

Sleep Deprivation Leads to Medication Error During Spinal Epidural Anesthesia

August 30, 2023

Bohringer C, Osborne R. Sleep Deprivation Leads to Medication Error During Spinal Epidural Anesthesia. PSNet [internet]. 2023.

<https://psnet.ahrq.gov/web-mm/sleep-deprivation-leads-medication-error-during-spinal-epidural-anesthesia>

The Case

A 27-year-old primigravid woman with a history of exercise-induced asthma presented to a labor and delivery unit at an estimated gestational age of 37 4/7 weeks for induction of labor due to gestational hypertension. She reported intolerable labor pain and requested neuraxial analgesia. The anesthesia care provider, who was 32 hours into a 48-hour call shift and had only had 3 hours of sleep in the prior 32 hours, performed L3-4 combined spinal epidural analgesia for labor and delivery. The intended anesthesia included 5 micrograms of intrathecal sufentanil and an epidural test dose of 4 ml 1.5% lidocaine with 1:200,000 epinephrine. The patient did not experience rapid onset of analgesia as expected and required a 6 ml bolus of 0.2% ropivacaine and 3 ml of 1% lidocaine over 20 minutes to achieve adequate analgesia.

About one hour later, the anesthesia care provider's audit of the controlled substance box found that this patient had been given intrathecal morphine 1 mg instead of 5 micrograms sufentanil. This error resulted in slower onset of analgesia, significant pruritus requiring intravenous naloxone infusion, prolonged respiratory monitoring for 24 hours after intrathecal morphine injection, and potential neurological injury due to intrathecal administration of a product that was not preservative-free. Analgesia was successfully maintained with patient-controlled epidural analgesia of 0.2% ropivacaine with 2 micrograms/ml fentanyl for the duration of labor and delivery, and no further complications were reported.

The Commentary

By Christian Bohringer, MBBS, and Ryan Osborne, MD

This case describes a 27-year-old primigravid woman who requested neuraxial anesthesia during induction of labor. The anesthesia care provider, who was sleep deprived near the end of a 48-hour call shift (during which they only slept for 3 hours), performed the procedure successfully but injected an analgesic drug that was not appropriate for this clinical indication. As a result, the patient suffered slower onset of analgesia

and significant pruritis, and required more prolonged monitoring, than if she had received the correct medication. This case provides an opportunity to discuss the implications of sleep deprivation, especially in high-risk settings such as anesthesia care and obstetric care, and approaches to improve patient safety during labor and delivery.

Background

Sleep deprivation impairs cognitive function and adversely affects performance in many occupations. Motor vehicle crashes with a culpable driver are significantly more common following periods of sleep deprivation.¹ A multidisciplinary expert panel convened by the National Sleep Foundation conducted a systematic review and concluded that sleep-deprived motor vehicle operators are unfit to drive.² Truck drivers in many countries must now comply with strict government regulations requiring them to present their logbooks to authorities to demonstrate compliance with mandatory rest periods. Under these regulations, truck drivers get more sleep than before,³ which may decrease their high-risk consumption of beverages containing concentrated caffeine or amphetamines,^{4,5,6} or cocaine, during long haul trips.⁷

Amphetamines and other sympathomimetic drugs have also been used in the United States military to combat the effects of sleep deprivation, sustaining performance when sleep is not possible due to combat conditions.^{8,9} While the use of amphetamines did enhance cockpit performance of helicopter pilots in operation “Desert Storm” in Iraq, “friendly fire” deaths were directly attributed to these drugs by the personnel involved.^{10,11} Sympathomimetic drugs can effectively mask drowsiness from sleep deprivation, but they can also lead staff to commit errors because they impair judgment. When stimulants wear off, users experience rebound fatigue with extreme somnolence, which has been shown to increase the risk of traffic crashes.¹²

Lack of sleep has also been increasingly recognized as a [contributing factor](#) for adverse events in health care. Sleep deprivation in resident physicians in hospitals has been associated with impaired psychomotor skills and cognitive performance, similar to the effect of alcohol, as well as increased risk of needlestick injuries.¹³ Sleep deprived residents have higher levels of inflammatory biomarkers and display greater impulsivity, slower cognitive processing, and impaired executive function.¹⁴ On psychomotor testing, at least 4 hours of sleep were needed to reduce attentional failures among post-call intensive care unit (ICU) residents.¹⁵ A randomized controlled trial of eliminating extended-duration shifts (≥24 h) for interns in ICUs demonstrated [significant reductions](#) in serious medical errors, including medication-related and diagnostic errors, and attentional failures documented by polysomnogram. In surveys, resident physicians also reported being more likely to commit fatigue-related significant medical errors and to cause preventable adverse events during months in which they worked [extended shifts](#).

The Accreditation Council for Graduate Medical Education (ACGME) introduced work hour limitations (e.g., 80 hours per week, 30 hours per shift) for resident physicians in 2003. At least among pediatric residents, the total number of hours of work and sleep, the overall medication error rate, and the self-reported medical error rate [did not change after implementation](#). Three systematic reviews found inconsistent effects of the 2003 reform on mortality and complications, although resident burnout and/or mood improved in most studies.¹⁶⁻¹⁸ The ACGME responded to increasing evidence of the adverse effect of shift duration^{19,20} by [restricting shift length to 16 hours for first-year residents in 2011](#); this change was associated with

decreased risk of motor vehicle crash involvement and needlestick injury,²¹ but no change in [patient experience](#) or [30-day mortality or readmissions](#). Two subsequent cluster randomized trials of more flexible shift duration policies showed that flexible policies were non-inferior to the 16-hour policy with respect to mortality, readmissions, complications, unplanned reoperations, and other adverse patient outcomes.^{22,23} [Altogether](#), these studies suggest that long shifts impair trainee performance, but shorter trainee shifts burden other team members, and systems with appropriate supervision are able to intercept or mitigate the impact of any resulting errors.

It is not as widely appreciated that sleep deprivation also affects senior physicians and nursing staff,^{24,25} and has been reported to be associated with physician burnout.^{26,27} Attending physicians are frequently expected to work long shifts, just like trainees, but their work hours are not regulated, and they have no direct supervision to intercept or mitigate the impact of medical errors. The [anesthesiologist](#) in this case worked for 32 hours straight with only a 3-hour rest period when the error occurred. After the error, they were on duty for another 16 hours to complete the 48-hour shift.

At the moment, there is a significant shortage of anesthesia care providers in many countries around the world. This shortage undermines efforts by health care systems to reduce the length of shifts worked by anesthesiologists. The planned reduction in call shift duration from 26 hours to 18 hours by the Israeli Health Ministry, for example, has been estimated to remove 155 anesthesiologists from the daytime workforce. These providers will then no longer be available to staff elective surgery operating rooms during the day,²⁸ limiting patients' access to surgical care unless the pool of clinicians can be expanded.

Anesthesiology is a high-stakes procedural specialty, in which seemingly minor slip-ups in attention can have devastating repercussions for the patient. The work is at times monotonous and repetitive. Physicians working in [procedural specialties](#) should make every effort to be well rested before they start their work. If feelings of exhaustion set in towards the end of the shift it may be prudent for clinicians to employ simpler, less complex management strategies that are less likely to lead to treatment errors and adverse events for patients.

An injection into the cerebrospinal fluid within the subarachnoid space is a sterile procedure. Great care needs to be taken to maintain sterile technique to avoid inadvertently injecting microorganisms into the cerebrospinal fluid, which could lead to meningitis. The syringe used for spinal injection is usually not labelled because medications are drawn up on the sterile field and sterile pens are not readily available in many operating rooms. Special attention is therefore necessary to prevent medication errors. Saline may be inadvertently misidentified as local anesthetic solution, leading to failure of the spinal block. An incorrect medication can also be added to the local anesthetic, as in this case. If an assistant opens the ampule, the anesthesiologist should personally read the label to make sure the correct medication is injected. Mixing fewer drugs together or using a local anesthetic alone for spinal injection reduces the chance of error. The provenance of the medication to be needs to be always maintained.

Pregnant patients in active labor often report extreme pain when the spinal/epidural is requested, which puts anesthesia care providers under significant time pressure. This emotionally charged atmosphere when the parturient is crying or writhing in pain, combined with the need for rapid completion of the spinal/epidural injection, increases the potential for medication errors. Whenever possible, epidural

analgesia should be requested early before the parturient is in extreme pain. The epidural placement can then occur at a regular pace with optimal positioning and full cooperation from the patient.

Approaches to Improving Patient Safety

Avoid and discourage working while tired

Clinicians should avoid working while they are tired, especially if they are employed in a high-stakes procedural specialty. In anesthesia, an error as simple as forgetting to flick a switch or to open a valve can end up being fatal for the patient. Every effort should therefore be made by anesthesia clinicians to be well rested before they start shifts in the operating room.

Provide regular breaks to clinical staff

Regular breaks should be provided for clinicians during the day analogous to rest stops for truck drivers. Walking out of the operating room resets the mind and helps to prevent lapses in attention after returning to the operating room. Regular breaks allow staff to continue to provide vigilant care even when they must work long shifts.²⁹ Breaks positively affect patient outcome as clinicians providing temporary relief may identify a problem that was overlooked by the primary clinician.³⁰ Microbreaks with targeted stretching exercises have also been shown to enhance physical function and mental focus in surgeons without increasing operative time.³¹

Stop requiring or encourage clinicians to work excessively long shifts

Based on the medical education literature summarized earlier, shift duration generally should not exceed 12-16 hours when continuous alertness is essential. Errors as well as needle stick injuries increased threefold when nurses worked shifts exceeding 12 hours.^{32,33} The current shortage of anesthesia care providers has put a lot of pressure on health care systems to increase shift length and the number of hours worked per week, despite concerns about burnout and patient safety. Nationwide campaigns to increase the number of anesthesiology residents and student nurse anesthetists are currently underway to address the provider shortfall.^{34,35}

Provide convenient access to call rooms for napping on long shifts

Regular breaks can help to mitigate the adverse effect of long shifts. Call rooms should be provided for staff on overnight shifts so that they can lie down and relax while they wait for their pager to go off again. Quiet rooms with bean bags or cots for napping are commonly utilized in the technology industry. Napping has also been found to be beneficial for professional athletes and pilots in the airline industry.^{36,37} When the operating rooms are quiet overnight, staff should take the opportunity to rest so that they feel restored and energetic when the next emergency rolls through the door.

Encourage an institutional culture that values rest

A culture of taking deliberate breaks during long shifts, with or without naps, is also important for maintaining worker health. A study in Korean janitorial shift workers found that long working hours increased the number of reported health problems only when insufficient breaks were provided.³⁸ Providing

adequate breaks improves morale and may reduce occupational injuries.³⁹ When staff have completed a long shift the previous day, they should be allowed to go home early the next day so that they can catch up on their sleep deficit.

Avoid and discourage excessive use of stimulants

Clinicians should not try to overcome a sleep deficit using excessive doses of caffeine. Some caffeinated beverages in common use today are highly concentrated and can induce transient hypertension and possibly tachyarrhythmias in susceptible individuals.^{40,41} Stimulants effectively mask drowsiness but can impair clinical judgement. Using amphetamines that are still advocated for short term use in the military during combat conditions is inappropriate in the health care setting, where clinicians must maintain their work performance over several decades. Sympathomimetic drugs also have significant potential for inducing addiction.

Simplify the treatment when tired or under time pressure

When clinicians are tired or pressured for time, it may be prudent to simplify the care to avoid errors. If this patient had received a spinal injection with local anesthetic alone, she would have experienced good pain relief for a relatively brief procedure without the adverse effect of an incorrectly administered opioid.

Carefully check the label on all ampules

The anesthesiologist is usually wearing sterile gloves when drawing up the spinal syringe and an assistant opens the vials. It is very important that the anesthesiologist personally reads the label of every ampule because it is their professional responsibility to ensure that the correct medication is injected into the cerebrospinal fluid. The [label of every ampule](#) should display the name and the concentration of the drug in lettering large enough to be readable.

Vigilantly monitor respiration and hemodynamics after a spinal/epidural

The patient in this case was carefully monitored. The error was fortunately discovered before the patient stopped breathing. The onset of respiratory depression after an intrathecal morphine injection usually occurs several hours later, at a time when the patient may no longer be under constant monitoring.⁴² A naloxone infusion was started to treat pruritus and to prevent respiratory arrest. In this case, it would have been prudent to remove the fentanyl from the standard epidural solution and infuse the local anesthetic drug ropivacaine on its own without adding fentanyl to the epidural solution.

Conclusion

This patient experienced pruritus and required a naloxone infusion in a carefully monitored environment as a result of the unintended spinal injection of morphine. The problem of sleep deprivation in health care workers has been extensively studied, but more among trainees who work in a supervised team environment than among licensed clinicians who are responsible for managing patients in very high-risk situations. Expanding the pool of clinicians available to staff hospitals, and improving the culture to support shorter shifts, regular breaks, and napping when appropriate, will hopefully allow us to make the same kind of progress in fatigue-related safety that has been made in transportation industries.

Take-Home Points

- Staff should be well rested before coming to work.
- Regular breaks are an important safety measure.
- Excessively long shifts should be avoided.
- Call rooms should be provided for overnight shifts to encourage quiet time and napping.
- Epidural catheters should be placed before pain becomes unbearable, whenever possible.
- Labels on ampules need to be checked carefully by two individuals, including the responsible clinician, before the medication is administered.

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This project was funded under contract number 75Q80119C00004 from the Agency for Healthcare Research and Quality (AHRQ), U.S. Department of Health and Human Services. The authors are solely responsible for this report's contents, findings, and conclusions, which do not necessarily represent the views of AHRQ. Readers should not interpret any statement in this report as an official position of AHRQ or of the U.S. Department of Health and Human Services. None of the authors has any affiliation or financial involvement that conflicts with the material presented in this report. [View AHRQ Disclaimers](#)