The Influence of a Night-Float Call System on the Incidence of Unintentional Dural Puncture: A Retrospective Impact Study

Kelly G. Elterman, MD, Lawrence C. Tsen, MD, Chuan-Chin Huang, ScD, and Michaela K. Farber, MD, MS

BACKGROUND: Resident night-float systems have been associated with adverse outcomes. We hypothesized that an obstetric anesthesia night float would increase the incidence of unintentional dural punctures.

METHODS: The July to December incidence of unintentional dural puncture before (control group) and with night float (night-float group) was compared retrospectively. The incidence of unintentional dural puncture by day of week and trainee level was evaluated.

RESULTS: The unintentional dural puncture rate of control group was 0.73% (20 of 2758) vs 1.49% (39 of 2612) in the night-float group (P = 0.008; relative risk = 2.06; 95% confidence interval = 1.23–3.74). The proportion of unintentional dural punctures attributed to clinical anesthesia-1 residents in the night-float and control groups was 28.2% (11 of 39) and 5.0% (1 of 20), respectively (relative risk = 5.64; 95% confidence interval = 1.07–152; P = 0.044).

CONCLUSIONS: Implementation of night float increased the incidence of unintentional dural puncture. (Anesth Analg 2015;120:1095–8)

The Accreditation Council on Graduate Medical Education instituted resident duty-hour restrictions in 2003, limiting work hours and call frequency. Subsequent studies associated duty hour restrictions with increased sleep, decreased attention failure, and reduced medical errors. Importantly, resident education and clinical training were not comprised.

In 2007, the Institute of Medicine recommended that work hours be restricted to 16 hours per shift for first-year residents. The Accreditation Council on Graduate Medical Education adopted the recommendations in July 2011. This recommendation had significant workforce implications, prompting academic programs to adopt night-float systems. Although initially observed to improve quality of care, some studies suggest that duty-hour restrictions have been associated with worse outcomes.

Our night-float system was instituted in July 2013. It consisted of 5 consecutive (Sunday to Thursday) overnight shifts of 13 hours’ duration, staffed by residents assigned to obstetric anesthesia and main operating room rotations. Residents new to the obstetric anesthesia rotation were oriented with daytime lectures, demonstrations, and direct attending supervision of neuraxial procedures for several days before starting night float. Residents providing night-float coverage while assigned to other rotations were required to have completed at least 1 month-long obstetric anesthesia rotation. Previously, only residents from the obstetric anesthesia monthly rotation took overnight shifts, which were of 16 to 24 hours’ duration.

This retrospective study aimed to assess whether our night-float system was associated with an increased incidence of unintentional dural punctures compared with the previous system without night float. We also sought to determine whether the incidence of unintentional dural punctures increased with each sequential shift during the night-float week.

METHODS
After obtaining approval from the IRB and a waiver of patient and resident informed consent, we identified all obstetric patients undergoing epidural techniques, including combined spinal-epidural techniques, from our electronic medical records. Patients who sustained an unintentional dural puncture were identified through an electronic postpartum database. The diagnosis was verified through medical record review. Unintentional dural puncture was defined as either a frank “wet tap” with cerebrospinal fluid visualized during attempted epidural technique or an intrathecal catheter identified by cerebrospinal fluid aspiration or significantly lower analgesia requirements defined as equal to or less than one-third the standard dose. The unintentional dural puncture rate (number of unintentional dural punctures divided by total number of neuraxial procedures) for a 6-month period before (July to December 2012; control group) and after (July to December 2013; night-float group) institution of night float was compared by month. Further validation of the control group was sought by the examination of the monthly incidence of unintentional dural punctures during the same 6-month period in 3 preceding years. The presence of attending anesthesiologists during the neuraxial procedures did not change during this time.

All occurrences of dural puncture, during both day and night, were recorded. Day was defined as 7:01 AM to 6:00 PM, and night was defined as 6:01 PM to 7:00 AM. The
faculty/resident ratio during both day and night did not change, and residents new to the obstetric anesthesia service were not assigned night shifts until they had completed the first week of their month-long rotation. The primary predictor was cohort before and after implementation of the night-float system. Secondary predictors included clinician experience, date, day of the week, and time of the neuraxial procedure, all of which are recorded on our labor analgesia records. Data were analyzed using the Fisher exact tests. Confidence intervals (CIs) were calculated by a bootstrap method in the R procedure risk ratio. Statistical significance was defined as \( P < 0.05 \). All analyses were performed using package “epitools” in R software (version 0.5–7, September 30, 2012; http://medepi.com/epitools/).

**RESULTS**

A total of 2758 and 2612 techniques were performed in the control and night-float groups, respectively. Twenty unintentional dural punctures occurred in the control group (rate of 0.73%) compared with 39 in the night-float group (rate of 1.49%; relative risk = 2.059; 95% CI = 1.23–3.74; \( P = 0.008 \); Fig. 1). Assessment of placement by level of experience revealed that clinical anesthesia (CA)-1 residents in the night-float group performed 40% more epidural placements than those in the control group (14% in the night-float group versus 10% in the control group; \( P = 0.0002 \)). Conversely, fellows in the night-float group performed 50% fewer epidural placements than those in the control group (14.5% in the control group versus 7.8% in the night-float group; \( P \leq 0.0001 \)). Placements performed by clinicians at all other levels of experienced were not different (\( P = 0.962, 0.591, \) and 0.762 for CA-2 residents, CA-3 residents, and attendings and/or certified registered nurse anesthetists, respectively; Table 1).

P-chart analysis of the incidence of unintentional dural punctures by month during the study periods revealed minimal variation in the month-to-month incidence of unintentional dural punctures (control range 1–5 per month, night-float range of 4–9 per month) and for unintentional dural puncture by CA-1 residents (control range 0–1 per month, night-float range 0–4 per month). The unintentional dural puncture rate during the same period in 3 preceding years was 0.72% (Fig. 1).

In both the control and the night-float groups, the incidence of unintentional dural punctures did not vary significantly by day of week. Within the night-float group, the incidence of unintentional dural punctures did not increase with each sequential shift, Sunday through Thursday (Fig. 2). In both the groups, the incidence of unintentional dural puncture occurring at night compared with that at day was not different (control [70%] versus night float [69%]; \( P = 1.0 \); Table 2).

The proportion of unintentional dural punctures attributed to CA-1 residents between the control and the night-float periods was significantly different (night float 11 of 39 [28.2%], control 1 of 20 [5.0%]; relative risk = 5.64; 95% CI = 1.07–152; \( P = 0.044 \); Fig. 3). By contrast, despite a decrease in total number of epidural placements performed by fellows, no differences were observed in the proportion of unintentional dural punctures by CA-2 and CA-3 residents, fellows, and attendings (\( P = 0.62, 0.24, 0.15, 0.44 \), respectively).

**DISCUSSION**

The initiation of a night-float system resulted in an increase in the incidence of unintentional dural punctures when compared with our previous call system. The incidence of unintentional dural punctures did not increase with each sequential night-float shift; however, the number of unintentional dural punctures attributed to CA-1 residents was significantly different. Although the schedule change

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**Table 1. Number of Neuraxial Anesthetic Procedures Performed by Residents, Fellows, and Faculty in Control and Night-Float Groups, by Level of Experience**

<table>
<thead>
<tr>
<th>Level of experience</th>
<th>2012 Control (%)</th>
<th>2013 Night float (%)</th>
<th>( P ) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA-1</td>
<td>300 (10.9)</td>
<td>372 (14.2)</td>
<td>0.0002</td>
</tr>
<tr>
<td>CA-2</td>
<td>814 (29.5)</td>
<td>805 (30.8)</td>
<td>0.962</td>
</tr>
<tr>
<td>CA-3</td>
<td>1012 (36.7)</td>
<td>977 (37.4)</td>
<td>0.591</td>
</tr>
<tr>
<td>Fellow</td>
<td>401 (14.5)</td>
<td>205 (7.8)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Attending/CRNA</td>
<td>191 (6.9)</td>
<td>169 (6.5)</td>
<td>0.762</td>
</tr>
<tr>
<td>Experience level unknown</td>
<td>40 (1.5)</td>
<td>84 (3.2)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Total placements</td>
<td>2758</td>
<td>2612</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

There was no difference in the distribution between time periods (\( P = 1.0 \)). CA = clinical anesthesia year; CRNA = certified registered nurse anesthetist.
Night-Float System Effect on Unintentional Dural Puncture

resulted in a greater number of epidural placements by CA-1 residents, the percentage increase in the incidence of unintentional dural puncture among CA-1 residents was disproportionately greater. This finding suggests that although a night-float system may be beneficial in providing CA-1 residents with more experience, it can be detrimental to residents and patients.

Our results are consistent with studies in the fields of internal medicine and surgery in which authors demonstrate that night-float systems increase sleepiness and decrease the quality of care, resident education, and clinical experience.1-11 Although the number of dural punctures did not differ between night and day shifts, the increase in the overall incidence of unintentional dural punctures suggests that scheduling changes can affect learning and performance of complex technical skills.

Some authors have found that acute sleep deprivation after a 24-hour shift affects subjective alertness but not performance of technical skills.12 Others have shown that sleep deprivation does increase the difficulty of technical tasks.13 Cumulative sleep deficiency has been associated with deterioration in neurobehavioral performance. Anderson et al.14 observed that repeated exposure to call shifts every 3 days for 3 weeks resulted in decreased mean response time and increased numbers of lapses, with the greatest deterioration in the penultimate and ultimate call shifts. The epidural technique is among the most difficult skills to master.15 It is possible that less-experienced anesthesiologists may miss technical subtleties when subjected to chronic sleep deprivation.

Attending anesthesiologists directly observe epidural procedures at our institution, including the study periods. No changes in attending call structure occurred. A notable difference in the composition of the night-float team, however, was the presence of residents from main operating room rotations. These residents were required to have at least 1 month of obstetric anesthesia experience, although many months may have elapsed since that exposure. This lack of clinical consistency, together with cumulative fatigue, may have contributed to the increase in the unintentional dural puncture incidence.

We acknowledge the limitations of this study inherent to its retrospective design, including reliance on accuracy of documentation and selection bias with regard to capturing all patients having an unintentional dural puncture. To address accuracy, we obtained patient lists from our electronic medical record and cross-referenced this list with another maintained by our department to ensure that our numbers of unintentional dural puncture and total techniques were correct. To address selection bias, we chose the less-subjective inclusion criterion of dural puncture rather than postdural puncture headache. Another limitation is that our data collection period for the night-float group was only 6 months. To address this, we validated the consistency of the control group incidence over several years. Evaluation of data over a longer time after initiation of night float will further strengthen the analysis.

A potential confounder in this study is the introduction of residents from the general operating room rotation into the obstetric anesthesia call pool. This study lacks the power to distinguish unintentional dural puncture incidence between these residents and those rotating on the obstetric service at the time of the dural puncture. Future research may determine whether residents who take obstetric anesthesia call while not on the obstetric anesthesia rotation have a higher incidence of unintentional dural puncture compared with their obstetric anesthesia-rotating counterparts.

To our knowledge, our study is the first to demonstrate that a night-float call system can increase the risk of unintentional dural punctures. Future studies are warranted to validate this phenomenon, elucidate mechanisms to counteract fatigue-related complications, and improve patient safety. Because postdural puncture headache can significantly impair a patient’s quality of life postpartum, all efforts must be made to minimize its occurrence, including mitigating risks of unintentional dural puncture.

Table 2. Number of Unintentional Dural Punctures Occurring in Total and at Night in the Control and Night-Float Groups, by Level of Experience

<table>
<thead>
<tr>
<th>Level of experience</th>
<th>2012 Control Total (%)</th>
<th>2012 Control Overnight (%)</th>
<th>2013 Night float Total (%)</th>
<th>2013 Night float Overnight (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA-1</td>
<td>1 (5)</td>
<td>1 (7)</td>
<td>11 (28)</td>
<td>7 (26)</td>
</tr>
<tr>
<td>CA-2</td>
<td>7 (35)</td>
<td>4 (29)</td>
<td>11 (28)</td>
<td>8 (30)</td>
</tr>
<tr>
<td>CA-3</td>
<td>8 (40)</td>
<td>6 (46)</td>
<td>13 (33)</td>
<td>10 (37)</td>
</tr>
<tr>
<td>Fellow</td>
<td>2 (10)</td>
<td>2 (14)</td>
<td>2 (5)</td>
<td>2 (7)</td>
</tr>
<tr>
<td>Attending/CRNA</td>
<td>2 (10)</td>
<td>1 (7)</td>
<td>2 (5)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Total unintentional dural punctures</td>
<td>20 (100)</td>
<td>14 (100)</td>
<td>39 (100)</td>
<td>27 (100)</td>
</tr>
</tbody>
</table>

There was no difference in the distribution between time periods or day and night shifts (P = 1.0).

CA = clinical anesthesia year; CRNA = certified registered nurse anesthetist.
DISCLOSURES

Name: Kelly G. Elterman, MD.
Contribution: This author participated in the study design, data collection, data analysis, and manuscript preparation.
Attestation: Kelly G. Elterman approved the final manuscript and attests to the integrity of the original data and analysis reported in this manuscript, and is the archival author.

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Contribution: This author participated in the study design, data analysis, and manuscript preparation.
Attestation: Lawrence C. Tsen approved the final manuscript and attests to the integrity of the original data and analysis reported in this manuscript.

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Attestation: Lawrence C. Tsen approved the final manuscript, data analysis, and attests to the integrity of the original data and analysis reported in this manuscript.

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REFERENCES