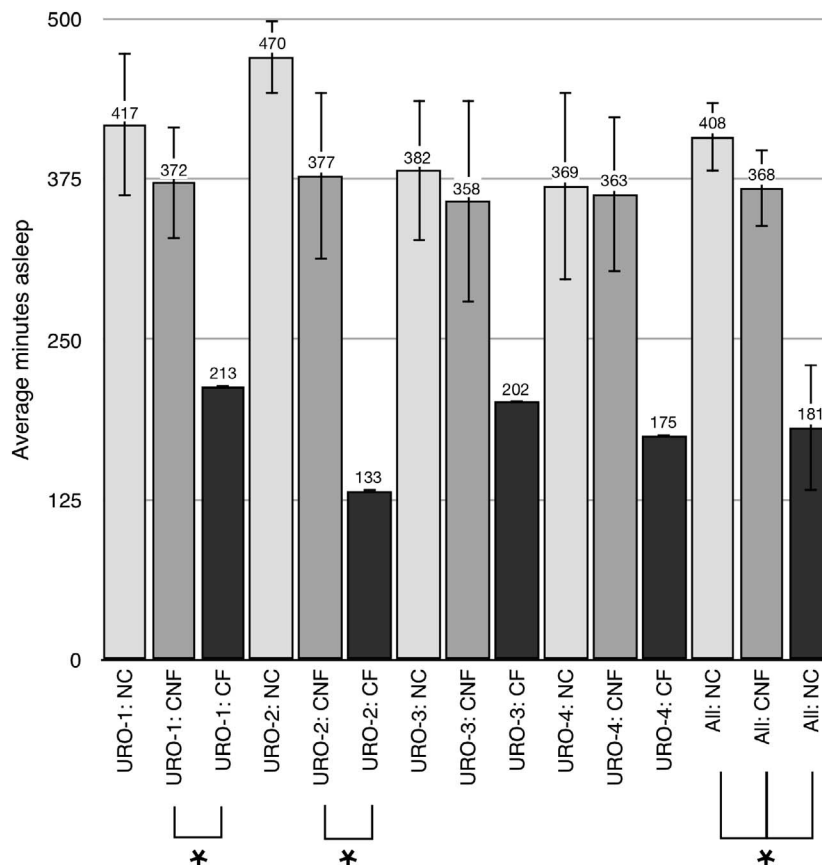
A total of 4 of 4 urology residents (100%, postgraduate year [PGY]-2 to PGY-5) at a single 637-bed tertiary care center wore a FitBit Charge HR (FitBit Inc, San Francisco, CA) device continuously from July 2015 to July 2016. Each night's "total minutes asleep" value was collected and averaged. Nights were discarded if data were not available. Vacations and holidays were excluded from analysis.

Every morning, the postcall resident was instructed to report either being *not fatigued* or *fatigued*. Residents who reported being *fatigued* were excused without consequence from clinical duties at noon that day.

Home Call

The resident on home call was the primary urology contact for a single major tertiary care medical center and for all after-hours outpatient clinic calls, and was required to remain within a 20-minute drive of the hospital. Weekday call started at 4 PM and ended at 8 AM. Call was distributed equally among the 4 urology residents. Weekend call was continuous starting Friday at 4 PM and ending Monday at 8 AM; however, only pages received between 4 PM and 8 AM were analyzed.

DOI: <http://dx.doi.org/10.4300/JGME-D-18-00174.1>

**FIGURE 1****Average Minutes Asleep for All Residents**

Note: Asterisks denote $P < .05$.

Abbreviations: NC, not on call; CNF, on call and not too fatigued to perform duties; CF, on call and too fatigued to perform duties.

Page Tracking

Pages received between January 2016 and July 2016 were automatically copied to a Health Insurance Portability and Accountability Act–compliant e-mail account. All pages were categorized as either *clinic*, *floor*, or *other*. *Clinic* pages were defined as any page received from outpatients via the after-hours answering service, requiring the resident to contact the patient directly by telephone. *Floor* pages were defined as any page in which the callback number was from one of the telephones in the inpatient urology unit. All other pages were categorized as *other*, including new consults and pages from the emergency department.

This study received approval from the hospital's Institutional Review Board.

Data Analysis

For the analysis of sleep time, total minutes asleep data were stratified, based on the resident's response to that morning's fatigue assessment, into the following 3 categories: (1) not on call; (2) on call

but not too fatigued; or (3) on call and too fatigued. The categories were compared pairwise using 2-sided t tests for each resident. To combine the data, a mixed model was fit with a fixed scenario effect using the 3 categories. Random resident and resident-by-scenario effects were used to account for the correlation within each resident/scenario combination.

For analysis of pages, a mixed model was fit with a fixed scenario effect using each page category. Random resident and resident-by-call effects were used to account for the correlation within each resident/call combination. Mixed linear regression analysis was used to correlate number of pages and minutes asleep.

Results**Time Asleep**

A total of 219 of 265 call periods (83%) were available for analysis. As a group, residents slept less while on call, and even less when they subsequently reported being fatigued (FIGURE 1). Residents were excused at noon due to fatigue a total of 31 times. Residents slept an average of 408 minutes per night

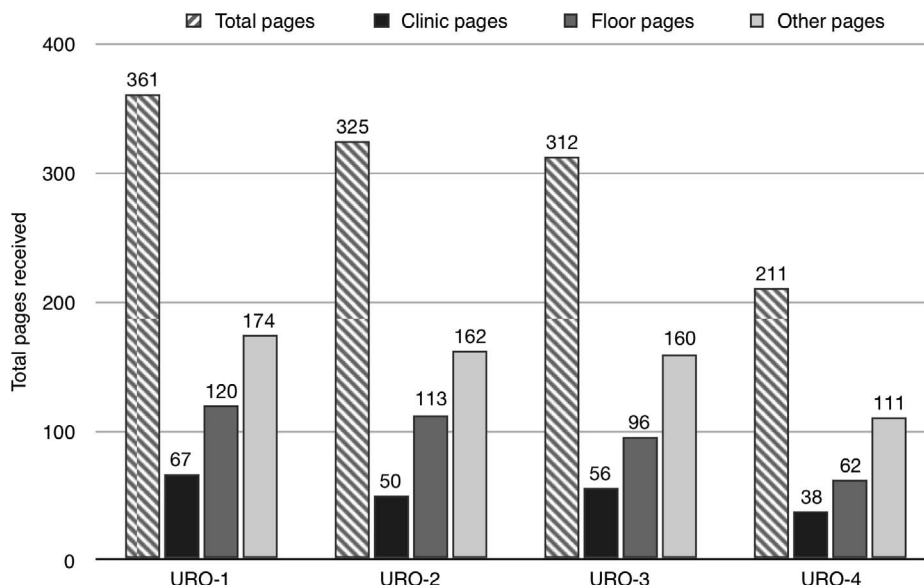


FIGURE 2

Total Number of Pages Received in Total and by Category for All Residents

while not on call, versus 368 minutes while on call but not fatigued, and 181 minutes while on call and fatigued ($P < .05$).

Volume of Pages

Residents received a total of 1209 overnight pages while on call during the 6-month page analysis window (FIGURE 2). The difference between the average number of pages received per night by the most junior resident and the most senior resident was statistically significant (7.0 versus 5.0, respectively, $P < .05$).

Effect on Sleep per Page

Each page was associated with 4.71 fewer minutes asleep for all residents ($r = -0.24$, $P < .05$). Pages in the *other* category were associated with 7.74 fewer minutes asleep per page for all residents ($r = -0.24$, $P < .05$), but only the most junior resident had significantly less sleep per *floor* page (9.02 minutes

less per page; $r = -0.35$; $P < .05$). Results are summarized in the TABLE.

Discussion

Residents slept less while on call compared with nights they were not on call. Examined as a group, residents who reported that they were too fatigued had a consistent reduction in sleep the previous night. However, on individual analysis, this difference only reached significance for the 2 most junior residents, suggesting senior residents spend less time awake per page.

To our knowledge, this is the first study to objectively track page volume and category in urology residents, and to show a relationship to time asleep. Despite equal call distribution, page volume was significantly more for the most junior resident compared with the most senior resident. While it is possible in some situations that a staff member's lack of familiarity with a junior resident may prompt more pages, another explanation is that senior residents

TABLE

Changes in Minutes Asleep While on Call Compared With Not on Call

Participants	Minutes Asleep Per Any Page	Minutes Asleep Per Clinic Page	Minutes Asleep Per Floor Page	Minutes Asleep Per Other Page
All residents	$-4.97^a \pm 1.58$	-8.65 ± 5.74	-5.29 ± 3.09	$-7.92^a \pm 2.66$
URO-1	$-4.23^a \pm 1.89$	-2.36 ± 6.82	$-9.02^a \pm 3.74$	-7.40 ± 3.92
URO-2	-1.13 ± 4.53	-16.53 ± 13.24	8.57 ± 7.62	-5.94 ± 7.37
URO-3	-5.30 ± 2.69	-13.74 ± 10.69	-7.65 ± 5.46	-7.20 ± 4.71
URO-4	-9.00 ± 4.82	-9.43 ± 18.25	-6.33 ± 8.95	-10.11 ± 6.19

^a Denotes statistically significant at $P < .05$.

become more efficient at managing existing problems and preempting future ones. The junior resident may also ask a nurse for more frequent updates on patients. This phenomenon is not likely unique to urology, and may have relevance to any specialty or call structure in which a nurse communicates directly with a physician.

The *other* page category showed a consistent impact on sleep regardless of resident training level, likely reflecting the increased work required when a patient is not immediately familiar to the resident.

Our study explicitly examines only acute fatigue (more precisely, sleepiness) the morning after a call period, and does not rigorously examine chronic fatigue. While studies of acute fatigue have shown variable effects on the ability to learn new operative techniques,^{8,9} the concept of burnout is an area of interest, and may relate more to chronic, ongoing fatigue than any “bad night.”¹⁰ The concept of fatigue is complex and extends beyond simple sleep deprivation.^{11,12}

Limitations of this study include a very small sample, and the fact that it was performed at a single institution in a single specialty. Another limitation is the implicit assumption that page volume can be used to judge how “busy” a call night was; for example, if the resident is in the hospital, there may be no need for staff to page.

Future studies should confirm the correlation of subjective fatigue with objective sleep measures and page volume. Taking into account the actual location of residents while on home call would greatly increase the value of this analysis. While the effects of acute fatigue on clinical performance have been well studied, chronic fatigue deserves further study as well. Together, this may contribute to improve our understanding of fatigue and mitigation procedures.

Conclusion

Our study demonstrates that it is feasible for programs to objectively track both sleep and page volume over long periods of time, and that residents’ self-assessment of fatigue correlates well with their actual time asleep. We show that senior residents’ sleep is less disrupted by pages than junior residents’ sleep. Finally, we show that it is possible to associate time asleep with pages received, and with specific types of pages.

References

1. Accreditation Council for Graduate Medical Education. History of duty hours. [http://www.acgme.org/What-We-Do/Accreditation/Clinical-Experience-and-](http://www.acgme.org/What-We-Do/Accreditation/Clinical-Experience-and-Education-formerly-Duty-Hours/History-of-Duty-Hours)
2. Accreditation Council for Graduate Medical Education. Summary of Changes to ACGME Common Program Requirements Section VI. <https://www.acgme.org/What-We-Do/Accreditation/Common-Program-Requirements/Summary-of-Proposed-Changes-to-ACGME-Common-Program-Requirements-Section-VI>. Accessed September 4, 2018.
3. Accreditation Council for Graduate Medical Education. Common Program Requirements Section VI with Background and Intent. https://assets.fridgectms.com/81a7119e-968c-425c-b67c-1cc44e028d44/CPRs_Section%20VI_with-Background-and-Intent_2017-01.pdf. Accessed September 4, 2018.
4. Morhardt DR, Luckenbaugh A, Goldstein C, et al. Determining resident sleep during and after call with commercial sleep monitoring devices. *Urology*. 2017;106:39–44.
5. Cautley L, Quimby AE, Barrowman N, et al. Effect of home-call on otolaryngology resident education: a pilot study. *J Surg Educ*. 2017;74(2):228–236.
6. Brooke SM, An HS, Kang SK, et al. Concurrent validity of wearable activity trackers under free-living conditions. *J Strength Cond Res*. 2017;31(4):1097–1106.
7. Lee HA, Lee HJ, Moon JH, et al. Comparison of wearable activity tracker with actigraphy for sleep evaluation and circadian rest-activity rhythm measurement in healthy young adults. *Psychiatry Investig*. 2017;14(2):179–185.
8. Yamany T, Woldu SL, Korets R, et al. Effect of postcall fatigue on surgical skills measured by a robotic simulator. *J Endourol*. 2015;29(4):479–484.
9. Robison W, Patel SK, Mehta A, et al. Can fatigue affect acquisition of new surgical skills? A prospective trial of pre- and post-call general surgery residents using the da Vinci surgical skills simulator. *Surg Endosc*. 2018;32(3):1389–1396.
10. Chaikos D, Chad-Friedman E, Mehta DH, et al. Risk and resilience factors associated with resident burnout. *Acad Psychiatry*. 2017;41(2):189–194.
11. West CP, Tan AD, Habermann TM, et al. Association of resident fatigue and distress with perceived medical errors. *JAMA*. 2009;302(12):1294–1300.
12. Antiel RM, Reed DA, Van Arendonk KJ, et al. Effects of duty hour restrictions on core competencies, education, quality of life, and burnout among general surgery interns. *JAMA Surg*. 2013;148(5):448–455.



Adam E. Ludvigson, MD, is a Resident Physician, Maine Medical Center; **Stephen T. Ryan, MD**, is a Fellow, University of California, San Diego; **Christina R. Gentile, MPH**, is a Research Coordinator, Maine Medical Center; **Gregory J. Mills, BA**, is a Research Coordinator, Maine Medical Center; **Graham T. VerLee, MD**, is an

Attending Physician, Maine Medical Center; and **Moritz H. Hansen, MD**, is an Attending Physician, Maine Medical Center.

Funding: The authors report no external funding source for this study.

Conflict of interest: The authors declare they have no competing interests.

This study was presented as a poster at the American Urological Association annual meetings, San Diego, California, May 6–10,

2016, and Boston, Massachusetts, May 12–16, 2017; and the American Urological Association New England Section Annual Meeting, Montreal, Canada, September 7–9, 2017.

Corresponding author: Adam E. Ludvigson, MD, Maine Medical Center, 22 Bramhall Street, Portland, ME 04102, 207.662.6901, aludvigson@mmc.org

Received February 27, 2018; revisions received May 24, 2018, and July 16, 2018; accepted July 18, 2018.