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Anesthesia care transitions and risk of postoperative complications

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Hyder JA, Bohman K, Kor DJ, Subramanian A, Bittner EA, Narr BJ, Cima RR, Montori VM

Abstract

Purpose The purpose of this study was to determine if an increase in the number of anesthesiologist and anesthesia provider handoffs was associated with increased postoperative complications.

Background Effective provider handoffs are essential to minimizing complications. Anesthesia care teams are a common delivery model in the United States. With this practice model, there may be multiple anesthesia provider handoffs; both between anesthesiologists and among nurse anesthetists, during a single case. If handoffs are ineffective, there is the potential that critical information may not be passed on, and this may contribute to complications. Additionally, multiple anesthesia provider involvement in a case may expose patients to cross-contamination, increasing the risk of nosocomial infections. Unfortunately, there is limited empirical evidence related to whether or not multiple anesthesia provider handoffs impact postoperative complications.

Methodology This was a retrospective review of care transitions (patient handoffs) between attending anesthesiologists and subsequent postoperative complications. The secondary aim was to examine the number of care transitions (patient handoffs) between in-room anesthesia providers and postoperative complications. These providers were either nurse anesthetists or anesthesia residents. The investigators also examined the effect of “high-provider anesthesia teams” (two or more attending anesthesiologists and three or more in-room anesthesia providers) on complications. With high-provider teams this would mean there had been at least one handoff between attending anesthesiologists and at least two handoffs among in-room providers. Care transitions for CRNAs or residents were primarily attributed to breaks or appointments.

In the study facility all care was provided in an anesthesia care team model, with an attending anesthesiologist medically directing up to two to three CRNAs and/or residents who provided direct anesthesia care. No standardized handoff protocol was used at this facility. Attending anesthesiologists and CRNAs typically worked within one specialty area. Very little staff turnover occurred at the facility and no locum tenens CRNAs were used.

In their analysis, investigators controlled for case duration, contaminated or dirty wounds, ASA physical status, and time of day (cases ending after 1700).

Postoperative complications were defined as a composite variable with the presence of at least one of these 30-day major postoperative complications.
reported in the database from which the study data was drawn:

• death within 30 days of surgery
• acute renal failure
• bleeding requiring transfusion of 4 or more units of red blood cells within 72 hours
• cardiac arrest requiring CPR
• coma of 24 hours or longer
• myocardial infarction
• unplanned intubation
• ventilator use for ≥48 hours
• pneumonia
• stroke
• wound disruption
• deep or organ-space surgical-site infection
• superficial surgical-site infection
• sepsis
• septic shock
• systemic inflammatory response syndrome

Result There were 927 elective colectomy surgeries included in this analysis. Within this sample, 71 patients experienced at least one major complication (complication rate 7.7%, 105 total complications). Seven patients died (0.8%). Most complications were infection related. They included superficial and deep surgical site infections, pneumonia, sepsis, and septic shock. Other complications were less common. Only one patient experienced an intraoperative complication (non-infection related).

Patients who experienced a complication were more likely than those who did not experience a postoperative complication to have the following:

• contaminated or dirty wounds (18% vs. 6%, P = 0.0002)
• ASA III or IV (56% vs. 37%, P = 0.001)
• preoperative dyspnea (34% vs. 15%, P < 0.0001)
• congestive heart failure (2.8% vs. 0.2%, P = 0.03)

No differences were found in age, body mass index, gender, independent functional status, preoperative dialysis, or surgery type. Almost all surgeries were performed by a colon surgeon.

In 57% of cases there were no handoffs between attending anesthesiologists. In 31% of cases there was one anesthesiologist handoff. In 12% of cases there were three or more handoffs. Only 2.2% of cases included a single anesthesiologist and one CRNA or resident physician. Only 3.5% of cases included only one CRNA or resident physician.

The highest rates of postoperative complications were found in the following circumstances:

• ASA III or IV patients (OR = 2)
• dirty or contaminated wounds (OR = 3)
• >1 handoff between attending anesthesiologists (OR = 1.44)
• >2 in-room anesthesia provider handoffs (OR = 1.39)
• high-provider teams (OR = 2.04; Figure 1)

These associations were significant even after adjustment for age, surgical duration, cases ending after 1700 h, blood loss, and greater surgical complexity. Associations persisted even when cases completing after 1700 h and dirty or contaminated wounds were excluded from the analysis.

Conclusion Elective colorectal surgeries that had >1 handoff between attending anesthesiologists and > 2 handoffs between in-room providers were independently associated with higher rates of postoperative complications, especially those that were infection related. These findings suggest that frequent handoffs among anesthesia providers may contribute to postoperative complications. Future research should explore the impact of handoff checklists on complications.
Comment

I have witnessed firsthand how a lack of a thorough handoff between anesthesia providers contributed to a bad outcome. I recall a case years ago of a perioperative death that may have been attributed, at least in part, to a lack of communication on the amount of blood loss and critical lab values. I personally hate turning challenging cases over and encourage my students to stick around to finish out cases. There is something to be said about having the “corporate knowledge” of a case, and even despite the best of patient handoffs, bad things can still happen.

The results of this study are not surprising to me. The results suggest more frequent turnovers, especially between attending anesthesiologists working in an anesthesia care team model, were associated with higher rates of postoperative complications. More frequent complications were also seen with more frequent CRNA or resident handoffs. These results may not be applicable at other practice settings or facilities; for example, non-medically directed practices or non-academic settings; practices which use handoff checklists.

The real strength of this study was the inclusion of only elective colectomy surgeries at a single institution. A limitation is that the investigators did not report the actual rates of complications; they just stated that infection-related complications predominated. The highest complication rates were seen in patients with dirty or contaminated wounds. Therefore, it is not surprising to see that infection-related complications were the most common outcome. Also it is possible that more frequent in-room and attending anesthesiologist handoffs may lead to greater cross-contamination, and this could have contributed to the higher rate of infection-related complications.

So what can we do? I think having a standardized handoff checklist may be helpful. Also I think frequent hand washing, wiping anything you touch down with sanitizing wipes, and when possible
minimizing handoffs in challenging cases may help reduce complications.

**Dennis Spence, PhD, CRNA**

The views expressed in this article are those of the author and do not reflect official policy or position of the Department of the Navy, the Department of Defense, the Uniformed Services University of the Health Sciences, or the United States Government.
Regional Anesthesia

Does Spinal block through tattooed skin cause histological changes in nervous tissue and meninges?

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Abstract

Purpose The purpose of this study was to look for tattoo ink in regional anesthesia needles or spinal tissue. If found, the study would examine the effects of tattoo ink on neural tissue in an attempt to identify any harmful effects.

Background Tattoos on and around the lumbar area of the back have become more common in recent years. Anesthesia providers have long asked whether or not it is safe to place a spinal or epidural needle through tattooed skin. A common concern is that passing a hollow needle through a tattoo, even with a stylet in place, may entrap tissue containing tattoo ink and deposit the ink near the dura or even past the blood-brain barrier. Needles as small as the 25-gauge Quincke and Whitacre have been shown to produce tissue coring. A cadaver study demonstrated the presence of a skin surface dye on 27-gauge Quincke, Sprotte, and Whitacre needles used for spinal injections.

Unlike other substances intended for application onto or into the body (e.g. cosmetics), tattoo inks are not regulated by the government. Their chemical composition is unknown. Often, tattoo ink has been produced as industrial pigments and not intended by the manufacturer for use in humans. No reports of complications following the placement of spinal or epidural needles through a tattoo have yet been published. Nevertheless, tattoo ink has been shown to contain hazardous, toxic, or carcinogenic compounds. Even if biologically inactive, tattoo ink could still induce arachnoiditis. Red tattoo ink is the color most commonly associated with skin irritation in persons who have received tattoos.

Methodology This was a prospective, randomized, placebo-controlled animal study. Prior to the insertion of block needles, animals in the Puncture Group and the Injection Group had their fur shaved off over the S1-2 area posteriorly. A working tattoo artist applied a 2 cm diameter red tattoo while the animals were anesthetized. The animals were then observed for 30 days.

All spinal needle insertions were performed in anesthetized adult rabbits with a 22-gauge Quincke needle. Proper needle placement was observed using ultrasound. If more than one attempt was needed to place the needle, the animal was removed from the study. Rabbits were randomized into one of three groups, 12 per group. Groups were as follows:
• **Control Group** - Needle placed through clear skin. Normal saline injected in subarachnoid space.
• **Puncture Group** - Needle placed through tattooed skin up to ligamentum flavum. No saline injected.
• **Injection Group** - Needle placed through tattooed skin. Normal saline injected in subarachnoid space.

In the **Control Group** the meninges and neural tissue were examined for any effects of normal saline injection through skin without a tattoo (see method following Injection Group). In the **Puncture Group** the needle itself was examined for tissue coring and for the presence of tattoo ink. After inserting the spinal needle to the level of the ligamentum flavum, it was withdrawn, the stylet removed, and saline injected through the needle onto a histologic slide. A smear was prepared with dye that adheres to tissue, thus facilitating the identification of any tissue that might have remained in the needle. In the **Injection Group**, the meninges and neural tissue were examined for the presence of skin tissue cores containing tattoo ink. After normal saline injection into the subarachnoid space in both the Control and Injection groups, rabbits were rested for six months and observed. This time allowed complications from injection of tattoo ink to develop if the ink was present. After six months animals were killed. The meninges and spinal cord were examined histologically. Two histologists familiar with the tissue effects of neurotoxicity independently examined the samples.

**Result** Animals in the Placebo Group weighed more than animals in either of the experimental groups. Otherwise the groups were demographically similar. During the six month observation period following puncture with the spinal needle, no animals exhibited changes in motor function or nociception.

Histologic examination of the meninges and neural tissue were normal in the Control Group. In the Puncture Group smears from saline flushed through the needle after passage through tattooed skin and removal revealed microscopic red tattoo ink particles. Histologic examination of the meninges and neural tissue in the Injection Group showed meningeal injury in 4 of 12 animals in the group.

**Conclusion** Spinal needles passed through tattooed skin contain tattoo ink particles and transport these particles to deeper tissues. The stylet did not prevent tattoo ink from entering the spinal needle. Subarachnoid injections through spinal needles passed through tattooed skin resulted in histologic damage visible six months later in some animals. A lack of published case studies reporting complications following neuraxial anesthesia through tattooed skin should not be misconstrued as indicating the safety of this practice.

**Comment** Having practiced and taught regional anesthesia regularly throughout most of my career, I have often been asked about the safety of placing a spinal or epidural needle through tattooed skin. Until now I’ve never had any scientific evidence upon which to base a good answer. For years I was on the lookout for a study that would help answer this question and there
just weren’t any. This is the first study I’ve found that starts to answer the question. I know we often aren’t interested in animal studies, but the question of the safety of placing a neuraxial needle through tattooed skin will doubtfully ever be studied in humans, and rightly so. This animal study is methodologically sound. It clearly shows two things: 1) tattoo ink gets into a spinal needle even with the stylet in place when it is passed through tattooed skin and 2) when a subarachnoid injection is made through a needle placed through a tattoo, some subjects develop unmistakeable signs of meningeal and neural injury over time. Given the magnitude of the risk and the small chance that we are going to get more good information on this topic any time soon, it is enough for me to answer, “it isn’t safe” the next time I’m asked.

Michael A. Fiedler, PhD, CRNA
Postoperative hypoxemia is common and persistent: a prospective blinded observational study

Anesth Analg 2015;121:709-15

Abstract
Purpose This study proposed that desaturation after inpatient noncardiac surgery is common and often prolonged. It also hypothesized that monitoring oxygen saturation (SpO$_2$) after discharge from PACU only during routine nursing care underestimates the magnitude and duration of postoperative desaturation.

Background Typically after discharge from PACU, SpO$_2$ is monitored every 4-6 hours postoperatively. Patients that would have issues with their SpO$_2$ during rest are awakened to obtain their vital signs. This would change their breathing pattern and potentially increase the SpO$_2$ reading. Therefore, the values acquired for SpO$_2$ may not reflect the severity of postoperative hypoxemia.

Methodology This was a blinded observational study. Oximetry data from a subgroup of the Vascular events In Surgery patIents cOhort evaluatioN (VISION) study was collected and analyzed secondarily. A total of 15,000 patients at least 45 years old who were scheduled for noncardiac inpatient surgery with general and/or regional anesthesia were included. Elective and nonelective surgeries were included. Patients that were not expected to stay overnight were not included in the study. For the 1,250 patients at Cleveland Clinic, routine nurse-recorded SpO$_2$ was extracted. This information was not available for the other 250 patients.

Monitoring of the patients started on arrival to the step-down unit. Monitoring continued for the entire hospitalization up to 48 hours or the morning after that. Direct measurements from nursing care and continuous measurements that were not visible or available to anyone were collected. Patients were allowed to disconnect from the continuous monitoring equipment for transport, personal hygiene, and interventions. The continuous measurements, including the SpO$_2$ waveform, were recorded internally and then transferred to a secure database. Artifact, any value less than 60% which only accounted for 0.09% of all values, was discarded. Patients that had <12 hours of continuous monitoring, gaps in monitoring >4 hours, or if the unrecorded time comprised more than 30% of the total monitoring time were excluded from the study.

Raw and filtered SpO$_2$ data was included. Raw data was summarized to show the distribution of hypoxemic minutes per hour using incidence curves. In order to show the relationship between distribution
of \( \text{SpO}_2 \) and postoperative time, quantile regression was utilized. A weighted average for the specific time point was created. The incidence of \( \text{SpO}_2 < 90\% \) of varying durations was then estimated along with the 95% confidence intervals.

There were two ways this data was collected, intermittently by the nurse as a part of nursing care and continuously but not visible to anyone. The nurse-recorded data and the continuously-recorded data were compared. Incidence of \( \text{SpO}_2 < 90\% \) recorded by the nurse during the continuous monitoring period was calculated. Since the remaining patients had no hypoxemic episodes recorded by the nurse, the incidence of adjacent \( \text{SpO}_2 < 90\% \) and \(< 85\% \) lasting 1 hour and 2 hours was given a weighted average.

**Result** Adequate data was collected for 833 patients. A raw oxygen saturation of \(< 90\% \) for 10 minutes or more during an hour occurred in 21% of patients. A raw oxygen saturation of \(< 90\% \) for 20 minutes or more occurred in 8% of patients. There was also at least 5 minutes per hour where the \( \text{SpO}_2 \) was \(< 85\% \) for 8% of the patients.

Looking at an \( \text{SpO}_2 < 90\% \), the smoothed data indicated 37% had at least 1 episode lasting an hour or more, and 11% experienced at least 1 episode lasting 6 hours or more. An \( \text{SpO}_2 < 80\% \) for at least 30 minutes was observed in 3% of patients.

Looking at the nurse-recorded data, only 5% of patients had any hypoxemia recorded. Of the remaining patients without a clinical record of hypoxemia, the smoothed continuous \( \text{SpO}_2 \) showed that 38% had episodes of \( \text{SpO}_2 < 90\% \) that lasted \( > 1 \) hour and 27% had an episode lasting \( > 2 \) hours. Therefore, the nurses missed 90% (214 of 237) of the episodes where \( \text{SpO}_2 \) was \(< 90\% \) for at least 1 hour. The raw data demonstrated that 12% of patients had at least 1 episode of hypoxemia lasting \( > 6 \) hours.

When considering an \( \text{SpO}_2 < 85\% \), the study indicated that 10% of the patients had at least 1 episode lasting \( > 1 \) hour, 6% had at least 1 episode lasting \( > 2 \) hours, and 1% had at least 1 episode lasting \( > 6 \) hours.

**Conclusion** Hypoxemia after surgery was more common than previously known. Monitoring \( \text{SpO}_2 \) every 4-6 hours does not adequately reflect a patient’s \( \text{SpO}_2 \) over time. Continuous monitoring captured 90% more incidences of hypoxia that lasted at least 1 hour.

**Comment** Postoperative hypoxemia can indicate patient instability and can lead to other complications such as compromised wound healing, cognitive dysfunction, dysrhythmias, and myocardial ischemia. This study demonstrates that hypoxemia is a serious complication that is taking place right under our noses. Therefore, continuously monitoring \( \text{SpO}_2 \) during the first 48 hours postoperatively may be necessary. Another question that we must ask is if patients that have not had surgery also have these fluctuations in \( \text{SpO}_2 \). Is it normal to have these fluctuations? Are we treating the
monitor? If we could see data for the impact, if there was any, these periods of hypoxemia had on the patient’s cognitive ability, wound healing, and cardiac status, we would get a better idea of the severity of this issue. As anesthesia providers, we can help reduce the incidence of hypoxia postoperatively by ensuring that we do not overmedicate the patient and by educating other staff about this potential adverse event. This study is a great reminder that bad things can happen when you least expect them, especially if you aren’t looking for them.

Heather Fields, MBA, MSN, CRNA