Effects of 24-hour versus night-float call schedules on the clinical and operative experiences of postgraduate year 2 and 3 neurosurgical residents

Stephen G. Bowden, MD, Dominic A. Siler, MD, PhD, Maryam N. Shahin, MD, David J. Mazur-Hart, MD, MS, Daniel N. Munger, MD, Miner N. Ross, MD, MPH, Brannan E. O’Neill, MD, Caleb S. Nerison, BS, Michael Rothbaum, MD, Seunggu J. Han, MD, James M. Wright, MD, Josiah N. Orina, MD, Jesse L. Winer, MD, and Nathan R. Selden, MD, PhD

OBJECTIVE To comply with the removal of the 88-hour week exemption and to support additional operative experience during junior residency, Oregon Health & Science University (OHSU) switched from a night-float call schedule to a modified 24-hour call schedule on July 1, 2019. This study compared the volumes of clinical, procedural, and operative cases experienced by postgraduate year 2 (PGY-2) and PGY-3 residents under these systems.

METHODS The authors retrospectively studied billing and related clinical records, call schedules, and Accreditation Council for Graduate Medical Education case logs for PGY-2 and PGY-3 residents at OHSU, a tertiary academic health center, for the first 4 months of the academic years from 2017 to 2020. The authors analyzed the volumes of new patient consultations, bedside procedures, and operative procedures performed by each PGY-2 and PGY-3 resident during these years, comparing the volumes experienced under each call system.

RESULTS Changing from a PGY-2 resident–focused night-float call system to a 24-hour call system that was more evenly distributed between PGY-2 and PGY-3 residents resulted in decreased volume of new patient consultations, increased volume of operative procedures, and no change in volume of bedside procedures for PGY-2 residents. PGY-3 residents experienced a decrease in operative procedure volume under the 24-hour call system.

CONCLUSIONS Transition from a night-float system to a 24-hour call system altered the distribution of clinical and procedural experiences between PGY-2 and PGY-3 residents. Further research is necessary to understand the impact of these changes on educational outcomes, quality and safety of patient care, and resident satisfaction.

ABBREVIATIONS ACGME = Accreditation Council for Graduate Medical Education; OHSU = Oregon Health & Science University; PGY = postgraduate year; VA = Veterans Affairs.


INCLUDE WHEN CITING DOI: 10.3171/2022.5.FOCUS22181.

KEYWORDS resident curriculum; call schedule; night-float; learning curve; duty-hour restrictions
with details of on-call workload systematically reported for only a single resident. The first months of junior neurosurgery residency present a unique challenge after what is, at our program, a relatively more generalized clinical internship with rotations in neurology, anesthesia, trauma critical care, and otolaryngology. Residents are required to optimize personal workflows, improve efficiency at managing a wide array of pathologies, and advance independence in performing bedside procedures, while also coping with lengthier on-call duty schedules. Development of these core call-related clinical skills competes with scheduled exposure to elective operative cases. In this study, we sought to determine the effects of workload redistribution after switching from a night-float system to a 24-hour call system with particular attention to new patient evaluations, bedside procedures, and operative cases that are central to junior resident education.

Methods

Study Setting

We performed a retrospective review of departmental billing records and ACGME case logs of junior neurosurgery residents at OHSU, a tertiary-care academic medical center in Portland, Oregon, from July 1 to November 1 of each year from 2017 to 2020. The residency program was divided into 4 clinical services (university A and B, pediatric, and Veterans Affairs [VA]) during the study period. These services have a cumulative average inpatient census of 50 to 60 patients.

The program had just completed a transition from alternating classes of 2 and 3 residents to 3 residents per year. All 4 classes of postgraduate year 2 (PGY-2) residents had 3 residents each. The local IRB approved data collection for this study.

Call Schedule Change and Resident Responsibilities

Under the night-float system, PGY-2 residents rotated through 2-week periods of 14-hour “day-float” and “night-float” call and 2 weeks in the operating room. Generally, residents did not go to the operating room while on call. PGY-2 through PGY-4 residents provided weekend coverage under the 24-hour system (Fig. 1). Daytime workload was divided as follows. The day-float PGY-2 resident oversaw the university services’ censuses and emergency department consultations (adult and pediatric). The PGY-3 resident at Doernbecher Children’s Hospital oversaw the pediatric service’s census. The PGY-3 resident at the VA managed that census and saw consultations at the VA. At night, PGY-2 (during weeknights) and PGY-3 or PGY-4 (weekends) residents covered all nonoperative responsibilities at all 3 hospitals. One resident from this pool provided 24-hour coverage on Saturdays.

The schedule transitioned to a rotating 24-hour call system on July 1, 2019, to accommodate the new 80-hour duty-hour restrictions and to increase PGY-2 residents’ operative exposure. Daytime workload was divided between residents in the same way, but the university call was rotated between PGY-2 residents every other day (Fig. 1). Nighttime coverage at all hospitals was provided by either the daytime PGY-2 resident completing a 24-hour shift or by a PGY-3 resident. Both Saturday and Sunday were covered with 24-hour shifts.

Balancing Call and Operating Room Experience

Call schedules were reviewed for the study period. The number of day, night, and 24-hour call shifts were recorded for each resident. To best compare the proportions of day to night calls between cohorts, 24-hour shifts were recorded as one 14-hour day plus one 14-hour night.

Resident operating room experience was measured in two overlapping ways to account for time spent in the clinic rather than the operating room, which can vary between services. The number of potential operative days (i.e., all weekdays excluding postcall days) were recorded for PGY-2 residents and nonresearch PGY-3 residents and normalized to per-month values.

The web-based ACGME case log system was queried for all logged procedures during the same period for each resident, and the number of operative cases was extracted. Case numbers were normalized to per-month values and compared between the night-float and 24-hour cohorts.

New Patient Evaluation and Bedside Procedure Distribution

On-call resident workload was determined from consult, admission, and procedure notes obtained from the departmental billing records. Electronic medical record
The share of daytime call handled by PGY-2 residents increased from 16.8% to 48.8% of nighttime call under the 24-hour system, p < 0.0001 (Table 1), predominantly due to a greater share of total call taken by PGY-2 residents under the night-float system vs 31.4% under the 24-hour system (16.6% of all call was taken by PGY-2 residents significantly decreased from the night-float to 24-hour call system (82.2% vs 63%, p < 0.0001) (Fig. 3A), with a compensatory increase in the proportion of evaluations by PGY-3 or PGY-4 residents (17.8% to 35%). In total, the average number of consultations seen per month increased from 8 to 11.25 per month after the transition (p = 0.009), whereas operative cases for PGY-3 residents decreased from 15.6 to 10.7 cases per month (p = 0.345) (Fig. 2B).

The median number of potential operative days for PGY-2 residents increased from 6 to 10 days per month (p = 0.002) (Fig. 2A). In contrast, pediatric (n = 4) and VA (n = 3) PGY-3 residents had a median 3.5 fewer operative days per month under the 24-hour call system (p = 0.057). Accordingly, median PGY-2 operative case numbers increased from 8 to 11.25 per month after the transition (p = 0.009), whereas operative cases for PGY-3 residents decreased from 234.3 under the 24-hour system to 201.8 under the night-float system (p = 0.002) (Fig. 3A).

Consult Workload, but not Procedure Volume, Was Redistributed Under the 24-Hour Call System

The proportion of new patient evaluations by PGY-2 residents significantly decreased from the night-float to 24-hour call system (82.2% vs 63%, p < 0.0001) (Fig. 3A), with a compensatory increase in the proportion of evaluations by PGY-3 or PGY-4 residents (17.8% to 35%). In total, the average number of consultations seen per month over the 4-month study period decreased slightly from 2017–2018 to 2019–2020 (244.6 under the night-float system to 234.3 under the 24-hour system).

In contrast, the proportion of total bedside procedures performed by PGY-2 residents did not change (82.9% to 75.0%, p = 0.178) (Fig. 3B). This effect was true for all types of bedside procedures (Fig. 4). The average number of bedside procedures per month over the 4-month study also remained similar between 2017–2018 and 2019–2020 (52.3 under the night-float system vs 51 under the 24-hour system).

ACGME Survey Scores Were Unchanged or Improved Under the 24-Hour Call System

The ACGME Annual and Well-Being Survey results were retrieved for 2018 (night-float system) and 2021 (24-hour call system). These results showed substantial improvements in compliance with weekly duty-hour limits.

---

**TABLE 1. Distribution of call shifts, July 1 to November 1, 2017–2020**

<table>
<thead>
<tr>
<th>Schedule</th>
<th>Total Call</th>
<th>Day Call</th>
<th>Night Call</th>
</tr>
</thead>
<tbody>
<tr>
<td>Night float</td>
<td>408 (83)</td>
<td>210 (84)</td>
<td>198 (83)</td>
</tr>
<tr>
<td>PGY-3/4</td>
<td>81 (17)</td>
<td>41 (16)</td>
<td>40 (17)</td>
</tr>
<tr>
<td>24 hr</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PGY-2</td>
<td>337 (69)</td>
<td>211 (86)</td>
<td>126 (51)</td>
</tr>
<tr>
<td>PGY-3</td>
<td>154 (31)</td>
<td>34 (14)</td>
<td>120 (49)</td>
</tr>
</tbody>
</table>

All values are shown as number (%).

---

**FIG. 2. Enhanced operative experience of PGY-2 residents when our institution switched from the night-float to 24-hour call system.**

A: The median number of potential operative days increased for PGY-2 residents (p = 0.002) and decreased for PGY-3 residents (p = 0.057). B: An increased median number of surgical cases was performed by PGY-2 residents under the 24-hour call system compared with the night-float system (p = 0.009), with no significant changes in cases performed by PGY-3 residents (p = 0.345). Error bars indicate SD. ns = nonsignificant. *p < 0.05.
(80- or 88-hour work weeks) and scheduling 24 or fewer consecutive work hours. Scores from overlapping questions on the Well-Being Survey varied somewhat between years, but there was no obvious trend in overall well-being scores, with almost identical average scores for comparable questions noted between survey years (data not shown).

Discussion

Call schedules are a common target of quality improvement efforts in residency curriculum design. In surgical specialties, most adaptations have sought to optimize resident operative experience in the face of progressively restrictive duty-hour limits.2–7 Our program recently transitioned from a night-float to a 24-hour call schedule by assigning a greater share of overnight call duties to PGY-3 residents. We sought to quantify the effects of this change on formative junior resident clinical experiences both inside and, in the first report to our knowledge, outside of the operating room. These data may serve as a baseline against which to compare future duty schedule innovations.

PGY-2 residents performed significantly fewer new patient evaluations in their first 4 months participating in the 24-hour call system compared with the night-float system. At face value, this reduced volume of patient consultations prolongs the learning curve for early junior residents by slowing specialized skill development. The general trend across programs toward greater time spent with the neurosurgery service during internship may smooth this transition more than in the past, but it remains a significant escalation in responsibility within our program’s curriculum. Managing large inpatient censuses with high acuity demands efficient personal workflows, risk triage, knowledge of a wide array of pathologies, and procedural skill. Objectively measuring the effects of changes in volume and timing of clinical experience on educational outcomes is a difficult but very important goal for future studies.

Unlike new patient evaluations, there was no significant change in PGY-2 bedside procedural experience after the transition to a 24-hour call schedule. We did not study the timing at which bedside procedures were performed in this or the previous study of the night-float system at our institution.2 In the only study to examine this to date—a single junior resident’s call log from a different institution—a significantly higher proportion of bedside procedures was performed during the daytime! At OHSU, PGY-2 residents took similar proportions of the nighttime call under the 24-hour and night-float call systems, possibly accounting for the unchanged procedural volumes between the two systems.

Transition to the 24-hour call system at OHSU was intended to improve the volume of operative procedural experience for PGY-2 residents. Under the night-float call schedule, PGY-2 residents were in the operating room for 2 weeks of each 6-week block and took day- and nighttime calls for the remaining 4 weeks. Under the 24-hour call schedule, operative experience was more frequent for PGY-2 residents and often included multiple days per week in the operating room. This was enabled by PGY-3 residents taking a greater share of the nighttime call, but unfortunately this came at the expense of their operative experience, with a decrease in potential operative days. However, a key advantage of the 24-hour call system is that both PGY-2 and PGY-3 residents have consistently distributed operative training. Robust evidence supports the effectiveness of distributed practice in motor skill acquisition.10,11 The magnitude of this beneficial effect depends on training context and task complexity,12 and it has never been directly studied in neurosurgical training. Even so, most studies of laparoscopic and microvascular anastomosis demonstrate greater proficiency and skill retention with spaced training sessions—similar to those now experienced by OHSU neurosurgery residents who work under the 24-hour call schedule.12–16 Appropriately distributing clinical practice experiences during neurosurgery training may similarly maximize training efficiency and effectiveness.

The call schedule alteration had effects beyond those directly related to resident workload and education. For example, the 24-hour schedule resulted in postcall weekdays that were free of clinical duties, allowing residents to rest, attend personal healthcare appointments, or partici-
pate in other wellness activities. Furthermore, the 24-hour call schedule was partially responsible for shifting PGY-4 residents to home call, thereby improving their work-life balance and allowing them to develop the skills necessary for this important clinical function that is central to independent practice.

Reducing the frequency of patient care handoffs improves care quality and reduces medical errors. Transition to a modified 24-hour call schedule, as reported here, reduced the frequency of handoffs from an average of 2 to 1.5 per day, while simultaneously necessitating increased cross-overage between services by PGY-3 residents who were uninvolved in the direct care of patients at the primary university service. The effects of these changes on patient care quality, if any, were not measured and are beyond the scope of the present study, but these are an important topic for additional research.

This study has several limitations. It is the product of a 4-year experience at a single academic center with a relatively small number of residents, limiting its generalizability. Resident well-being and satisfaction with either call schedule was not rigorously studied before or after the scheduling change. A daily quality-of-life survey was administered to all on-call residents after the transition to the 24-hour call system, but it was abandoned due to poor compliance and the lack of any comparison data from the night-float cohorts. The results from the ACGME Well-Being Surveys administered before and after the scheduling change suggest no significant impact on resident wellness, but these data were compiled across the entire resident cohort and subject to many other factors. We plan to investigate quality-of-life measures with greater scrutiny after future call schedule changes. Lastly, the COVID-19 pandemic affected our case volume and inpatient censuses in the fall of 2020, partially confounding comparisons with other years. However, PGY-2 residents from that year performed the same number of procedures and had higher case numbers than any year before, suggesting that the benefits of the curriculum design change persisted despite negative effects on clinical volume due to COVID-19.

Conclusions

Transitioning from a night-float to 24-hour call schedule reduced the volume of patient consultations by PGY-2 residents, but not their procedural experience. PGY-2 residents experienced an increase in operative procedural experience at the expense of PGY-3 residents under the 24-hour call schedule. These data may serve as a baseline by which to evaluate the impact of any future call schedule innovations. Future research should also investigate the impact of call schedule changes on patient care quality and educational outcomes.

Acknowledgments

We thank Michael McGehee for his laborious vetting of departmental records and Dr. Thomas Sutton for his statistical advice.

References


Disclosures

The authors report no conflict of interest concerning the materi-
als or methods used in this study or the findings specified in this paper.

**Author Contributions**
Conception and design: Selden, Bowden, Siler, Mazur-Hart, Munger, Ross, Rothbaum, Han, Wright, Orina, Winer. Acquisition of data: Bowden, Siler, Shahin, Mazur-Hart, Munger, Ross, O’Neill, Nerison, Rothbaum. Analysis and interpretation of data: Selden, Bowden, Siler, Shahin, Mazur-Hart, Munger, Ross, O’Neill, Han, Wright, Orina, Winer. Drafting the article: Bowden, Siler, Nerison, Orina. Critically revising the article: Selden, Bowden, Shahin, Mazur-Hart, Ross, Han, Wright, Orina, Winer. Reviewed submitted version of manuscript: all authors. Statistical analysis: Bowden, Siler, Munger, O’Neill. Administrative/technical/material support: Bowden. Study supervision: Bowden.

**Supplemental Information**
**Previous Presentations**
Some findings from this study were presented virtually in the form of an electronic poster at the American Association of Neurological Surgeons Annual Meeting, Orlando, FL, August 2021.

**Correspondence**
Nathan R. Selden: Oregon Health & Science University, Portland, OR. seldenn@ohsu.edu.