BIS Index Below 45 Is Dangerous

Association of Perioperative Risk Factors and Cumulative Duration of Low Bispectral Index With Intermediate-Term Mortality After Cardiac Surgery in the B-Unaware Trial.

Kertai MD, Pal N, et al:

Anesthesiology 2010; 112 (May): 1116-1127

A low BIS value for a long period of time during cardiac surgery suggests the patient is at increased risk for postoperative mortality.

Background: A low bispectral (BIS®) index for a prolonged period of time has been associated with an increased postoperative mortality in noncardiac surgery. This study investigates the cumulative effect of a low BIS index on postoperative mortality following cardiac surgery.

Objective: To determine the cumulative effect of a low BIS index during cardiac surgery on intermediate-term mortality and to identify possible reasons for its effect.

Design: A subset of patients who underwent cardiac surgery as part of a larger prospective randomized trial of the effect of the BIS monitor on awareness (the B-Unaware) trial, were included. All of the patients in this trial were prospectively identified as being at risk for anesthesia awareness by having risk factors, such as a previous history of anesthesia awareness, a history of drug use, difficult intubation, and use of anti-seizure medications.

Participants: 460 patients (287 of whom were men with a mean age of 63 ± 13 years) undergoing cardiac surgery.

Methods: As part of the B-Unaware trial, patients were randomized into 2 groups. One group had the anesthetic agent adjusted to maintain a BIS value between 40 and 60. The other group had the anesthetic agent adjusted between 0.7 and 1.3 of the age-adjusted minimum alveolar concentration (MAC) values using standard management, without being aware of the BIS values. The patients were followed-up for 3 years after surgery, and their mortality was recorded. The time and duration of the BIS values, end-tidal gas values, patient characteristics, and surgical characteristics were examined and related to the patient mortality.

Results: Each hour a patient spent with a BIS value of <45 resulted in a 29% increase in the 3-year mortality rate regardless of what group the patient was in. The end-tidal gas values were similar in the patients with low BIS values and higher mortality rates and those with the lower mortality rates and higher BIS values. The patients with lower BIS values had more severe underlying medical conditions, longer bypass times, and greater transfusion requirements than those with the higher BIS values.

Conclusions: Patients who spent a longer time with a low BIS value after cardiac surgery had a higher 3-year mortality rate postoperatively. This appears to be due to more severe systemic disease and vulnerability rather than excessive anesthetic administration.

Reviewer’s Comments: This study suggests that the BIS monitor may be an identifier for patients who are more likely to have an adverse outcome following cardiac surgery. Perhaps electroencephalograms of frail patients react differently than more robust patients and develop a lower BIS value in response to anesthetic administration. However, it does not follow that reducing the anesthetic concentration to cause a higher BIS value will lead to better outcomes since mortality did not correlate with end-tidal anesthetic values. (Reviewer-David S. Beebe, MD).

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Keywords: BIS® Index, Cardiac Surgery, Postoperative Morbidity/Mortality

Print Tag: Refer to original journal article
Spinal analgesia may help women successfully undergo external cephalic with less pain and greater success.

**Background:** Spinal analgesia has increased the success rate for external cephalic version for nulliparous women with breech presentation. However, spinal analgesia has an uncertain impact on external cephalic version in multiparous women, who have a lower success rate than nulliparous women.

**Objective:** To compare the success rate for external cephalic version for breech presentation using spinal analgesia with the success rate using no analgesia in nulliparous women.

**Design:** Randomized, prospective, open-label study.

**Participants:** 65 multiparous women with breech presentation who were at least 37 weeks gestation and agreed to participate in the study.

**Methods:** The women were randomized to receive either spinal analgesia with 7.5% bupivacaine prior to external uterine version or no analgesia. All women in the study received 1000 mL of Ringer’s lactate solution and either IV ritodrine or oral nifedipine for uterine relaxation. The success rates for external cephalic version, vaginal delivery, uterine relaxation, and pain rated with a 10-point visual analogue score were noted and compared among the groups.

**Results:** The women receiving spinal analgesia had a higher success rate for external cephalic version than those who did not (87.1% vs 57.5%; \( P = 0.009 \)). The visual analogue scores were also lower in the spinal analgesia group compared to the controls (1.7 ± 2.4 vs 5.5 ± 2.9; \( P < 0.0001 \)). However, the incidence of hypotension was higher in the spinal analgesia group (32% vs 0%; \( P = 0.0003 \)), which was easily treated in all cases with ephedrine.

**Conclusions:** Spinal analgesia increases the success rate for external cephalic version and provides pain relief for multiparous women undergoing external cephalic version.

**Reviewer's Comments:** It appears that spinal analgesia is beneficial for women undergoing external cephalic version. I suspect we will be asked to provide spinal analgesia increasingly in the future for this procedure as obstetricians try to reduce the Caesarian section rate. The only difference is that I may use shorter acting agents since the procedure does not take that long. (Reviewer-David S. Beebe, MD).

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Keywords: External Cephalic Version, Spinal Analgesia, Multiparous

Print Tag: Refer to original journal article
Epidural Dexmedetomidine May Be Useful in Thoracic Surgery

**Effect of Epidural Dexmedetomidine on Intraoperative Awareness and Post-Operative Pain After One-Lung Ventilation.**

Elhakim M, Abdelhamid D, et al:

Acta Anaesthesiol Scand 2010; 54 (July): 703-709

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Epidural dexmedetomidine may improve oxygenation during, and pain scores after, thoracic surgery.

**Background:** Dexmedetomidine is being used in a number of off-label ways. Some reports are starting to appear describing the epidural administration of dexmedetomidine.

**Objective:** To compare analgesic efficacy, bispectral index, and intraoperative awareness in patients undergoing thoracic surgery with one-lung ventilation (OLV) using superficial isoflurane anaesthesia combined with thoracic epidural anaesthesia (TEA) with bupivacaine plus dexmedetomidine versus plain bupivacaine.

**Design:** Prospective, randomized, clinical trial.

**Participants:** Male patients from 40 to 60 years of age and requiring open thoracotomy for lung surgery were included. Patients were excluded if they had allergy to study drugs, significant renal or hepatic disease, neurologic or psychiatric disease, were morbidly obese, >60 years of age, or were on drugs that could affect electroencephalogram (EEG) activity.

**Methods:** All patients were given a standard anesthetic, and a T₆₋₇ epidural catheter was placed. Bispectral index (BIS) values were recorded before induction, during induction, at multiple times during single- and double-lung ventilation, and at multiple times after surgery. The anesthetic was titrated to maintain a BIS value of 40 to 60. Patients received (epidurally) either 30 to 40 mg of 0.5% bupivacaine or bupivacaine with 1 µg/kg of dexmedetomidine. Blood gases were obtained at the same times as BIS values. Isoflurane was maintained at an end-tidal concentration of 0.3% to 0.5%. Postoperative pain and sedation scores were standard scales. Intraoperative awareness was evaluated by modified Brice interviews and other questions at 6 hours, 24 hours, and 30 days after surgery. Postoperative analgesia was with 0.25% epidural bupivacaine or 0.25% bupivacaine plus 0.2 µg/kg/h dexmedetomidine. IV paracetamol was used for breakthrough pain.

**Results:** No differences were noted between the 2 groups in any demographics or lung function. Patients who received dexmedetomidine required significantly less fentanyl during surgery than those who did not. BIS values were significantly lower in the dexmedetomodine group during most of the 1- and 2-lung ventilation periods. Pain scores were significantly better in the dexmedetomidine group during the first 24 hours after surgery. Sedation scores were similar. Two patients in the bupivacaine group reported dreams or nightmares, but there were no cases of explicit recall for intraoperative events. Hemodynamic variables were similar between the 2 groups. Arterial oxygenation was better in the dexmedetomidine group during OLV. Shunt fraction increased in both groups with OLV but less in the dexmedetomidine group. ICU stay was significantly shorter in the dexmedetomidine group.

**Conclusions:** The authors conclude that epidural dexmedetomidine during OLV decreases anaesthetic requirements, prevents awareness during anaesthesia, and improves intraoperative oxygenation and postoperative analgesia.

**Reviewer’s Comments:** Although I agree that the epidural use of dexmedetomidine had demonstrable efficacy in reducing anesthetic requirements, improving pain, and decreasing shunt, I am not sure this study was adequately powered to really detect a difference in awareness. (Reviewer-Allen Miranda, MD).

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Keywords: Dexmedetomidine, Intraoperative Awareness, Postoperative Pain

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Vitamin B12 and B6 to the Rescue

Pre-Operative Vitamin B Infusion and Prevention of Nitrous Oxide-Induced Homocysteine Increase.

Rao LK, Francis AM, et al:
Anaesthesia 2010; 65 (July): 710-715

Nitrous oxide associated hyperhomocysteinemia may not be preventable with vitamin B infusion.

**Background:** Nitrous oxide is known to inhibit methionine synthase, which can result in elevated levels of homocysteine. Vitamins $B_{12}$ and $B_6$ are known to lower homocysteine levels.

**Objective:** To determine the effects of a single intravenous B-vitamin treatment on homocysteine after nitrous oxide anaesthesia.

**Design:** Prospective, randomized, double-blinded, placebo-controlled clinical trial.

**Participants:** Adults (ASA physical status 1 to 3) undergoing elective surgery using general anesthesia of >2 hours were included. Patients were excluded if they had a contraindication to the use of nitrous oxide, vitamin $B_{12}$ or vitamin $B_6$.

**Methods:** Patients were randomized to receive either nitrous oxide plus vitamin B, placebo plus nitrous oxide, or placebo plus air. Those receiving vitamin B infusion were given 1 mg of vitamin $B_{12}$ and 5 mg of folic acid diluted in 250 mL normal saline. Blood samples for serum $B_{12}$, $B_6$, and homocysteine levels were obtained preoperatively, 30 minutes after surgery, and again on the first postoperative day. The remainder of the anesthetic was relatively standardized but left to the discretion of the anesthesia team.

**Results:** Almost 60 patients were enrolled. There were no demographic differences between the 3 groups, and preoperative homocysteine, $B_{12}$, and $B_6$ levels were similar. Patients who received the vitamins demonstrated significant increases in postoperative vitamin levels. Plasma homocysteine levels rose $>20\%$ compared to baseline in patients who received nitrous oxide without the vitamin infusion and almost $20\%$ in those who received nitrous oxide with the vitamin infusion. This difference was not considered significant. There were patients in whom the homocysteine levels decreased, however, and the authors note that this was unpredictable. Homocysteine levels were essentially unchanged in the patients who did not receive nitrous oxide. Only 3 adverse effects were noted in the study. Two patients who received nitrous oxide developed postoperative nausea and vomiting and 1 patient who did not receive nitrous developed an elevated troponin level.

**Conclusions:** The authors conclude that a single preoperative infusion with vitamin $B_{12}$ and $B_6$ may not prevent nitrous oxide-induced hyperhomocysteinemia.

**Reviewer’s Comments:** Although inadequately established, the possibility of nitrous oxide potentially influencing the development of perioperative cardiac events needs further evaluation. My personal opinion is that nitrous oxide use is almost never clinically necessary with the current drugs available at our disposal. (Reviewer-Allen Miranda, MD).

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Keywords: Methionine Synthase, Homocysteine, Vitamin B, Nitrous Oxide

Print Tag: Refer to original journal article
More antiemetics are required in neurological, head and neck, and abdominal surgeries.

**Background:** Postoperative nausea and vomiting (PONV) are associated with a number of risk factors, including those related to the patient and to the anesthesia. However, it is unclear whether, and to what extent, the type of surgical procedure impacts the risk for or rate of PONV, as studies have been conflicting or inconclusive.

**Objective:** To test the hypothesis that the type of surgery, when categorized and compared anatomically, influences the use of antiemetic therapy in the postanesthesia care unit (PACU).

**Design:** Retrospective analysis of oncology surgery cases from the automated anesthesia information system of M.D. Anderson Cancer Center.

**Methods:** The electronic perioperative anesthesia database was searched for adult surgical patients admitted over a 2-year period. The primary end point was antiemetic administration within the first 2 hours of PACU admission. Surgeries were categorized as neurological, head and neck, breast or axilla, thoracic, abdominal, endoscopic, and integumentary musculoskeletal and superficial (IMS). This latter group (IMS) was used as a reference category. In addition, gender, smoking status, history of PONV or motion sickness, duration of anesthesia, number of prophylactic antiemetics, intraoperative analgesic used, and postoperative opioid administration were included as covariates in the analysis. Data were analyzed using multivariate linear regression to determine the impact of type of surgery on antiemetic administration within the 2 hours of PACU admission, after adjusting for other risk factors.

**Results:** Data from 18,109 procedures (14,789 patients) were analyzed. Patients undergoing neurological ($P < 0.0001$), head and neck ($P < 0.0001$), and abdominal ($P < 0.0001$) surgeries received significantly more antiemetic therapy in the PACU than those in the IMS reference group. In contrast, patients undergoing thoracic surgery had significantly less antiemetic administration ($P = 0.02$). There was no difference between the IMS reference group and those in any of the other anatomical categories on the main outcome measure. Among the other risk factors examined, females ($P < 0.0001$), those with prior PONV or motion sickness ($P < 0.0001$), receiving intraoperative opioids ($P < 0.0001$), having a longer duration of anesthesia ($P < 0.0001$), smoking status ($P = 0.003$), and receiving postoperative opioids ($P = 0.0005$) had increased administration of antiemetics in the PACU than other patients.

**Conclusions:** When categorized anatomically, the authors found that the type of surgical procedures is associated with increased use of antiemetic administration in the 2 hours after admission to the PACU.

**Reviewer's Comments:** This study confirms findings of previous studies. As the authors pointed out, one of the study limitations is that the main end point is not PONV but the antiemetic administration as a substitute end point. The indications for antiemetic administration may not always relate to PONV, as it can be given as prophylaxis. (Reviewer-Ioanna Apostolidou, MD).
Bridging Strategy With Tirofiban May Reduce Risk of Bleeding Urgent Surgery in Patients With a Recently Implanted Coronary Drug-Eluting Stent: A Phase II Study of ‘Bridging’ Antiplatelet Therapy With Tirofiban During Temporary Withdrawal of Clopidogrel.


Bridging with a short-acting antiplatelet agent may be used in patients with drug-eluting stents.

Background: Current guidelines state that patients with a recently implanted drug-eluting stent (DES) should be treated with aspirin and clopidogrel for at least 1 year post-implantation. Managing the risk of bleeding is difficult in patients with DESs who require urgent surgery, because discontinuing antiplatelet therapy increases the risk of stent thrombosis and its sequelae.

Objective: To evaluate the safety and efficacy of a strategy involving strict cardiac monitoring, replacement of clopidogrel with IV tirofiban in the perioperative period, and resumption of dual antiplatelet therapy postoperatively.

Design: Phase II study with a Simon 2-stage design.

Participants/Methods: The study included 30 patients with recently implanted (DESs) who required either urgent major surgery or eye surgery. Five days prior to surgery, clopidogrel was withdrawn. The following day, patients were admitted to the hospital and began treatment with IV tirofiban (standard dose of 0.4 µg/kg-1/min-1 over 30 minutes followed by 0.1 µg/kg-1/min-1), which was continued until 4 hour prior to surgery. Two hours after surgery, tirofiban was restarted until clopidogrel could be safely resumed. Aspirin was used during the perioperative period at the discretion of the surgeon. The primary end point was the composite measure of cardiovascular death, myocardial infarction (MI), acute occlusion of the target lesion during hospitalization, and need for surgical re-exploration due to bleeding. Safety was also determined by number of units of blood transfused as well as nonoperative bleeding.

Results: Patients (n=30) had a mean of 60 years of age (range, 25 to 80 years), with a median ejection fraction of 55%. Seventy percent were taking a beta-blocker and 77% were taking a statin prior to surgery. All were at high risk of stent thrombosis or catastrophic outcomes based on their medical conditions, and for surgical bleeding due to the type of surgery to be performed. Nearly half of the patients (14) had multiple stents, and 20 had been stented during an acute coronary syndrome. The median time between stenting and surgery was 4 months (1 to 12). There were no deaths, MIs, stent thromboses, or need for surgical re-exploration due to bleeding associated with the use of this tirofiban protocol (risk estimate of 0% to 11.6%; one-tail 97.5% CI). One patient had major bleeding and 1 had minor bleeding postoperatively. Four patients required transfusion but did not meet criteria for major or minor bleeding.

Conclusions: A bridging strategy with IV tirofiban appears to reduce the risk of bleeding associated with clopidogrel withdrawal in surgical patients with recently implanted DESs.

Reviewer’s Comments: A larger study is required before routinely implementing a strategy of IV antiplatelet therapy to "bridge" these patients in the perioperative period. The optimal antiplatelet agent has yet to be defined. (Reviewer-Ioanna Apostolidou, MD).

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Keywords: Clopidogrel, Drug-Eluting Stents, Urgent Surgery

Print Tag: Refer to original journal article
Mild Hypothermia, Supplemental Protective Drugs Do Not Influence Neurologic Outcome

No Association Between Intraoperative Hypothermia or Supplemental Protective Drug and Neurologic Outcomes in Patients Undergoing Temporary Clipping During Cerebral Aneurysm Surgery: Findings from the Intraoperative Hypothermia for Aneurysm Surgery Trial.

Hindman BJ, Bayman EO, et al:
Anesthesiology 2010; 112 (January): 86-101

Mild hypothermia does not improve neurological outcomes after aneurysm clipping.

Background: The results of the Intraoperative Hypothermia for Aneurysm Surgery Trial (IHAST) showed no effect of hypothermia on neurologic outcomes in patients undergoing surgery for an acutely ruptured intracranial aneurysm. However, patients undergoing temporary clipping as part of the procedure were not examined separately, and it may be in these patients that the impact of hypothermia may best be assessed.

Objective: To evaluate the potential protective effect of hypothermia in only those IHAST patients who underwent temporary clipping.

Design: Post hoc analysis of the protective effects of hypothermia in patients from the IHAST who had temporary clipping during aneurysm repair, as well as potential interactions between temperature, supplemental protective drug, and temporary clip duration.

Methods: The IHAST was a prospective, multicenter, randomized, and partially blinded trial on the potential protective effect of mild systemic hypothermia on neurological outcomes in patients undergoing surgery for acutely ruptured intracranial aneurysm. After induction, patients were randomly assigned to hypothermia (target esophageal temperature, 33°C) or normothermia (target esophageal temperature, 36.5°C). The use of temporary clipping was at the discretion of the surgeon and was defined as occlusion of a vessel for at least 1 minute. Patients were assessed for the presence of any of 106 predefined intercurrent events. The primary outcome measures for this subgroup analysis were 3-month Glasgow Outcome Scale score of 1 (good recovery) or >1 (any/all levels of disability and death) and neuropsychological composite score dichotomized as either normal or abnormal.

Results: The final sample consisted of 441 patients who underwent temporary clipping and 553 who did not; 208 of the patients who underwent clipping were randomly assigned to hypothermia and 233 to normothermia. In addition, 198 patients had supplemental protective drug therapy during clipping (thiopental in 157, etomidate in 20, and not identified in 1). Univariate analysis showed no difference in neurologic outcome between hypothermia and normothermic patients or between those who received supplemental drug therapy and those who did not, regardless of temperature condition. Multivariate analysis revealed no interactions between temperature and clip duration, effect of supplemental protective drug and clip duration, or effect of supplemental protective drug and temperature.

Conclusions: Neither mild systemic hypothermia nor supplemental protective drug administration influenced neurologic outcome in patients undergoing temporary clipping for intracranial aneurysm repair.

Reviewer’s Comments: Mild hypothermia improved the outcome of ischemic and traumatic brain insults in the laboratory and has been used to treat head trauma, stroke, and cardiac arrest. Although hypothermia is used during surgery for intracranial aneurysms, its benefit is not clear. (Reviewer-Ioanna Apostolidou, MD).

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Keywords: Intracranial Aneurysm, Hypothermia, Temporary Clipping

Print Tag: Refer to original journal article
Physiologic capacity measurements may be predictors of postoperative outcomes after major abdominal surgery.

**Background:** Physiological capacity (PC), which defines a patient’s metabolic capacity during cardiopulmonary exercise testing, may be an appropriate tool for risk assessment.

**Objective:** To compare the value of preoperative PC measurements to ASA physical classification rank as predictors of acute postoperative morbidity in the same patients.

**Design:** Prospective, blinded, observational pilot study.

**Participants/Methods:** Study subjects were patients scheduled for 1 of 8 elective major abdominal cancer surgical procedures. Patients were evaluated preoperatively with 2 separate processes: (1) the standard of care at M.D. Anderson (ASA classification); and (2) assessment of preoperative PC using exercise testing. Exercise testing was conducted within 2 weeks of surgery and consisted of 5 phases: pulmonary function testing; supine resting; unloaded cycling; ramp protocol, and recovery. Vital signs, gas exchange, and electrocardiography were evaluated continuously during phases 2 through 5. Standard procedures were used for surgical evaluation, general anesthesia regimen, surgical technique, and postoperative care. Acute morbidity was measured for up to 1 week after surgery, and patients were classified into all-event or nonevent groups. Data were analyzed using univariate and multivariate logistic regression, and receiver operating characteristic curves were generated.

**Results:** 32 patients were enrolled in the study, 2 in ASA class 1, 16 in ASA class II, and 14 in ASA class III. Of the preoperative variables examined, only preoperative diabetes and treatment with β-blockers were associated with more postoperative events. Half of all patients experienced at least 1 event postoperatively. Several variables were significantly associated with postoperative morbidity, including ASA rank ($P = 0.038$; area under the curve [AUC]=0.688, 95% CI=0.52315, 0.85185), heart rate at anaerobic threshold ($P = 0.025$; AUC=0.734, 95% CI=1.008, 1.133), change in heart rate from resting to anaerobic threshold ($P = 0.010$; AUC=0.799, 95% CI=0.64510, 0.95256), and percent predicted anaerobic threshold achieved (<75% vs >75%; $P = 0.016$; AUC=0.719, 95% CI=0.56789, 0.86961). Pair-wise comparisons failed to detect superiority of any one of these measures over any other in terms of predictive value. However, a 2-variable model of PC measurements, including change in heart rate and percent predict threshold achieved, was statistically significant in predicting postoperative events ($P = 0.023$; AUC=0.826; sensitivity=0.813; specificity=0.688) and may be superior to ASA alone.

**Conclusions:** These results show that 3 previously unidentified measures of PC are predictive of acute postoperative morbidity as independent factors and as part of a multivariate model (2 of the 3). ASA classification rank was also associated with postoperative events.

**Reviewer’s Comments:** Different measures of cardiopulmonary exercise testing have been shown to predict postoperative complications and varied with the type of surgery. The maximum oxygen uptake at peak exercise is the most common measure and has previously been found to be the most useful predictor of postoperative cardiopulmonary complications, both in patients undergoing radical esophagectomy and after surgical procedures for lung cancer. (Reviewer-Ioanna Apostolidou, MD).

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Keywords: ASA Physical Status, Physiologic Capacity Postoperative Outcomes

Print Tag: Refer to original journal article
Blood glucose level can be controlled with insulin infusion at a constant rate and a variable rate of 20% glucose infusion modified according to blood glucose measurements in abdominal surgery.

**Background:** Hyperglycemia and blood glucose variability are associated with poorer outcomes following surgery. Randomized trials of intensive intraoperative and postoperative insulin treatment in cardiac patients have, however, given conflicting results, mainly due to the increased morbidity and mortality caused by hypoglycemia in treated patients. Studies in noncardiac patients are very few.

**Objectives:** To investigate the effects of liver resection surgery on blood glucose levels and the efficacy of blood glucose control with infusion of insulin at a constant rate and a variable infusion of 20% glucose solution (GIN therapy).

**Participants/Methods:** 56 patients undergoing liver resection for malignancy under general anesthesia with thoracic epidural for pain control were included in this randomized study; 28 patients received standard treatment with blood glucose measurements every 30 minutes in the operating room and every 60 minutes in the ICU. If glucose was >110 mg/dL, an insulin infusion was started at 1 U/h and titrated according to the sliding scale to glucose of 63 to 110 mg/dL. In 28 patients in the GIN group, blood glucose levels were measured every 15 minutes. After basal glucose level was obtained, 2 U of insulin were administered followed by an insulin infusion of 2 U/kg/min. Ten minutes after initiation of insulin infusion and when blood glucose was <110 mg/dL, infusion of dextrose 20% was initiated. The infusion of 20% glucose was modified to maintain blood glucose levels between 63 and 110 mg/dL. The proportion of normoglycemic measurements was recorded as well as the incidence of hypoglycemia and hyperglycemia. Furthermore, variability of blood glucose was observed.

**Results:** In the standard treatment group, target glycemia was achieved in 37.4% of patients intraoperatively and 18.3% after surgery. In diabetic patients, target blood glucose was achieved only in 4.3% of patients during surgery and in 2.9% after the surgery. In the GIN treatment group, the target glycemia was achieved in non-diabetic patients in 90.1% during the surgery and 77.8% after surgery. In diabetics, target glycemia was achieved in 81.2% during the surgery and in 70.5% after surgery. The glucose oscillation was smaller in the GIN therapy group. No patient experienced severe hypoglycemia. Mild hypoglycemia (40 to 63 mg/dL) was observed in the GIN treatment group but not in the standard treatment group.

**Conclusions:** GIN treatment is better at achieving normoglycemia during and after surgery in liver resection patients. Mild hypoglycemia without neurologic sequelae can occur with GIN treatment, and vigilance is necessary.

**Reviewer's Comments:** The presented study introduces a shift from insulin adjusting management to glucose infusion adjusting management for attainment of desired glycemia, which seems to be more effective. Due to unsatisfactory results of standard treatment, the presented protocol may improve perioperative glycemic control. It remains to be seen whether 15-minute blood tests are feasible in a busy operating room and whether the results translate into improved outcomes. (Reviewer-Mojca Remskar Konia, MD).

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Keywords: Perioperative Glucose, Insulin, Normoglycemia

Print Tag: Refer to original journal article
Intrathecal morphine can render cardioprotection after ischemia-reperfusion injury via central opiate receptors.

**Background:** IV opiates are known to render cardioprotection from ischemia-reperfusion injury similar to ischemic preconditioning. Animal studies have further demonstrated that intrathecal morphine can also induce cardioprotection. Whether protection is mediated through peripheral or central opiate receptors, however, has not been established.

**Objectives:** To investigate the role of central and peripheral opioid receptors in the cardioprotective effects of intrathecal morphine.

**Methods:** 48 rats were assigned to 7 treatment groups: control (intrathecal saline); intravenous naloxone (IVNM); intrathecal naloxone (ITNM); ischemic preconditioning (IPC; three 5-minute coronary artery occlusion periods with 5 minutes of reperfusion + intrathecal saline), intrathecal morphine preconditioning (ITMPC; 3 injections of 1 µg/kg of morphine; IVNM followed by ITMPC (IV naloxone before intrathecal injections of morphine); and ITNM followed by ITMPC (intrathecal naloxone followed by intrathecal morphine). The animals were exposed to 30 minutes of regional ischemia and 120 minutes of reperfusion. Myocardial infarct size as a percentage of the area of myocardium at risk was measured.

**Results:** Intrathecal morphine and ischemia induce cardioprotection. The effect of intrathecal morphine was reversed with intrathecal naloxone but not with IV naloxone.

**Conclusions:** This study demonstrated that cardioprotective effects of intrathecal morphine are mediated primarily through central opiate receptors and not through peripheral opiate receptors.

**Reviewer's Comments:** The idea of intrathecal opiates and cardioprotection is clinically very appealing. If, indeed, intrathecal morphine can produce cardioprotection also in humans, that may have important implications for the choice of anesthesia and pain control in noncardiac and cardiac surgery. The finding is especially important since intrathecal opiates have been successfully and safely used in clinical practice for decades. I am looking forward to further human studies. (Reviewer-Mojca Remskar Konia, MD).

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Keywords: Intrathecal Opiate Preconditioning, Myocardial Ischemia-Reperfusion Injury

Print Tag: Refer to original journal article
Objective: To assess the analgesic duration of levobupivacaine versus ropivacaine for sciatic nerve block in patients for foot and ankle surgery.

Design/Participants: Prospective, double-blinded, randomized, clinical study involving 80 adult ASA I to III patients for foot and ankle surgery.

Methods: Patients were randomized into 2 study groups. Group 1 received 20 mL of 0.5% levobupivacaine for sciatic nerve block, while group 2 received 20 mL 0.5% ropivacaine. All combined sciatic and femoral nerve blocks were performed by anesthesiologists in training. Femoral nerve was blocked with 20 mL 0.5% ropivacaine. All posterior sciatic nerves were identified using the classic Labat technique modified by Winnie using a nerve stimulator. Block success, adverse events, tourniquet tolerance, sensory and motor block duration, and supplementary analgesia were recorded. The primary end point was duration of analgesia.

Results: The 2 study groups were comparable in demographics. Three patients from each group received supplementary IV fentanyl during the operation for an incomplete sciatic block. Twenty-seven percent of the patients in group 1 and 21% of the patients in group 2 received IV fentanyl for tourniquet discomfort ($P =0.545$). Time from tourniquet inflation to the pain outbreak was 60 minutes in group 2 and 90 minutes in group 2, which was not statistically different. The duration of sensory and motor blocks, as well as duration of analgesia, was statistically longer in the levobupivacaine group ($P <0.0001$). The levobupivacaine group received less rescue analgesia and had less opiate consumption at 24 hours.

Conclusions: Levobupivacaine produced nearly 50% longer analgesia than ropivacaine, when used for posterior sciatic nerve block.

Reviewer's Comments: The 55% difference in duration of action between levobupivacaine and ropivacaine (both L-isomers) cannot be explained just with the difference in protein binding between the 2 (92% for ropivacaine and 95% for levobupivacaine). Further studies are needed to investigate whether the potency ratio of those 2 drugs can be explained with the type of block performed. (Reviewer-K. George Bojanov, MD).
Midazolam in higher concentrations abolishes explicit and implicit memory.

**Background:** Memory includes implicit and explicit elements. Explicit memory is accompanied by awareness (e.g., recognizing a face), while implicit memories are changes in behaviour without recognizing the event causing the change.

**Objective:** To evaluate the effect of midazolam on the implicit and explicit memory.

**Design:** Randomized volunteer study.

**Participants:** 12 male volunteers who each had received >12 years education.

**Methods:** On their first visit, the participants were randomly assigned to either mild (sedation score of 3) or deep (sedation score of 1) sedation. Midazolam was infused to the allocated sedation level with the target controlled infusion (TCI). Then, a steady state over 10 minutes was maintained. At the second visit, a 2-character word list (auditory word stimulus) was required to remember. Before sedation and at the same TCI as randomized at the first visit, the auditory word stimulus was given again. The blood oxygen-level-dependent-functional magnetic resonance imaging (BOLD-fMRI) was measured at 4 time points: before and during the first auditory stimulus; with the midazolam sedation; and at the second auditory stimulus. Four hours later, explicit and implicit memories were assessed. The word stimulus included words from study lists that were delivered binaurally from a CD player with magnetic resonance-compatible electrostatic headphones, which shield from the scanner noise. The pre-sedative list was played 10 times before midazolam sedation and was preceded by a request to "Listen carefully to the list and try to remember these words." The intra-sedative list was also played 10 times, beginning after the predicted target plasma concentrations obtained on the first visit. Finally, the volunteers wrote their responses on a form and completed the word stems. Memory data were presented as mean (SD) or mean (95% confidence interval). A P value <0.05 was considered significant.

**Results:** During midazolam sedation, the explicit memory scores (mild and deep groups) did not differ from zero, which means no explicit memory. All brain areas were uninhibited by mild midazolam sedation. On deep sedation, the superior, temporal gyrus was depressed but not the middle temporal or transverse temporal gyrus.

**Conclusions:** Midazolam in higher concentrations abolishes explicit and implicit memory; the BOLD-fMRI shows depression of the superior, temporal gyrus, which might be a target of memory.

**Reviewer's Comments:** This is a complicated study. Much research is still needed, especially with the blood oxygen-level-dependent-functional magnetic resonance imaging. (Reviewer-Olga Plattner, MD).

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**Keywords:** Midazolam, Memory, Temporal Gyrus

**Print Tag:** Refer to original journal article
Anesthesiologist Usually Have to Rely on End-Tidal Sevoflurane Concentration

Monitoring of the Responsiveness to Noxious Stimuli During Sevoflurane Mono-Anaesthesia by Using RIII Reflex Threshold and Bispectral Index.

van Dincklage F, Velten H, et al:

Br J Anaesth 2010; 104 (June): 740-745

The RIII reflex threshold shows a comparable prediction probability of reactions to noxious stimuli as the end-tidal sevoflurane concentration.

Background: Movement responses to noxious stimuli under general anesthesia are an important determinant of anesthetic depth.

Objective: To compare the accuracy of the RIII reflex threshold, the bispectral index (BIS), and the end-tidal sevoflurane concentration in predicting movement responses during sevoflurane anesthesia.

Design: Volunteer study.

Participants: 14 healthy male volunteers.

Methods: The RIII reflex threshold was traced continually by an automated RIII threshold tracking system. The system varies the stimulus intensity according to an up-down staircase algorithm, with a variable step length to estimate the stimulus intensity associated with a 50% probability of RIII reflex occurrence, which is defined as the reflex threshold. The RIII reflex recording was started 10 minutes before administration of sevoflurane, and the stimuli perceived ranged from not painful to slightly above the pain threshold. Reactions to verbal and noxious stimuli were tested every 5 minutes (verbal command, trapezius squeeze, and electrical stimulation). Vital parameters were monitored (electrocardiography, pulse oximetry, and CO₂) via the tight-fitting mask and the bispectral EEG index with the BIS. Sevoflurane was administered via a facemask and slowly increased every 10 minutes in steps of 0.2 vol% end-tidal concentrations. After loss of responses to the noxious stimuli, 3 more steps of increase of the concentration were conducted before the end of the administration of sevoflurane. Analyses were performed with the RIII reflex threshold data, BIS data, and the sevoflurane concentration after the loss of consciousness. The prediction probability, or $P_K$ values, of the 3 parameters were compared using Friedman’s test with Dunn’s post-test.

Results: Reactions to the repeated verbal commands were lost for all 14 subjects at a median end-tidal sevoflurane concentration of 1.6 vol% (range, 0.8 to 2.0 vol%). Reactions to the loss of noxious stimuli were at a concentration of 2.6 vol% (range, 2.2 to 3.0 vol%). The comparison between the 3 parameters showed that the prediction probabilities for the RIII reflex threshold were significantly higher compared with those of the BIS ($P < 0.05$), while no significant differences could be detected between RIII reflex threshold and end-tidal sevoflurane concentrations or BIS and the end-tidal sevoflurane concentrations ($P < 0.05$). The prediction probabilities for movement reaction to noxious stimuli were 0.79 for the BIS, 0.91 for the RIII threshold, and 0.89 for the end-tidal sevoflurane concentration.

Conclusions: The RIII reflex threshold shows a comparable prediction probability of reactions to noxious stimuli as the end-tidal sevoflurane concentration. The BIS shows a lower prediction probability.

Reviewer’s Comments: For research purposes, investigation for prediction of movement with the BIS and RIII reflex are interesting. However, in most hospitals, this monitoring is not available and therefore end-tidal sevoflurane concentration seems to be the parameter the anesthesiologist has to rely on. (Reviewer-Olga Plattner, MD).

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Keywords: Noxious Stimuli, Sevoflurane, Mono-Anaesthesia, Bispectral Index, RIII Reflex

Print Tag: Refer to original journal article
Airway Scope May Be Better Choice

A Comparison of the Airway Scope® and McCoy Laryngoscope in Patients With Simulated Restricted Neck Mobility.

Komatsu R, Kamata K, et al:

Anaesthesia 2010; 65 (June): 564-568

Intubation with the Airway Scope® is 10 seconds faster and less likely to result in an esophageal intubation than intubation with the McCoy laryngoscope.

**Background:** The Airway Scope® is a new videolaryngoscope that requires less cervical spine movement than conventional laryngoscopy, similar to the distal hinged tip of the McCoy laryngoscope.

**Objective:** To compare the efficacy between the Airway Scope and the McCoy laryngoscope in patients with an immobilized neck by a rigid cervical collar.

**Design:** Prospective, randomized, clinical study.

**Participants:** 100 patients scheduled for a surgical procedure requiring tracheal intubation.

**Methods:** Patients were anesthetized according to the protocol; after full neuromuscular blockade, the pillow under the head was removed and a rigid Philadelphia Cervical Collar was positioned around the neck. Patients were randomly allocated to tracheal intubation with an Airway Scope preloaded with a tracheal tube (7 mm or 8 mm) or McCoy laryngoscope with a styleted tracheal tube. The Airway Scope was inserted in the mouth and positioned with the glottis seen at the center of the cross-mark on its monitor; the tube was then advanced into the trachea. The McCoy laryngoscope size 3 was inserted to obtain the best glottic view, and subsequently, the distal hinged tip was activated by pressing the lever, and intubation was performed. However, >3 intubation attempts with either device was considered as a failure. All intubations were performed by a single anesthesiologist who performed >100 with each device. The primary outcome of the study was the intubation time. Intubation success rate and complications were tested with Fischer’s exact or chi-square tests as appropriate. Continuous data were compared with Fischer’s exact test. A P value <0.05 was considered significant.

**Results:** Morphometric data were comparable. Time to intubation was significantly faster with the Airway Scope (30 [7] s) than with the McCoy laryngoscope (40 [14] s); P <0.0001. There were 6 esophageal intubations with the McCoy laryngoscope and none with the Airway Scope. No dental injuries or hypoxia occurred in either group.

**Conclusions:** Both the Airway Scope and the McCoy laryngoscope offer high success rates when difficult airways are stimulated by the application of a rigid cervical collar. However, the Airway Scope was 10 seconds faster and less likely to result in an esophageal intubation than the McCoy laryngoscope.

**Reviewer’s Comments:** Immobilization of the neck is one reason of the difficult airway management; prominent teeth, a big tongue, or previous radiotherapy may also cause even more difficulties in visualizing the vocal cords. In these cases, the Airway Scope might be too difficult to insert without causing bigger injuries of the lips, teeth, or tongue. (Reviewer-Olga Plattner, MD).

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Keywords: Difficult Airway, Restricted Neck Mobility, Airway Scope®, McCoy Laryngoscope

Print Tag: Refer to original journal article
The most appropriate devices for use during MRI are the i-gel supraglottic airway and the Ambu® Disposable Laryngeal Mask because they do not contain any metal parts.

Background: General anesthesia and airway management with a laryngeal mask airway (LMA) is needed in patients requiring an MRI and being unable to remain still.
Objective: To evaluate different LMAs in terms of producing artifacts on the MRI.
Design: Experimental study.
Methods: The devices were positioned on top and inside a phantom simulator. The cylindrical water phantom was made of polymethylmethacrylate plastic with dimensions of 15 x 15 x 35 cm (width x height x length), filled with a copper sulphate solution. The imaging planes were oriented to encompass the short and long axis of the phantom using T2-weighted gradient echo (GE) images. Six supraglottic airway devices were tested, including the cLMATM, the LMA ProSealTM, the LMA UniqueTM, the Ambu® Disposable Laryngeal Mask, the LMA SupremeTM, and the i-gel supraglottic airway device. The phantom with the supraglottic airway device was centered in the magnetic field, and the study was repeated with 3 different examples of each supraglottic device. The artifacts of the MRI images were evaluated by an expert neuroradiologist.
Results: The artifacts of the cLMA, the LMA ProSeal, the LMA Unique, and the LMA Supreme were similar (most prominent in the ProSeal) due to the ferromagnetic material in the pilot balloon valve. No artifacts were seen with the i-gel and the Ambu Disposable Laryngeal Mask.
Conclusions: The i-gel and the Ambu Disposable Laryngeal Mask do not contain any metal parts, and therefore cause no artifacts on MRI. Most appropriate for using in the MRI are the i-gel and the Ambu Disposable Laryngeal Mask.
Reviewer’s Comments: For MRI diagnostic procedures, patients are often sedated and one should be aware of using a metal-free device for airway management when needed. (Reviewer-Olga Plattner, MD).

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Keywords: Laryngeal Mask Airways, MRI, Imaging Artifacts

Print Tag: Refer to original journal article
What Factors Influence Amount of Post-CPB Blood Loss?

The Influence of Perioperative Coagulation Status on Postoperative Blood Loss in Complex Cardiac Surgery: A Prospective Observational Study.

Karkouti K, McCluskey SA, et al:

Anesth Analg 2010; 110 (June): 1533-1540

Blood loss is influenced by reduced pre-cardiopulmonary bypass thrombin generation, increased post-cardiopulmonary bypass consumption and dilution of clotting factors, and inadequate clot stabilization.

Objective: To evaluate how coagulation status before and after cardiopulmonary bypass (CPB) relates to postoperative blood loss.

Design/Participants: Prospective cohort study, including 101 adult patients, without coagulopathy, scheduled for complex cardiac surgery with CPB.

Methods: Patient demographics, comorbidities, preoperative medications, surgical times, amount and timing of fluid infusions, blood products, intraoperative medications, chest tube output, and postoperative complications were recorded. Coagulation testing was performed before and after CPB, including markers for thrombin generation, clotting factor dilution and consumption, clot stabilization, and fibrinolysis. Primary outcome was the amount of post-CPB blood loss, starting from heparin reversal to 24 hours postoperatively or until chest tube removal if chest tube removal occurred < 24 hours postoperatively. The Spearman rank correlation coefficient test and multivariable linear regression were used for statistical analysis.

Results: Estimated median post-CPB blood loss was 952 mL. Post-CPB cell salvage and processing was used in 10 patients, each receiving on average 848 ± 356 mL salvaged blood. Twenty-nine patients received red blood cell transfusions during the CPB. Variables independently associated with increased blood loss included previous sternotomy, lower pre-CPB prothrombin fragments 1 and 2, lower post-CPB platelet counts, higher post-CPB fibrin monomer concentrations, and larger percent decrease in fibrinogen concentrations.

Conclusions: The amount of post-CPB blood loss was influenced by a history of sternotomy, reduced basal thrombin generation, increased post-CPB consumption, dilution of clotting factors, and inadequate clot stabilization.

Reviewer's Comments: Limitations of this study include its observational design, small sample size, and no evaluation of qualitative platelet function. Several platelet function studies that are objective are now available that could have been deployed by the authors. (Reviewer-K. George Bojanov, MD).

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Keywords: Perioperative Coagulation Status, Postoperative Blood Loss

Print Tag: Refer to original journal article
Ventilation strategies used to manage hypoxic patients undergoing various surgeries under general anesthesia are similar, regardless of P/F (oxygenation) ratio.

Objective: To examine the current management of hypoxicemic patients in the operating room in order to determine the frequency at which lung protective ventilation strategy (LPVS) is implemented in response to low PaO$_2$/fraction of inspired oxygen (P/F) ratio.

Design/Participants: Retrospective review of study institution’s surgical cases from January 1, 2005, to July 31, 2009, during which at least 1 arterial blood gas (ABG) was recorded.

Methods: Predicted body weight (PBW) was calculated for all study participants. Intraoperative data, including arterial blood gas (ABG), fraction of inspired oxygen (FIO$_2$), peak inspiratory pressure (PIP), tidal volume (VT), positive end-expiratory pressure (PEEP), oxygen saturation (SpO$_2$), and end tidal carbon dioxide (ETCO$_2$) were collected every minute for 15 minutes after each documented ABG. P/F ratio was calculated for each ABG, as well as the mL/kg PBW using median VT and the PBW. ABGs were divided into 4 cohorts: P/F >300; 300 ≥ P/F >200; 200 ≥ P/F >100; 100 ≥ P/F.

Results: Reviewed were 28,706 ABGs from 11,445 operative cases. The average VT for all cases was 9.07 mL/kg PBW with an average PEEP of 3.13 cm H$_2$O. Even when P/F ratios were ≤100, anesthesiologists made minimal changes in ventilation management (VT=8.64 mL/kg PBW; PEEP=5.48 cm H$_2$O). A total of 494 cases (14%) with P/F <300 had decreases in VT of at least 1 mL/kg PBW, while 672 cases (19%) had increases of at least 1 mL/kg PBW. In the lowest P/F group, 25% had an increase in FIO$_2$ of at least 5%, 16% had decrease in VT of at least 1 mL/kg PBW, and 32% had an increase in PEEP of at least 2 cm H$_2$O. Trend was consistent with lowering VT, lowering PIP, and increasing PEEP.

Conclusions: Ventilation management was not changed for patients with mild to moderate hypoxia. In patients with severe hypoxia (P/F <100), the most common ventilator management was to use a higher FIO$_2$, tolerate higher PIP, and target an ETCO$_2$ of approximately 34 mm Hg.

Reviewer’s Comments: These results suggest that even in severely hypoxic patients with possible acute lung injury (ALI)/acute respiratory distress syndrome (ARDS), VT was maintained at higher levels than the 6 mL/kg recommended by an LPVS. It is not unreasonable to assume that in some cases, ALI/ARDS can begin during anesthesia care (ie, ALI/ARDS can occur at any time). (Reviewer-K. George Bojanov, MD).

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Keywords: Ventilator Management, Strategies, Hypoxic Patients

Print Tag: Refer to original journal article
Perioperative administration of ketorolac is associated with reduced risk of breast cancer recurrence.

**Objective:** To evaluate the incidence of local recurrence and metastatic disease after mastectomy in patients with breast cancer who were treated with different intraoperative analgesics.

**Design/Participants:** Retrospective, medical records analysis of 327 consecutive patients postmastectomy with axillary dissection.

**Methods:** All mastectomies were performed by the same surgeon and managed jointly by the surgeon and the same oncologist. Type, dosage, and combination of intraoperative analgesics were left to the discretion of 2 attending anesthesiologists. Drugs used during anesthesia included sufentanil, clonidine, ketamine, and ketorolac. Postoperative analgesia consisted of piritramide, acetaminophen, and diclofenac. Chemotherapy, radiotherapy, and endocrine therapy were performed as needed. For 2 consecutive years, medical consultation occurred every 3 months, then every 6 months for 3 years, and then once a year. Primary end points were the effect of the administration of different intraoperative analgesics on cancer recurrence and recurrence-free survival.

**Results:** Data from 319 patients were available for analysis. Median follow-up time was 27.3 months. Recurrence was noted in 35 patients (11%). Seventeen patients (5%) died of oncologic causes during follow-up. Patients were similar in demographics, cancer prognostic factors, and length of surgery. Univariate and multivariate analyses associated ketorolac with longer recurrence-free survival. Sufentanil, clonidine, ketamine, and other drugs did not have a significant effect on cancer recurrence. Univariate analysis also showed that age, histological grade, lymph node invasion, and Nottingham Prognostic Index were significantly associated with recurrence-free survival.

**Conclusions:** Ketorolac administered preoperatively for breast cancer surgery was associated with a decrease in cancer recurrence when compared to other analgesics.

**Reviewer's Comments:** This study is limited by its retrospective design. As cyclooxygenase-2 (COX-2) could play a role in some tumors development, including breast cancer, COX-2 inhibitors could provide an additional treatment modality. It has been shown that over expression of COX-2 leads to stimulation of epithelial cell growth, inhibition of apoptosis, stimulation of angiogenesis, immune suppression, and more. (Reviewer-K. George Bojanov, MD).

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Gastric insufflation occurs during face mask ventilation mainly in children <1 year of age.

**Objective:** To evaluate the upper limit of inspiratory pressures in children providing proper and safe mask ventilation and avoid gastric insufflation (GI).

**Design/Participants:** This prospective, observational study included 100 consecutive children, from 1 day to 16 years in age, ASA I and II, who were scheduled for a procedure under general anesthesia.

**Methods:** After induction of general anesthesia, children were mask ventilated with pressure-controlled ventilation as soon as respiratory support was needed. Insufflation pressure was set at 10 cm H$_2$O for 5 breaths. If epigastric auscultation did not observe GI, the insufflation pressure was increased in steps of 5 cm H$_2$O to a max of 25 cm H$_2$O. GI was assessed by a second anesthesiologist performing continuous gastric auscultation. If GI was detected, the inspiratory pressure was decreased to the lower level and the disappearance of GI verified. Protocol was discontinued if either GI occurred at an inspiratory pressure of ≤25 cm H$_2$O or if no GI occurred at a pressure of 25 cm H$_2$O. At the end of the protocol, the inspiratory pressure was set to a tidal volume of 10 mL/kg. In case of GI, tidal volume was reduced. If there was no GI at 10 mL/kg, inspiratory pressure was set to the higher pressure providing no GI. The inspiratory-to-expiratory ratio was set at 1:2, with no positive end-expiratory pressure.

**Results:** The incidence of GI was 95% in children ≤1 year old and 93% in the 1- to 5-year-old age group; it was significantly lower in the age group ≥5 years old (53%). The pressure threshold for GI increased with age. Only children ≤1 year old experienced GI at 10 cm H$_2$O. In the same age group, GI pressure was ≤15 cm H$_2$O in 50% of the cases. In children ≥5 years old, GI pressure was ≥20 cm H$_2$O in 90% of the cases, while for children 1 to 5 years old, GI pressure was ≥20 cm H$_2$O in 72% of the cases. Univariate regression showed age and weight to be independent risk factors for GI at a pressure of 15 cm H$_2$O. Tidal volume increased with inspiratory pressure between 10 and 15 cm H$_2$O, after which increasing the inspiratory pressure did not result in significantly higher tidal volumes.

**Conclusions:** The pressure at which GI occurs is age-dependent and increases with age. For most cases, an inspiratory pressure ≤15 cm H$_2$O is sufficient to provide adequate mask ventilation.

**Reviewer's Comments:** The only limitation of the study is that it included only normal children. Conclusions may not be valid for obese children, children with gastroesophageal reflux disease, and children with facial and lung abnormalities. (Reviewer-K. George Bojanov, MD).

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Keywords: Facemask, Pressure-Controlled Ventilation, Children

Print Tag: Refer to original journal article
Children Receiving Nitric Oxide of >50% Remain Minimally Sedated

**Level of Sedation With Nitrous Oxide for Pediatric Medical Procedures.**

Zier JL, Tarrago R, Liu M:

*Anesth Analg* 2010; 110 (May): 1399-1405

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Children receiving high concentrations of nitrous oxide via nasal mask frequently remain in a minimally sedated state.

**Objective:** To test the hypothesis that children receiving >50% nitrous oxide would reach an equal level of sedation as those receiving ≤50%.

**Design/Participants:** A retrospective chart review was completed of 2045 children aged ≤18 years, who received nitrous oxide for procedural sedation for the time period September 2006 to January 2008.

**Methods:** Nitrous oxide was administered by registered nurses, trained in nitrous oxide administration, throughout various departments of the Children's Hospital and Clinics of Minnesota hospital system. Administration was achieved with a continuous flow device and a standard dental nasal hood, allowing for titration of nitrous oxide from 0% to 70%, with oxygen as the remaining gas. The level of sedation was assessed on a 0 to 6 sedation scale. Patient age, procedure, time of nitrous oxide administration, maximal nitrous oxide concentration, lowest sedation score at any time during sedation, and adverse events were recorded and analyzed.

**Results:** Of the total 2045 nitrous oxide administrations recorded during the study period, 1858 sedations performed in 1585 patients were available for analysis. Median patient age was 5.2 years, and median duration of administration of nitrous oxide was 6 minutes. Most administrations used a maximal nitrous oxide concentration of >50%. Most patients reached a sedation level of 5 and 6, with 4.3% reaching a sedation level of 4. There was no difference in the number of patients reaching a sedation level of 4 between those receiving ≤50% and those receiving >50% nitrous oxide. Younger children (<2 years old) achieved a sedation level of 4. Of the available adverse events data (including 1763 sedations), 59 patients experienced adverse events. The incidence of adverse events was not significantly different between patients receiving ≤50% and those receiving >50% nitrous oxide and between patients <2 years of age and those ≥2 years of age.

**Conclusions:** A significant number of children receiving nitrous oxide of >50% via nasal hood remain minimally sedated. Adverse events were similar for the patients receiving >50% and those receiving ≤50% nitrous oxide.

**Reviewer's Comments:** I would like to point to one detail of the study; nitrous oxide was delivered via nasal mask designed for dental office settings, and the concentration delivered is actually the concentration dialed but not the measured end-tidal nitrous oxide concentration. Therefore, conclusions should not be interpolated for full face mask nitric oxide sedation. (Reviewer-K. George Bojanov, MD).

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Keywords: Nitrous Oxide, Sedation, Pediatric Medical Procedures

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